

NED UNIVERSITY OF ENGINEERING & TECHNOLOGY PROCUREMENT CELL

Phone # 99261261-68, (Ext. 2471 & 2501) Fax # 99261255, e-mail: dp@neduet.edu.pk

“SAY NO TO CORRUPTION”



Director Procurement

Notice Inviting Tender

Ref: PC/NED/77266/9813

Date: 19.06.2025

NEDUET invites sealed bids on Single Stage One Envelope procedure from Reputable and Well Experienced Firms / Companies to carry out following works:

Companies to carry out following works:								
S#	Tender / Number	Tender Schedule – Date and Time				Estimated Cost (Rs. In Million)	Tender Fee Rs.	Time of Completion
		Issue / Sale		Submission	Opening			
		From	To					
1	Construction of Hilton Pharma Nano Technology Centre (Remaining Works) at NEDUET. Tender No. PC/NED/DWS/6945-B/2025	24.06.2025	09.07.2025	10.07.2025 10:30 AM	10.07.2025 11:00 AM	87.975	7000	10 Months

Eligibility Criteria

- Valid Professional Tax Certificate of Govt. of Sindh
- Income Tax returns filed for the last 03 years with Documentary Proof.
- Audit report / bank Statement of the firm for last 03 years showing the yearly above Rs 88 million.
- Details of Equipment's Machineries and transport owned by firm / contractor with documented proofs.
- Valid Registration with Pakistan Engineering Council in relevant Category; C-4 & above and have specialized codes CE-10, EE-11 or EE-11(vi).
- Affidavit on Original Stamp Paper affirming that the firm has never been black listed, not involved in any Litigation with any Government, Semi-Government & Autonomous Body.
- List of Similar Projects executed in last 05 years & atleast 02 projects with Cost of work over Rs 40 million showing Documentary proof (Work Orders and Work Completion Certificate).
- Valid Registration with tax authorities (Federal Board of Revenue, Sindh Revenue Board) with proof of company in Active Tax Payer list, Professional Tax paid & copy of CNIC along with company registration proof.
- Valid Registered License from Electrical Inspector for Electrical Works. However, those who have applied for registration or renewal will also be eligible but it should be submitted within 14 days after opening of the bid. In case of non-compliance, bid shall be rejected.

Terms & Conditions

- Under these conditions bid shall be Rejected:
 - Black listed firms.
 - Unsigned & Stamp Bid.
 - Conditional and telegraphic bids/tender.
 - Bids received after specified date and time.
 - Bids not accompanied by bid security of required amount and form, as mentioned in Tender Documents.
- Bid Validity Period: - (90) days from the date of opening of tender.
- Bid Security: 2% of bid cost in the form of Deposit at Call or Pay Order or Demand Draft or a Bank Guarantee issued by a scheduled bank in favor of Director Finance NEDUET, Karachi.

Tender Fee in shape of Payorder / bank draft should be in favor of Director Finance NEDUET. Procuring Agency reserves the right to reject all or any bids subject to the relevant provisions of Sindh Public Procurement Rules 2010 (Amended upto date). Bidding documents can be obtained and shall be submitted in the office of DDP as per above schedule. Bidders are requested to give their Best and Final Price as “No negotiations” is permitted. Bidding Documents containing detailed terms and conditions are available at Websites <https://www.neduet.edu.pk> and <https://www.portalsind.eprocure.gov.pk>. In case of public holiday or any holiday or non-working day due to Force Majeure, the next official working day shall be deemed to be date for issuance, submission and opening of tenders. NEDUET shall not be responsible for any cost or expenses incurred by bidders.

Director Procurement

19/6/2025



TENDER DOCUMENTS FOR

**CONSTRUCTION OF HILTON PHARMA NANO
TECHNOLOGY CENTRE
(REMAINING WORKS)**

NED University of Engineering & Technology, Karachi.

VOLUME – I

LEGAL PART

**NED University of Engineering and Technology,
University Road,
Karachi-75270.**

TABLE OF CONTENTS

<u>Sr. No.</u>	<u>Subject</u>	<u>Page No</u>
(I)	INVITATION FOR BIDS	01
(II)	INSTRUCTIONS TO BIDDERS & BIDDING DATA	03
(III)	FORM OF BID & SCHEDULES TO BID	17
(IV)	CONDITIONS OF CONTRACT & CONTRACT DATA	27
(V)	STANDARD FORMS	44
(VI)	SPECIFICATIONS	53
(VII)	DRAWINGS	54

**INVITATION
FOR
BIDS**



NED UNIVERSITY OF ENGINEERING & TECHNOLOGY

PROCUREMENT CELL

Phone # 99261261-68, (Ext. 2471 & 2501) Fax # 99261255, e-mail: dp@neduet.edu.pk

“SAY NO TO CORRUPTION”



Director Procurement

Notice Inviting Tender

Ref: PC/NED/77266/

Date: 19.06.2025

NEDUET invites sealed bids on Single Stage One Envelope procedure from Reputable and Well Experienced Firms / Companies to carry out following works:

S#	Tender / Number	Tender Schedule – Date and Time				Estimated Cost (Rs. In Million)	Tender Fee Rs.	Time of Completion
		Issue / Sale		Submission	Opening			
		From	To					
1	Construction of Hilton Pharma Nano Technology Centre (Remaining Works) at NEDUET. Tender No. PC/NED/DWS/6945-B/2025	24.06.2025	09.07.2025	10.07.2025 10:30 AM	10.07.2025 11:00 AM	87.975	7000	10 Months

Eligibility Criteria

- Valid Professional Tax Certificate of Govt. of Sindh
- Income Tax returns filed for the last 03 years with Documentary Proof.
- Audit report / bank Statement of the firm for last 03 years showing the yearly above Rs 88 million.
- Details of Equipment's Machineries and transport owned by firm / contractor with documented proofs.
- Valid Registration with Pakistan Engineering Council in relevant Category; C-4 & above and have specialized codes CE-10, EE-11 or EE-11(vi).
- Affidavit on Original Stamp Paper affirming that the firm has never been black listed, not involved in any Litigation with any Government, Semi-Government & Autonomous Body.
- List of Similar Projects executed in last 05 years & atleast 02 projects with Cost of work over Rs 40 million showing Documentary proof (Work Orders and Work Completion Certificate).
- Valid Registration with tax authorities (Federal Board of Revenue, Sindh Revenue Board) with proof of company in Active Tax Payer list, Professional Tax paid & copy of CNIC along with company registration proof.
- Valid Registered License from Electrical Inspector for Electrical Works. However, those who have applied for registration or renewal will also be eligible but it should be submitted within 14 days after opening of the bid. In case of non-compliance, bid shall be rejected.

Terms & Conditions

- Under these conditions bid shall be Rejected:
 - Black listed firms.
 - Unsigned & Stamp Bid.
 - Conditional and telegraphic bids/tender.
 - Bids received after specified date and time.
 - Bids not accompanied by bid security of required amount and form, as mentioned in Tender Documents.
- Bid Validity Period: - (90) days from the date of opening of tender.
- Bid Security: 2% of bid cost in the form of Deposit at Call or Pay Order or Demand Draft or a Bank Guarantee issued by a scheduled bank in favor of Director Finance NEDUET, Karachi.

Tender Fee in shape of Payorder / bank draft should be in favor of Director Finance NEDUET. Procuring Agency reserves the right to reject all or any bids subject to the relevant provisions of Sindh Public Procurement Rules 2010 (Amended upto date). Bidding documents can be obtained and shall be submitted in the office of DDP as per above schedule. Bidders are requested to give their Best and Final Price as “No negotiations” is permitted. Bidding Documents containing detailed terms and conditions are available at Websites <https://www.neduet.edu.pk> and <https://www.portalsindh.eprocure.gov.pk>. In case of public holiday or any holiday or non-working day due to Force Majeure, the next official working day shall be deemed to be date for issuance, submission and opening of tenders. NEDUET shall not be responsible for any cost or expenses incurred by bidders.

Director Procurement

**INSTRUCTIONS
TO BIDDERS
&
BIDDING DATA**

INSTRUCTIONS TO BIDDERS

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

A. GENERAL

IB.1 Scope of Bid & Source of Funds

1.1 Scope of Bid

The Employer as defined in the Bidding Data (hereinafter called “the Employer”) wishes to receive Bids for the Works summarized in the Bidding Data (hereinafter referred to as “the Works i.e. **Construction of Hilton Pharma Nano Technology Centre (Remaining Works)**).

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

1.2 Source of Funds

The Employer has arranged funds from its own sources.

IB.2 Eligible Bidders

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

- a) duly licensed by the Pakistan Engineering Council (PEC) in the appropriate category for value of Works.
- b) duly pre-qualified/enlisted with the Employer.

IB.3 Cost of Bidding

3.1 The bidder shall bear all costs associated with the preparation and submission of its bid and the Employer will in no case be responsible or liable for those costs, regardless of the conduct or outcome of the bidding process.

B. BIDDING DOCUMENTS

IB.4 Contents of Bidding Documents

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

1. Instructions to Bidders & Bidding Data
2. Form of Bid & Schedules to Bid comprise the following:
 - (i) Schedule A: Schedule of Prices
 - (ii) Schedule B: Specific Works Data
 - (iii) Schedule C: Works to be Performed by Subcontractors
 - (iv) Schedule D: Proposed Programme of Works
 - (v) Schedule E: Method of Performing Works
3. Conditions of Contract & Contract Data
4. Standard Forms:
 - (i) Form of Bid Security
 - (ii) Form of Performance Security
 - (iii) Form of Contract Agreement
 - (iv) Form of Bank Guarantee for Advance Payment
5. Specifications
6. Drawings, if any

IB.5 Clarification of Bidding Documents

- 5.1 A prospective bidder requiring any clarification(s) in respect of the Bidding Documents may notify the Engineer/Employer at the Employer's/Engineer's address indicated in the Bidding Data.
- 5.2 The Engineer/Employer will respond to any request for clarification which it receives earlier than ten (10) days prior to the deadline for the submission of Bids. Copies of the Engineer/Employer's response will be forwarded to all prospective bidders, at least five (5) days prior to dead line for submission of Bids, who have received the Bidding Documents including a description of the enquiry but without identifying its source.

IB.6 Amendment of Bidding Documents

- 6.1 At any time prior to the deadline for submission of Bids, the Employer may, for any reason, whether at his own initiative or in response to a clarification requested by a prospective bidder, modify the Bidding Documents by issuing addendum.
- 6.2 Any addendum thus issued shall be part of the Bidding Documents pursuant to Sub- Clause 6.1 hereof, and shall be communicated in writing to all purchasers of the Bidding Documents. Prospective bidders shall acknowledge receipt of each addendum in writing to the Employer.

- 63 To afford prospective bidders reasonable time in which to take an addendum into account in preparing their Bids, the Employer may at its discretion extend the deadline for submission of Bids.

C. PREPARATION OF BIDS

IB.7 Language of Bid

- 7.1 The bid prepared by the bidder and all correspondence and documents relating to the Bid, exchanged by the bidder and the Employer shall be written in the English language, provided that any printed literature furnished by the bidder may be written in another language so long as accompanied by an English translation of its pertinent passages in which case, for purposes of interpretation of the Bid, the English translation shall govern.

IB.8 Documents Comprising the Bid

- 8.1 The bid prepared by the bidder shall comprise the following components:
- (a) Covering Letter
 - (b) Form of Bid duly filled, signed and sealed, in accordance with Sub-Clause IB.14.3.
 - (c) Schedules (A to F) to Bid duly filled and initialed, in accordance with the instructions contained therein & in accordance with Sub-Clause IB.14.3.
 - (d) Bid Security furnished in accordance with Clause IB.13.
 - (e) Power of Attorney in accordance with Sub-Clause IB.14.5.
 - (f) Documentary evidence in accordance with Clause IB.11
 - (g) Documentary evidence in accordance with Clause IB.12.

IB.9 Sufficiency of Bid

- 9.1 Each bidder shall satisfy himself before Bidding as to the correctness and sufficiency of his Bid and of the rates and prices entered in the Schedule of Prices, which rates and prices shall except in so far as it is otherwise expressly provided in the Contract, cover all his obligations under the Contract and all matters and things necessary for the proper completion of the Works.
- 9.2 The bidder is advised to obtain for himself at his own cost and responsibility all information that may be necessary for preparing the bid and entering into a Contract for execution of the Works.

IB.10 Bid Prices, Currency of Bid and Payment

- 10.1 The bidder shall fill up the Schedule of Prices (Schedule A to Bid) indicating the unit rates and prices of the Works to be performed under the Contract. Prices in the Schedule of Prices shall be entered keeping in view the instructions contained in the Preamble to Schedule of Prices.
- 10.2 Unless otherwise stipulated in the Conditions of Contract, prices quoted by the bidder shall remain fixed during the bidder's performance of the Contract and not subject to variation on any account.
- 10.3 The unit rates and prices in the Schedule of Prices shall be quoted by the bidder in the currency as stipulated in Bidding Data.

IB.11 Documents Establishing Bidder's Eligibility and Qualifications

- 11.1 Pursuant to Clause IB.8, the bidder shall furnish, as part of its bid, documents establishing the bidder's eligibility to bid and its qualifications to perform the Contract if its bid is accepted.
- 11.2 Bidder/Manufacturer must possess and provide evidence of its capability and the experience as stipulated in Bidding Data and the Qualification Criteria stipulated in the Bidding Documents.

IB.12 Documents Establishing Works' Conformity to Bidding Documents

- 12.1 The documentary evidence of the Works' conformity to the Bidding Documents may be in the form of literature, drawings and data and the bidder shall furnish documentation as set out in Bidding Data.
- 12.2 The bidder shall note that standards for workmanship, material and equipment, and references to brand names or catalogue numbers, if any, designated by the Employer in the Technical Provisions are intended to be descriptive only and not restrictive.

IB.13 Bid Security

- 13.1 Each bidder shall furnish, as part of his bid, at the option of the bidder, a Bid Security in the amount stipulated in Bidding Data in Pak. Rupees in the form of Deposit at Call or a Pay Order or demand draft or Bank Guarantee issued by a Scheduled Bank in Pakistan or from a foreign bank duly countersigned and guaranteed by a scheduled bank in Pakistan in favor of Procuring Agency valid for a period up to Twenty Eight (28) days beyond the bid validity date.

- 13.2 Any bid not accompanied by an acceptable Bid Security shall be rejected by the Employer as non-responsive.
- 13.3 The bid securities of unsuccessful bidders will be returned upon award of contract to the successful bidder or on the expiry of validity of Bid Security whichever is earlier.
- 13.4 The Bid Security of the successful bidder will be returned when the bidder has furnished the required Performance Security, pursuant to Clause IB.21 and signed the Contract Agreement, pursuant to Sub-Clauses IB.20.2 & 20.3.
- 13.5 The Bid Security may be forfeited:
- (a) if a bidder withdraws his bid during the period of bid validity; or
 - (b) if a bidder does not accept the correction of his Bid Price, pursuant to Sub-Clause 16.4 (b) hereof; or
 - (c) in the case of a successful bidder, if he fails to:
 - (i) furnish the required Performance Security in accordance with Clause IB.21, or
 - (ii) sign the Contract Agreement, in accordance with Sub-Clauses IB.20.2 & 20.3.

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

- 14.1 Bids shall remain valid for the period stipulated in the Bidding Data after the date of bid opening.
- 14.2 All Schedules to Bid are to be properly completed and signed.
- 14.3 No alteration is to be made in the Form of Bid except in filling up the blanks as directed. If any alteration be made or if these instructions be not fully complied with, the bid may be rejected.
- 14.4 Each bidder shall prepare Original and number of copies specified in the Bidding Data of the documents comprising the bid as described in Clause IB.8 and clearly mark them “ORIGINAL” and “COPY” as appropriate. In the event of discrepancy between them, the original shall prevail.
- 14.5 The original and all copies of the bid shall be typed or written in indelible ink and shall be signed by a person or persons duly authorized to sign (in the case of copies, Photostats are also acceptable). This shall be indicated by submitting a written Power of Attorney authorising the signatory of the bidder to act for and on behalf of the bidder. All pages of the bid shall be initialed and official seal be affixed by the person or persons signing the bid.
- 14.6 The Bid shall be delivered in person or sent by registered mail at the address to Employer as given in Bidding Data.

D. SUBMISSION OF BID

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

- 15.1 Bids must be received by the Employer at the address/provided in Bidding Data not later than the time and date stipulated therein.
- 15.2 Bids submitted through telegraph, telex, fax or e-mail shall not be considered.
- 15.3 Any bid received by the Employer after the deadline for submission prescribed in Bidding Data will be returned unopened to such bidder.
- 15.4 Any bidder may modify or withdraw his bid after bid submission provided that the modification or written notice of withdrawal is received by the Employer prior to the deadline for submission of bids.
- 15.5 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 pursuant to Sub-Clause IB.13.5(a).

E. BID OPENING AND EVALUATION

IB.16 Bid Opening, Clarification and Evaluation

- 16.1 The Employer will open the bids, in the presence of bidders' representatives who choose to attend, at the time, date and location stipulated in the Bidding Data.
- 16.2 The bidder's name, Bid Prices, any discount, the presence or absence of Bid Security, and such other details as the Employer at its discretion may consider appropriate, will be announced by the Employer at the bid opening. The Employer will record the minutes of the bid opening. Representatives of the bidders who choose to attend shall sign the attendance sheet.

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

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

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

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

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

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

- 16.5 A Bid determined as substantially non-responsive will be rejected and will not subsequently be made responsive by the bidder by correction of the non-conformity.
- 16.6 Any minor informality or non-conformity or irregularity in a Bid which does not constitute a material deviation may be waived by Employer, provided such waiver does not prejudice or affect the relative ranking of any other bidders.
- 16.7 The Engineer/Employer will evaluate and compare only the bids previously determined to be substantially responsive pursuant to Sub-Clauses IB.16.4 to 16.6 as per requirements given hereunder. Bids will be evaluated for complete scope of works. The prices will be compared on the basis of the Evaluated Bid Price pursuant to Sub-Clause 16.8 herein below.

- (a) Technical Evaluation

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

- (b) Commercial Evaluation

It will be examined in detail whether the bids comply with the commercial/contractual conditions of the Bidding Documents. It is expected that no material deviation/stipulation shall be taken by the bidders.

16.8 Evaluated Bid Price

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

- (i) making any correction for arithmetic errors pursuant to Sub-Clause 16.4 hereof.
- (ii) making an appropriate price adjustment for any other acceptable variation or deviation.
- (iii) making an appropriate price adjustment for Deviations in terms of Payments (if any and acceptable to the Employer).
- (iv) discount, if any, offered by the bidders as also read out and recorded at the time of bid opening.

16.9 Evaluation Methods

Pursuant to Sub-Clause 16.8, Para (ii), and (iii) following evaluation methods for price adjustments will be followed:

(i) Price Adjustment for Technical Compliance

The cost of making good any deficiency resulting from technical non compliance will be added to the Corrected Total Bid Price for comparison and all further purposes. The adjustments will be applied taking the highest price quoted by other bidders being evaluated in detail in their original Bids for corresponding item. In case of non availability of price from other bidders, the price will be estimated by the Engineer/Employer.

(ii) Price Adjustment for Commercial Compliance

The cost of making good any deficiency resulting from any quantifiable variations and deviations from the Bid Schedules and Conditions of Contract, as determined by the Engineer/Employer will be added to the Corrected Total Bid Price for comparison and all further purpose. Adjustment for commercial compliance will be added to the Corrected Total Bid Prices.

(iii) Price Adjustment for Deviation in Terms of Payments

Refer to Bidding Data

IB.17 Process to be Confidential

- 17.1 Subject to Sub-Clause IB.16.3 heretofore, no bidder shall contact Engineer/Employer on any matter relating to its Bid from the time of the Bid opening to the time the bid evaluation result is announced by the Employer. The evaluation result shall be announced at least ten (10) days prior to 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.
- 17.2 Any effort by a bidder to influence Engineer/Employer in the Bid evaluation, Bid comparison or Contract Award decisions may result in the rejection of his Bid. Whereas, any bidder feeling aggrieved may lodge a written complaint not later than fifteen (15) days after the announcement of the bid evaluation result, however, mere fact of lodging a complaint shall not warrant suspension of procurement process.

F. AWARD OF CONTRACT

IB.18. Post Qualification

- 18.1 The Employer, at any stage of the bid evaluation, having credible reasons for or *prima facie* evidence of any defect 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:

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

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

IB.19 Award Criteria & Employer's Right

- 19.1 Subject to Sub-Clause IB.19.2, the Employer will 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, provided that such bidder has been determined to be qualified to satisfactory perform the Contract in accordance with the provisions of Clause IB.18.
- 19.2 Not with standing Sub-Clause IB.19.1, the Employer reserves the right to accept or reject any bid, and to annul the bidding process and reject all bids, at any time prior to award of Contract, without thereby incurring any liability to the affected bidders or any obligation to inform the affected bidders of the grounds for the Employer's action except that the grounds for its rejection of all bids shall upon request be communicated, to any bidder who submitted a bid, without justification of the grounds. Notice of the rejection of all the bids shall be given promptly to all the bidders.

IB.20 Notification of Award & Signing of Contract Agreement

- 20.1 Prior to expiration of the period of bid validity prescribed by the Employer, the Employer will notify the successful bidder in writing ("Letter of Acceptance") that his bid has been accepted.
- 20.2 Within seven (7) days from the date of furnishing of acceptable Performance Security under the Conditions of Contract, the Employer will send the successful bidder the Form of Contract Agreement provided in the Bidding Documents, incorporating all agreements between the parties.
- 20.3 The formal Agreement between the Employer and the successful bidder shall be executed within seven (7) days of the receipt of Form of Contract Agreement by the successful bidder from the Employer.

IB.21 Performance Security

- 21.1 The successful bidder shall furnish to the Employer a Performance Security in the form and the amount stipulated in the Conditions of Contract within a period of fourteen (14) days after the receipt of Letter of Acceptance.
- 21.2 Failure of the successful bidder to comply with the requirements of Sub-Clauses IB.20.2 & 20.3 or 21.1 or Clause IB.22 shall constitute sufficient grounds for the annulment of the award and forfeiture of the Bid Security.

IB.22 Integrity Pact

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

BIDDING DATA

(This section should be filled in by the Engineer/Employer before issuance of the Bidding Documents. The following specific data for the Works to be tendered shall complement, amend, or supplement the provisions in the Instructions to Bidders. Wherever there is a conflict, the provisions herein shall prevail over those in the Instructions to Bidders.)

Instructions to Bidders

Clause Reference

1.1 Name of Employer

NED University of Engineering & Technology, Karachi

Brief Description of Works

“Construction of Hilton Pharma Nano Technology Centre at NED University of Engineering & Technology, Karachi”

Scope of work is provided in the Bill of Quantities, Specifications and Drawings.

5.1 (a) Employer’s address:

Director Procurement,
NED University of Engineering & Technology,
Karachi - 75270
Tel: 021-99261261-8
Fascimile: 021-99261255
Email: dp@neduet.edu.pk

(b) Engineer’s address:

Directorate of Works & Services
NED University of Engineering & Technology,
Karachi - 75270
Tel: 021-99261261-8
Fascimile: 021-99261255
Email: ds@neduet.edu.pk

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

- 11.2 The bidder/manufacturer has the financial, technical and production capability necessary to perform the Contract as follows:

The bidder shall be duly licensed by the Pakistan Engineering Council in the Category C6 & above.

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

13.1 Amount of Bid Security

The Bid Security shall be equal to 2% of the total bid price.

14.1 Period of Bid Validity

Ninety Days (90).

14.4 Number of Copies of the Bid to be Submitted

One original plus two copies.

14.6 (a) Employer's Address for the Purpose of Bid Submission

Director Procurement Cell,
NED University of Engineering & Technology,
Karachi - 75270
Tel: 021-99261261-8
Fascimile: 021-99261255
Email: dp@neduet.edu.pk

15.1 Deadline for Submission of Bids

11:00 AM on _____ (date to be specified by client)

16.1 Venue, Time, and Date of Bid Opening

Venue: Director Procurement Cell,
NED University of Engineering & Technology,
Karachi - 75270

Time: 11:00 AM

Date: (To be specified by client)

16.2 Responsiveness of Bids

- (i) the Bid is valid till required period i.e. 90 days,
- (ii) the Bid prices are firm during currency of contract (if it is a fixed price bid)
- (iii) completion period offered is within specified limits i.e. **10 months**,
- (iv) the Bidder/Manufacturer is eligible to Bid and possesses the requisite experience, capability and qualification.
- (v) the Bid does not deviate from basic technical requirements and
- (vi) the Bids are generally in order, etc.

FORM OF BID AND SCHEDULES TO BID

FORM OF BID
(LETTER OF OFFER)

Bid Reference No. _____

(Name of Works)

To:

Gentlemen,

1. Having examined the Bidding Documents including Instructions to Bidders, Bidding Data, Conditions of Contract, Contract Data, Specifications, Drawings, if any, Schedule of Prices and Addenda Nos.
_____ for the execution of the above-named Works, we, the undersigned, being a company doing business under the name of and address _____
_____ and being duly incorporated under the laws of Pakistan hereby offer to execute and complete such Works and remedy any defects therein in conformity with the said Documents including Addenda thereto for the Total Bid Price of Rs (Rupees____) or such other sum as may be ascertained in accordance with the said Documents.
2. We understand that all the Schedules attached hereto form part of this Bid.
3. As security for due performance of the undertakings and obligations of this Bid, we submit herewith a Bid Security in the amount of _____
_____ drawn in your favour or made payable to you and valid for a period of twenty eight (28) days beyond the period of validity of Bid.
4. We undertake, if our Bid is accepted, to commence the Works and to deliver and complete the Works comprised in the Contract within the time(s) stated in Contract Data.
5. We agree to abide by this Bid for the period of _____ days from the date fixed for receiving the same and it shall remain binding upon us and may be accepted at any time before the expiration of that period.
6. Unless and until a formal Agreement is prepared and executed, this Bid, together with your written acceptance thereof, shall constitute a binding contract between us.
7. We undertake, if our Bid is accepted, to execute the Performance Security referred to in Conditions of Contract for the due performance of the Contract.
8. We understand that you are not bound to accept the lowest or any bid you may receive.

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

Dated this _____ day of _____, 2025

Signature _____

in the capacity of _____ duly authorized to sign bid for and on behalf of

(Name of Bidder in Block Capitals)

(Seal)

Address

Witness:

(Signature) _____

Name: _____

Address: _____

PREAMBLE TO SCHEDULE OF PRICES

1. General

- 1.1** The Schedule of Prices shall be read in conjunction with the Conditions of Contract, Contract Data together with the Specifications and Drawings, if any.
- 1.2** The Contract shall be for the whole of the Works as described in these Bidding Documents. Bids must be for the complete scope of works.

2. Description

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

3. Units & Abbreviations

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

4. Rates and Prices

- 4.1** Except as otherwise expressly provided under the Conditions of Contract, the rates and amounts entered in the Schedule of Prices shall be the rates at which the Contractor shall be paid and shall be the full inclusive value of the works set forth or implied in the Contract; except for the amounts reimbursable, if any to the Contractor under the Contract.
- 4.2** Unless otherwise stipulated in the Contract Data, the rates and prices entered by the bidder shall not be subject to adjustment during the performance of the Contract.
- 4.3** All duties, taxes and other levies payable by the Contractor shall be included in the rates and prices.
- 4.4** The whole cost of complying with the provisions of the Contract shall be included in the items provided in the Schedule of Prices, and where no items are provided, the cost shall be deemed to be distributed among the rates and prices entered for the related items of the Works and no separate payment will be made for those items.

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

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

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

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

5. Bid Prices

5.1 Break-up of Bid Prices

The various elements of Bid Prices shall be quoted as detailed by the Employer in the format of Schedule of Prices.

The bidder shall recognize such elements of the costs which he expects to incur the performance of the Works and shall include all such costs in the rates and amounts entered in the Schedule of Prices.

5.2 Total Bid Price

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

6. Provisional Sums

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

SCHEDULE OF PRICES / BILL OF QUANTITIES
(ATTACHED AS VOLUME III)

SCHEDULE - B TO BID

***SPECIFIC WORKS DATA**

The scope of work is defined in the Bill of Quantities, drawings and specification attached as Volume-II, Volume III and Volume-IV.

SCHEDULE – C TO BID

WORKS TO BE PERFORMED BY SUBCONTRACTORS

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

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

Note:

1. No change of Sub-Contractors shall be made by the bidder without prior approval of the Employer.
2. The truthfulness and accuracy of the statement as to the experience of Sub-Contractors is guaranteed by the bidder. The Employer's judgment shall be final as to the evaluation of the experience of Sub-Contractors submitted by the bidder.
3. Statement of similar works shall include description, location & value of works, year completed and name & address of the clients.

SCHEDULE – D TO BID

PROPOSED PROGRAMME OF WORKS

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

SCHEDULE – E TO BID

METHOD OF PERFORMING WORKS

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

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

CONDITIONS OF CONTRACT

CONDITIONS OF CONTRACT

1. GENERAL PROVISIONS

1.1 Definitions

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

The Contract

- 1.1.1 “Contract” means the Contract Agreement and the other documents listed in the Contract Data.
- 1.1.2 “Specifications” means the document as listed in the Contract Data, including Employer’s requirements in respect of design to be carried out by the Contractor (if any), and any Variation to such document.
- 1.1.3 “Drawings” means the Employer’s drawings of the Works as listed in the Contract Data, and any Variation to such drawings.

Persons

- 1.1.4 “Employer” means the person named in the Contract Data and the legal successors in title to this person, but not (except with the consent of the Contractor) any assignee.
- 1.1.5 “Contractor” means the person named in the Contract Data and the legal successors in title to this person, but not (except with the consent of the Employer) any assignee.
- 1.1.6 “Party” means either the Employer or the Contractor.

Dates, Times and Periods

- 1.1.7 “Commencement Date” means the date fourteen (14) days after the date the Contract comes into effect or any other date named in the Contract Data.
- 1.1.8 “Day” means a calendar day
- 1.1.9 “Time for Completion” means the time for completing the Works as stated in the Contract Data (or as extended under Sub-Clause 7.3), calculated from the Commencement Date.

Money and Payments

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

Other Definitions

- 1.1.11 “Contractor’s Equipment” means all machinery, apparatus and other things required for the execution of the Works but does not include Materials or Plant intended to form part of the Works.
- 1.1.12 “Country” means the Islamic Republic of Pakistan.
- 1.1.13 “Employer’s Risks” means those matters listed in Sub-Clause 6.1.
- 1.1.14 “Force Majeure” means an event or circumstance which makes performance of a Party’s obligations illegal or impracticable and which is beyond that Party’s reasonable control.
- 1.1.15 “Materials” means things of all kinds (other than Plant) to be supplied and incorporated in the Works by the Contractor.
- 1.1.16 “Plant” means the machinery and apparatus intended to form or forming part of the Works.
- 1.1.17 “Site” means the places provided by the Employer where the Works are to be executed, and any other places specified in the Contract as forming part of the Site.
- 1.1.18 “Variation” means a change which is instructed by the Engineer/Employer under Sub-Clause 10.1.
- 1.1.19 “Works” means any or all the works whether Supply, Installation, Construction etc. and design (if any) to be performed by the Contractor including temporary works and any variation thereof.
- 1.1.20 “Engineer” means the person notified by the Employer to act as Engineer for the purpose of the Contract and named as such in Contract Data.

1.2 Interpretation

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

1.3 Priority of Documents

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

1.4 Law

The law of the Contract is the relevant Law of Islamic Republic of Pakistan.

1.5 Communications

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

1.6 Statutory Obligations

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

2. THE EMPLOYER

2.1 Provision of Site

The Employer shall provide the Site and right of access thereto at the times stated in the Contract Data.

2.2 Permits etc.

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

2.3 Engineer's/Employer's Instructions

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

2.4 Approvals

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

3. ENGINEER'S/EMPLOYER'S REPRESENTATIVES

3.1 Authorised Person

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

3.2 Engineer's/Employer's Representative

The name and address of Engineer's/Employer's Representative is given in

Contract Data. However the Contractor shall be notified by the Engineer/Employer, the delegated duties and authority before the Commencement of Works.

4. THE CONTRACTOR

4.1 General Obligations

The Contractor shall carry out the Works properly and in accordance with the Contract. The Contractor shall provide all supervision, labour, Materials, Plant and Contractor's Equipment which may be required.

4.2 Contractor's Representative

The Contractor shall appoint a representative at site on full time basis to supervise the execution of work and to receive instructions on behalf of the Contractor but only after obtaining the consent of the Employer for such appointment which consent shall not be unreasonable withheld by the Employer. Such authorized representative may be substituted/replaced by the Contractor at any time during the Contract Period but only after obtaining the consent of the Employer as aforesaid.

4.3 Subcontracting

The Contractor shall not subcontract the whole of the Works. The Contractor shall not subcontract any part of the Works without the consent of the Employer.

4.4 Performance Security

The Contractor shall furnish to the Employer within fourteen (14) days after receipt of Letter of Acceptance a Performance Security of 05% of Contract Price at the option of the bidder, in the form of Deposit at Call or PayOrder or Demand Draft or Bank Guarantee for the amount and validity specified in Contract Data clause 4.4.

5. DESIGN BY CONTRACTOR

5.1 Contractor's Design

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

5.2 Responsibility for Design

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

6. EMPLOYER'S RISKS

6.1 The Employer's Risks

The Employer's Risks are:-

- a) war, hostilities (whether war be declared or not), invasion, act of foreign enemies, within the Country;
- b) rebellion, terrorism, revolution, insurrection, military or usurped power, or civil war, within the Country;
- c) riot, commotion or disorder by persons other than the Contractor's personnel and other employees including the personnel and employees of Sub-Contractors, affecting the Site and/or the Works;
- d) ionising radiations, or contamination by radio-activity from any nuclear fuel, or from any nuclear waste from the combustion of nuclear fuel, radio-active toxic explosive, or other hazardous properties of any explosive nuclear assembly or nuclear component of such an assembly, except to the extent to which the Contractor/Sub-Contractors may be responsible for the use of any radio-active material;
- e) Pressure waves caused by aircraft or other aerial devices travelling at sonic or supersonic speeds;
- f) use or occupation by the Employer of any part of the Works, except as may be specified in the Contract;
- g) late handing over of sites, anomalies in drawings, late delivery of designs and drawings of any part of the Works by the Employer's personnel or by others for whom the Employer is responsible;
- h) a suspension under Sub-Clause 2.3 unless it is attributable to the Contractor's failure; and
- i) physical obstructions or physical conditions other than climatic conditions, encountered on the Site during the performance of the Works, for which the Contractor immediately notified to the Employer and accepted by the Employer.

7. TIME FOR COMPLETION

7.1 Execution of the Works

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

7.2 Programme

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

7.3 Extension of Time

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

the Employer shall extend the Time for Completion as determined.

7.4 Late Completion

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

8. TAKING-OVER

8.1 Completion

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

8.2 Taking-Over Notice

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

9. REMEDYING DEFECTS

9.1 Remediating Defects

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

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

9.2 Uncovering and Testing

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

10. VARIATIONS AND CLAIMS

10.1 Right to Vary

The Employer/Engineer may issue Variation Order(s) in writing. Where for any reason it has not been possible for the Employer/Engineer to issue such Variations Order(s), the Contractor may confirm any verbal orders given by the Employer/Engineer in writing and if the same are not refuted/denied by the Employer/Engineer within seven (7) days of the receipt of such confirmation the same shall be deemed to be a Variation Orders for the purposes of this Sub- Clause.

10.2 Valuation of Variations

Variations shall be valued as follows:

- a) at a lump sum price agreed between the Parties, or
- b) where appropriate, at rates in the Contract, or
- c) in the absence of appropriate rates, the rates in the Contract shall be used as the basis for valuation, or failing which
- d) at appropriate new rates, as may be agreed or which the Engineer/Employer considers appropriate, or

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

10.3 Early Warning

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

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

10.4. Valuation of Claims

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

10.5 Variation and Claim Procedure

The Contractor shall submit to the Engineer/Employer an itemised make-up of the value of variations and claims within twenty eight (28) days of the instruction or of the event giving rise to the claim. The Engineer/Employer shall check and if possible agree the value. In the absence of agreement, the Employer shall determine the value.

11. CONTRACT PRICE AND PAYMENT

11.1 (a) Terms of Payments

The amount due to the Contractor under any Interim Payment Certificate issued by the Engineer pursuant to this Clause, or to any other terms of the Contract, shall be paid by the Employer to the Contractor within 30 days after such Interim Payment Certificate has been jointly verified by Employer and Contractor, or, in the case of the Final Certificate referred within 60 days after such Final Payment Certificate has been jointly verified by Employer and Contractor; Provided that the Interim Payment shall be caused in 42 days and Final Payment in 60 days. In the event of the failure of the Employer to make payment within the times stated, the Employer shall pay to the Contractor compensation at the 28 days rate of KIBOR+2% per annum in local currency upon all sums unpaid from the date by which the same should have been paid.

(b) **Valuation of the Works**

The Works shall be valued as provided for in the Contract Data, subject to Clause 10.

11.2 Monthly Statements

The Contractor shall be entitled to be paid at monthly intervals:

- a) the value of the Works executed; and
- b) The percentage of the value of Materials and Plant reasonably delivered to the Site, as stated in the Contract Data, subject to any additions or deductions which may be due.

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

11.3 Interim Payments

Within a period not exceeding seven (7) days from the date of submission of a statement for interim payment by the Contractor, the Engineer shall verify the same and within a period not exceeding thirty (30) days from the said date of submission by the Contractor, the Employer shall pay to the Contractor the sum verified by the Engineer less retention money at the rate stated in the Contract Data.

11.4 Retention

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

11.5 Final Payment

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

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

11.6 Currency

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

12. DEFAULT

12.1 Default by Contractor

If the Contractor abandons the Works, refuses or fails to comply with a valid instruction of the Engineer/Employer or fails to proceed expeditiously and without delay, or is, despite a written complaint, in breach of the Contract, the Employer may give notice referring to this Sub-Clause and stating the default.

If the Contractor has not taken all practicable steps to remedy the default within fourteen (14) days after receipt of the Employer's notice, the Employer may by a second notice given within a further twenty one (21) days, terminate the Contract. The Contractor shall then demobilise from the Site leaving behind any Contractor's Equipment which the Employer instructs, in the second notice, to be used for the completion of the Works at the risk and cost of the Contractor.

12.2 Default by Employer

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

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

12.3 Insolvency

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

12.4 Payment upon Termination

After termination, the Contractor shall be entitled to payment of the unpaid balance of the value of the Works executed and of the Materials and Plant

reasonably delivered to the Site, adjusted by the following:

- a) any sums to which the Contractor is entitled under Sub-Clause 10.4,
- b) any sums to which the Employer is entitled,
- c) if the Employer has terminated under Sub-Clause 12.1 or 12.3, the Employer shall be entitled to a sum equivalent to twenty percent (20%) of the value of parts of the Works not executed at the date of the termination, and

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

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

13. RISKS AND RESPONSIBILITIES

13.1 Contractor's Care of the Works

Subject to Sub-Clause 9.1, the Contractor shall take full responsibility for the care of the Works from the Commencement Date until the date of the Employer's/Engineer's issuance of Certificate of Completion under Sub-Clause 8.2. Responsibility shall then pass to the Employer. If any loss or damage happens to the Works during the above period, the Contractor shall rectify such loss or damage so that the Works conform with the Contract.

Unless the loss or damage happens as a result of any of the Employer's Risks, the Contractor shall indemnify the Employer, or his agents against all claims loss, damage and expense arising out of the Works.

13.2 Force Majeure

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

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

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

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

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

14. INSURANCE

14.1 Arrangements

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

14.2 Default

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

15. RESOLUTION OF DISPUTES

15.1 Engineer's Decision

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

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

15.2 Notice of Dissatisfaction

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

15.3 Arbitration

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

16 INTEGRITY PACT

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

- (a) recover from the Contractor an amount equivalent to ten times the sum of any commission, gratification, bribe, finder's fee or kickback given by the Contractor or any of his Sub-Contractors, agents or servants;
- (b) terminate the Contract; and
- (c) recover from the Contractor any loss or damage to the Employer as a result of such termination or of any other corrupt business practices of the Contractor or any of his Sub-Contractors, agents or servants.

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

CONTRACT DATA

(Note: Except where otherwise indicated, all Contract Data should be filled in by the Employer prior to issuance of the Bidding Documents.)

Sub-Clauses of Conditions of Contract

1.1.3 Employer's Drawings, if any
(The specifications and design are attached as Volume II & III.)

1.1.4 **The Employer** means

Director Procurement Cell,
NED University of Engineering & Technology,
Karachi - 75270
Tel: 021-99261261-8
Fascimile: 021-99261255
Email: dp@neduet.edu.pk

1.1.5 **The Contractor** means

1.1.7 **Commencement Date** means the date of issue of Engineer's Notice to Commence which shall be issued within fourteen (14) days of the signing of the Contract Agreement.

1.1.9 **Time for Completion** is 10 Months.

1.1.20 **Engineer**

Project Consultants
NED University of Engineering & Technology, Karachi

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

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

(The Employer may add, in order of priority, such other documents as form part of the Contract. Delete the document, if not applicable)

2.1 Provision of Site: On the Commencement Date

3.1 Authorized person :

Engr. Azhar Iqbal
Director Works & Services,
NED University of Engineering & Technology, Karachi

3.2 Name and address of Engineer's/Employer's representative

Project Consultants
NED University of Engineering & Technology,
Karachi.

4.4 Performance Security:

Amount equals to 05% of Contract Price stated in the Letter of Acceptance.

7.2 Programme:

Time for submission: Within fourteen (14) days of the Commencement Date.

Form of programme: The programme to be prepared and submitted using PERT.

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

9.1 Period for remedying defects

365 days from the effective date of Taking Over Certificate.

11.1 (a) Terms of Payments

Payment of Contract Price shall be made in the following manners:

- i) Ten percent (10%) of Contract Price shall be paid as advance payment within 30 days after the receipt of acceptable Performance Security and Bank Guarantee for advance payment,
- ii) Seventy five (75%) shall be paid in accordance with Clause 11.2 & 11.3 of Conditions of Contract,
 - i) Ten percent (10%) shall be paid on the date of issuance of Certificate of Completion as per Clause 8.2 of Conditions of Contract, and
- iv) Five percent (5%) shall be paid in accordance with Clause 11.4 of Conditions of Contract.

11.2 (b) Percentage of value of Materials and Plant:

Materials	eighty (80%)
Plant	ninety (90%)

11.3 Percentage of retention: five (5%) [From each interim payment]

11.6 Currency of payment: Pak. Rupees

14.1 Insurances:

Type of cover

Third Party-injury to persons and damage to property

Rs. One Million per occurrence with number of occurrences unlimited.

15.3 Arbitration

Place of Arbitration: Karachi, Pakistan.

STANDARD FORMS

FORM OF BID SECURITY
(Bank Guarantee)

Guarantee No. _____
Executed on _____

(Letter by the Guarantor to the Employer)

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

Name of Principal (Bidder) with
address: _____

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

Bid Reference No. _____ Date of Bid _____

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

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

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

- (1) that the Bid Security shall remain valid for a period of twenty eight (28) days beyond the period of validity of the bid;
- (2) that in the event of;
 - (a) the Principal withdraws his Bid during the period of validity of Bid, or
 - (b) the Principal does not accept the correction of his Bid Price, pursuant to Sub-Clause 16.4 (b) of Instructions to Bidders, or
 - (c) failure of the successful bidder to
 - (i) furnish the required Performance Security, in accordance with Sub-Clause IB-21.1 of Instructions to Bidders, or
 - (ii) sign the proposed Contract Agreement, in accordance with Sub-Clauses IB-20.2 & 20.3 of Instructions to Bidders,

the entire sum be paid immediately to the said Employer for delayed completion and

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

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

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

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

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

Guarantor (Bank)

Witness:

1. Signature _____

1. _____

2. Name _____

Corporate Secretary (Seal)

3. Title _____

2. _____

(Name, Title & Address)

Corporate Guarantor (Seal)

FORM OF PERFORMANCE SECURITY
(Bank Guarantee)

Guarantee No. _____
Executed on _____

(Letter by the Guarantor to the Employer)

Name of Guarantor (Scheduled Bank in Pakistan) with

address: _____

Name of Principal (Contractor) with

address: _____

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

Letter of Acceptance No. _____ Dated _____

KNOW ALL MEN BY THESE PRESENTS, that in pursuance of the terms of the Bidding Documents and above said Letter of Acceptance (hereinafter called the Documents) and at the request of the said Principal we, the Guarantor above named, are held and firmly bound unto the _____ (hereinafter called the Employer) in the penal sum of the amount stated above, for the payment of which sum well and truly to be made to the said Employer, 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 Employer'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 Employer, with or without notice to the Guarantor, which notice is, hereby, waived and shall also well and truly perform and fulfill all the undertakings, covenants terms and conditions of the Contract and of any and all modifications of the said Documents that may hereafter be made, notice of which modifications to the Guarantor being hereby waived, then, this obligation to be void; otherwise to remain in full force and virtue till all requirements of Clause 9, Remedying Defects, of Conditions of Contract are fulfilled.

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

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

PROVIDED ALSO THAT the Employer 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 Employer forthwith and without any reference to the Principal or any other person.

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

Witness:

1. _____

Corporate Secretary (Seal)

2. _____

(Name, Title & Address)

Guarantor (Bank)

1. Signature _____

2. Name _____

3. Title _____

Corporate Guarantor (Seal)

FORM OF CONTRACT AGREEMENT

THIS CONTRACT AGREEMENT (hereinafter called the "Agreement") made on the day of _____ 2021 between _____ (hereinafter called the "Employer") of the one part and _____ (hereinafter called the "Contractor") of the other part.

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

NOW this Agreement witnesseth as follows:

1. In this Agreement words and expressions shall have the same meanings as are respectively assigned to them in the Conditions of Contract hereinafter referred to.
2. The following documents after incorporating addenda, if any except those parts relating to Instructions to Bidders, shall be deemed to form and be read and construed as part of this Agreement, viz:
 - (a) The Letter of Acceptance;
 - (b) The completed Form of Bid alongwith Schedules A-F to Bid;
 - (c) Conditions of Contract & Contract Data;
 - (d) The priced Schedule of Prices;
 - (e) The Specifications; and
 - (f) The Drawings
3. In consideration of the payments to be made by the Employer to the Contractor as hereinafter mentioned, the Contractor hereby covenants with the Employer to execute and complete the Works and remedy defects therein in conformity and in all respects within the provisions of the Contract.
4. The Employer hereby covenants to pay the Contractor, in consideration of the execution and completion of the Works as per provisions of the Contract, the Contract Price or such other sum as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract.

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

Signature of the Contactor

Signature_____

Name : _____

(Seal)

Signed, Sealed and Delivered in the presence of:

Witness:

Signature_____

Name : _____

Address:_____

(Seal) _____

Signature_____

Name : _____

Address:_____

(Seal) _____

Signature of the Employer

Signature_____

Designation : Registrar

(Seal) _____

Witness:

Signature_____

Designation : Director Works & Services

(Seal) _____

Signature_____

Designation : Director Procurement

(Seal) _____

FORM OF BANK GUARANTEE FOR ADVANCE PAYMENT

Guarantee No. _____

Executed on _____

(Letter by the Guarantor to the Employer)

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

_____ (Particulars of Contract), with

_____ (hereinafter called the Contractor).

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

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

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

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

Notice in writing of any default, of which the Employer shall be the sole and final judge, as aforesaid, on the part of the Contractor, shall be given by the Employer 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 come into force as soon as the advance payment has been credited to the account of the Contractor.

This Guarantee shall expire not later than _____

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

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

	<hr/>	Guarantor (Scheduled Bank)
Witness:		
1. <hr/>		1. Signature <hr/>
<hr/>		2. Name <hr/>
Corporate Secretary (Seal)		
		3. Title <hr/>
2. <hr/>		
<hr/>		<hr/>
(Name, Title & Address)		Corporate Guarantor (Seal)

SPECIFICATIONS

(Attached as Volume -II)

DRAWINGS

(Attached as Volume -IV)



**TENDER DOCUMENTS FOR
CONSTRUCTION OF HILTON PHARMA NANO
TECHNOLOGY CENTRE
(REMAINING WORKS)**

NED University of Engineering & Technology, Karachi.

**VOLUME - II
TECHNICAL SPECIFICATION**

**NED University of Engineering and Technology,
University Road,
Karachi-75270.**

TABLE OF CONTENTS

SECTION - 1 GENERAL REQUIREMENTS	03
SECTION – 2 CONTRACTOR'S CAMP	18
SECTION – 3 STAKE-OUT SURVEY	20
SECTION – 4 CLEARING AND GRUBBING	22
SECTION – 5 DISMANTLING WORKS	23
SECTION – 6 EARTH WORK	27
SECTION – 7 FORM WORK	33
SECTION – 8 REINFORCEMENT	39
SECTION – 9 PLAIN AND REINFORCED CONCRETE	42
SECTION – 10 BLOCK & BRICK MASONRY	81
SECTION – 11 CARPENTRY AND JOINERY	84
SECTION – 12 ALUMINIUM WORKS	93
SECTION – 13 GLAZING	97
SECTION – 14 BITUMEN COATING	99
SECTION – 15 CEMENT PLASTER	101
SECTION – 16 MARBLE	105
SECTION – 18 FLOOR AND WALL FINISHES	109
SECTION – 19 PAINTING	117
SECTION – 20 TEXTURED I GRAFFITO WALL COATING	122
SECTION – 21 LIST OF APPROVED MANUFACTURES (CIVIL)	126
SECTION – 22 PLUMBING WORKS (Section 01 to 06)	129
SECTION – 23 ELECTRICAL WORKS (Section 01 to 22)	129
SECTION – 24 LIST OF APPROVED MANUFACTURED (Electrical)	365

SECTION - 1 GENERAL REQUIREMENTS

1. General

The General Conditions of Contract & Special Conditions of Contract 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 Consultant for approval before proceeding with the work.

The Tender Drawings, Design Criteria and Specifications are to be read in conjunction and shall be mutually explanatory. In case of any conflict the order of preference shall be as under duly followed by the Special and General Conditions of Contract in Volume I of Tender & Contract documents.

- i) Specifications
- ii) Tender Drawings
- iii) Bill of Quantities

2. Scope of Work

The scope of work comprises **Construction of Allied Building, Residential Buildings & External Development Work at J.I.M.S., Jacobabad, Sindh, including all civil, electrical, plumbing and HVAC works** as per drawings and specification as defined hereunder and as specified in subsequent sections of tender documents. The Contractor shall perform all relevant engineering, procurement, installation, construction and execution, coordination with other services, testing and commissioning including all documentation, drawings, calculations and supply of manuals as required to complete the work. The Contractor shall also be responsible to supply and install all other items not specifically mentioned in these documents but which are necessary for proper completion of the works included in the scope of this Contract.

3. 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 publications 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

BSICP British Standard Institute Code of

PCA Practice Portland Cement Association

PSI Pakistan Standard Institute

UBC Uniform Building Code

Should 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.

4. 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.

5. Units of Measurements

The British System of Units (FPS) shall be used throughout this Project.

6. Manufacturer's Recommendations

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

7. Existing Condition at Site

Drawings and information pertaining to existing project conditions are furnished for reference. Neither the Employer nor the Engineer warrants the adequacy or correctness of these.

8. 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 trades performing work under other Contracts as necessary for completion.

9. Setting Out of Work

Establish all boundaries, markers, leveling stakes and benchmarks on the site to adequately set out all work. Verify all data and their relationship to establish and Engineer's survey control points and public benchmarks and report discrepancies to the Engineer.

Permanently mark the necessary controls for distance and elevation sufficient to serve throughout the Contract and protect these control points adequately against damage and displacement.

Project setting out is for the use of all trades; each trade is responsible for the layout of its own work.

10. 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.

11. Lines and Levels

Survey control points will be established by' the Engineer. The Contractor shall be responsible for verifying these and shall be responsible for all requirements necessary for the execution of any work to the locations, lines, and levels specified or shown on the drawings, subject to such modifications as the Engineer may require as work progresses.

12. 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 Consultant will have the right to continue such use until such portion of the work can, without injury to the Consultant, 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 pending completion of appropriate remedial action shall not exceed twelve months unless otherwise mutually agreed upon in writing between the parties.

13. Existing Services

The Contractor shall search for, find locate and protect any visible/un visible 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, dismantling 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 himself. Should any 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 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.

14. 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.

15. 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.

16. 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.

17. Test Laboratory and Testing

- 17.1 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.
- 17.2 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.
- 17.3 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 requirement shall be provided by the Contractor.
- 17.4 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.
- 17.5 The quality contract 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.

18. 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 leveling, 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.

19. Bar Bending Schedule

Bar bending (reinforcement bars) schedule of all drawings shall be prepared by the Contractor and submitted to Consultants' Head Office for approval. The approved bar bending scheduled shall be followed for cutting of steel and preparation of bills.

20. Drawings

20.1 Tender Drawings: The drawings listed in the General Conditions of contract, Volume I and provided in Volume III are referred to as Tender Drawings and these show the scope of work to be performed by the Contractor. Tender 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 19.2 Drawings Issued for Construction. Tender Drawings are subject to be modified and supplemented by additional detail by the Engineer.

20.2 Drawings Issued for Construction: After Award of Contract, Tender 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 of Drawings under Sub-Clause 6.1 of General Conditions of Contract Part I. Drawings Issued for Construction may include some of the Tender 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.

- 20.3 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.

- 20.4 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 Custody of Drawings, of General Conditions of Contract - Part I Volume I.

- 20.5 Drawings to be furnished by the Contractor:

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 including 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.

a. 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.

b. 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.

c. Submissions and Approvals:

Except as otherwise specified, three copies of each drawing for approval or review shall be furnished to the Consultant. Within thirty calendar days after receipt the Consultant 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.

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.

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

21. 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 along with

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.

22. 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 Consultant/Engineer Incharge. 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.

23. Protection of the Works

The Contractor shall whenever necessary cover up and protect the works from Weather 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.

24. Product Data

Manufacturer'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.

25. Samples

25.1 The Contractor shall furnish for approval of the Engineer with reasonable Promptness all samples as directed by the Consultant or specifically called for in these Specifications. The Consultant 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.

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

25.3 Samples shall be furnished so as not to delay fabrication, allowing the Consultant/Engineer Incharge reasonable time for consideration of the sample' submitted.

25.4 Each sample shall be properly labeled with the name and quality of the material, manufacturers name, name of the project, the contractor's

name and the date of submission, and the Specifications Article number to which the sample refers.

- 25.5** 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 & Consultants' Head 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.
- 25.6** Samples shall be of adequate size and number to permit proper evaluation of the material by the Consultant/Engineer Incharge. 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.
- 25.7** If both Shop Drawings and samples are required for the same item, the Consultant/Engineer Incharge may require both to be submitted before approving either, 25.7 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.

In the event that the site cannot 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 Incharge 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 utilized 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 Client 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.

25.6.1 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 In charge and replaced with suitable fill material compacted and finished with topsoil all at the expense of the Contractor.

25.6.2 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 In charge and storage shall not be within building.

Torch-cutting and welding operations performed by the Contractor shall have the approval of the Engineer In charge 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 relevant department and or other local authority.

25.6.3 Telephone

The Contractor shall immediately after receiving the Letter of Acceptance take the necessary steps to obtain mobile and land line telephone on site. He shall be responsible for all installation and connection charges and periodic mobile and landline telephone accounts. The telephone shall be made available to the Engineer for the due performance of his duties at all times and free of charges during construction and defects liability period.

26. 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 an activities of the Works.

Should the Consultant / 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 Consultant/Engineer In charge for his approval.

27. 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.

28. 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.

29. 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.

30. 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 works) are properly, accurately and timely installed. The Contractor shall inform the other contractor 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 representation of the other contractor before carrying out any construction activity.

If any part of electrical 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/expensed shall be borne by the Contractor.

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

31. Submission Requirements

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

31.2 Submit Shop Drawings as per provision given in Sub-Clause 20.5 (a) and number of copies of Product Data which the Contractor requires for distribution plus four copies which will be retained by the Engineer.

31.3 Submit three samples unless otherwise specified.

31.4 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.

32. 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.

33. 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

Laser Meter

Precision Level invert Staff

Automatic Levels

Power level

Compass, steel tape, ranging poles

34. Weekly Progress Report and Photographs

34.1 During the continuance of the Contract, the Contractor shall submit weekly progress reports on forms as approved by the Consultant. Such weekly 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.

34.2 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 Employer's completion date.

34.3 Commencing after the first week of construction, and continuing every week 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.

35. 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 Consultant, 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 weekly progress report 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 as tests, alignment checks, etc. The Contractor shall be responsible for expediting the delivery of all material and equipment to be provided by him and his subcontractors.

36. Photographs

As soon as work commences on Site, the Contractor shall provide photographs (at least 10 to 12) of the works from positions to be selected by the Engineer. Each photographic print shall not be less than 297 mm x 210 mm and shall bear a printed description, a serial number and the date when taken.

The negatives 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.

37. Facilities for the Engineer

37.1 Site Office

The Contractor shall construct, provide and maintain Consultant's Site Office of about 125-150 square meter covered area as per the specifications. A preliminary layout of the site office shall be provided by the Consultant. After receiving letter of award the Contractor will submit to the Engineer detailed shop drawings for review and approval. Specifications for construction of site office shall be the same as provided in Volume-II of the tender documents.

The Consultant's site office shall be furnished and equipped with new and unused furniture, equipment, air-conditioners, electrical fittings etc., as per the list given below:

1	Wooden office table with drawers and side racks	4 (Four) No.
2	Office Chairs	4 (Four) No.
3	Wooden sitting visitors chairs with arms (standard size)	10 (Ten) No.
4	Steel filing cabinet (standard size)	4 (Four) No.
5	Split type (1-1/2 ton)	4 (Four) No.

6	Electric Kettle	2 (Two) No.
7	Computer Dual Core, Original Intel processor 2GB DDR2 Ram, 160 GB hard disk, 17" LCD Monitor along with Laser Printer (A-3 Size), Scanner, DVD Writer, Speakers, Licensed software for microsoft, MS office and autocad.	3 (Three) No.
8	56 k Speed Modem Card and Min,.1MB USB Internet Device including monthly charges etc.	3 (Three) No.
9	Computer Table & chair	3 (Three) No..
10	Conference Table (1.5 meter x 1.0 meter) & chairs 12Nos.	1 (One) set.

Mobile & Landline Telephone with connections 1 (One) No. Each Engineer. The Contractor shall furnish Rupees 2,000/= per month to the Engineer for the Mobile Cards.

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 Consultant. The Consultant's Site office with fittings, fixtures and all other equipment/accessories shall be maintained and operated for the entire duration of construction period as well as for the duration of subsequent defects liability period.

The Site Office including fittings, fixtures, furniture, furnishing and all other equipment/accessories shall be the property of the Employer on completion of the Contract.

37.2 Transport

The Contractor shall provide, operate and maintain One brand new, 1000CC, (with AC) & One Brand New 800CC, (with AC) or the equivalent facility will be provided on Rental car facility for the use of the Consultants' site supervision/ monitoring team to meet his transportation needs for the entire duration of actual construction period as well as for the duration of subsequent defects liability period. The use of such transport facility shall be under the control of the Engineer, and 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, lubricants, tires and other supplies, all maintenance, repairs and running costs and suitably qualified drivers at all times. The Contractor shall furnish Rupees 12,000/= per month per car to the Engineer for the fuel (CNG / Petrol) purposes.

Prior to Ordering the Vehicles, the Contractor shall furnish to the Engineer for approval, detailed specification, name of manufacturer and model no. of the vehicles 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.

Failure of the Contractor to do so shall make him liable' to bear its cost up to Rs. 80,000 per month, per car. The vehicles shall be right hand drive, and shall be brand new, 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. The vehicles shall become the property of the Contractor on completion of the Contract including defects liability period. If the contractor fails to provide the facilities as per tender documents then deductions as specified in tender documents will be made from contractors running bill and same will be compensated / paid to consultant.

37.3 Contractor's Employees

The Contractor shall provide and employ on the Site for the purpose of or in connection with the Contract:

S. No	Staff to be Employed with Qualification	No.	Experience
1	Project Manager - B.E. in Civil	1	Minimum 15 years experience
2	Senior Site Engineer - B.E./B.Tech in Civil	1	Minimum 8 years experience
3	Site Inspector - D.A.E. (3 years) in Civil	2	Minimum 5 years experience.
4	Site Inspector - D.A.E. (3 years) in Electrical / Mechanical	1	Minimum 5 years experience.
5	Surveyor - D.A.E. (3 years) in Civil	1	Minimum 5 years experience.
6	Material Engineer - B.E in Civil / M.Sc. in Geology	1	Minimum 10 years experience.
7	Quantity Surveyor - D.A.E. (3 years) in Civil	1	Minimum 10 years experience.

S. No.	Staff to be Employed with Qualification	No.	Experience
1	Work Superintendents	3	Metric / non-metric with 10 to 15 years experience in the construction of RCC work and can understand drawings well
2	Remaining staff be employed by the Contractor as required at site as per schedule of Work		

38. Payment of Work

No payment shall be made for the works involved within the scope of this section of specification. The cost thereof shall be deemed to have been included in the quoted unit rate of other items of the Bills of Quantities.

SECTION – 2 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.

The location of the Contractor's camps, including all buildings, utilities and facilities there for, 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 Consultant or the Employer, the Contractor shall continue such work to the extent required by the Contractor's personnel during the period of maintenance. No compensation shall be paid for the continued operation and maintenance of the Contractor's Camps during the period of maintenance.

Upon completion of the Works, or at such time within the period of maintenance as directed by the Consultant, 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 construction, operation and maintenance of all camps of the Contractor shall comply with all applicable provisions of current Pakistan Labour Camp Rules.

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 Consultant and the Employer.

2. Payment of Work

No payment shall be made for the works involved within the scope of this section of Specifications unless otherwise specifically stated in the Bills of Quantities or herein.

The cost thereof shall be deemed to have been include in the quoted unit rate of other items of the Bills of Quantities.

SECTION – 3 STAKE-OUT SURVEY

1. Scope

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. Payment of Work

No payment shall be made for the Works involved within the scope of this section of Specifications unless otherwise specifically stated in the Bills of Quantities or herein.

The cost thereof shall be deemed to have been included in the quoted unit rate of other items of the Bills of Quantities.

SECTION – 4 CLEARING AND GRUBBING

1. Scope

The clearing and grubbing shall consist of clearing the designated area of all trees, down timber, snags, bush, other vegetation, rubbish and all other objectionable material, and shall include grubbing stumps, roots, and matted roots, and disposal of all spoil material resulting from the clearing and grubbing. It shall also include the removal and disposal of structures that protrude, encroach upon, or otherwise obstruct the work, except when otherwise provided for on the plans or directed by the Engineer to be saved. The scope of this section of specifications is covered with detailed specifications laid down herein.

2. Limit of Area

2.1 Location of Works

The Engineer will define the limit of areas where clearing and grubbing is to be done. Normally it will include all land within the right of way and all other construction area including ditches, detours, minor road crossings and other areas shown on the plans or as specified or as directed by the Engineer. The Engineer will designate the fences, structures and debris and trees and bushes to be cleared where grubbing is not required. It shall not include clearing and grubbing of borrow or other pit areas from which material is secured. It shall include the leveling or removal of all bunds or mounds within the right of way unless otherwise directed by the Engineer.

2.2 Grubbing and Cutting

All roots and stumps within the limits of the site shall be grubbed and excavated unless otherwise specified or approved by the Engineer.

2.3 Disposal

All wood and bush shall be burned or otherwise disposed off within fifteen (15) days after cutting or felling unless otherwise approved. No tree trunks, stumps or other debris shall be left within Site unless approved in writing by the Engineer. The location of disposal areas shall be within or outside the limits of the project or as approved in writing by the Engineer and shall be acquired by the Contractor at his own expense. Any useable material shall remain the property of the Employer.

2.4 Protection and Restoration

The Contractor shall prevent all damage to pipes, conduits, wires, cables or structures above or below ground. No land monuments, property markers, or official datum points shall be damaged or removed until the Engineer has witnessed or otherwise referred their location and approved their removal. The Contractor shall so control his operations as to prevent damage to trees and shrubs, which are to be preserved. Protection may include fences and boards lashed to trees to prevent damage from machine operations. The existing covered or open benchmarks should be relocated as directed by the Engineer. In the event that anything specified herein to be saved and protected is damaged.

SECTION – 5 DISMANTLING WORKS

1. Scope

The work covered by this Section of the Specifications consists of furnishing all plant, labour, equipment, appliances and performing all operations in connection with demolition! dismantling and removal of existing building components, walls, floors, skirting, plaster and removing of doors, windows and ventilators, removal / re-routing of utility services of the building with accessories, removal of existing roof finishes and disposal/stacking of material to designated places. Whole work shall be done in accordance with these and other relevant specifications and as directed by the Engineer.

2. Procedures

- 2.1 The Engineer will define the limits where demolition/ dismantling and removal activity is to be done and shall approve the procedures/methods to be adopted by the Contractor.
- 2.2 Whole work shall be performed in an orderly manner and the Contractor shall take all necessary precautions and expedients to prevent damages to the adjacent structures, installed equipment/machinery, pipes, conduits etc. Any damage caused to the structures and installations due to negligence of the Contractor during demolition dismantled and removal operations shall be repaired/replaced by the Contractor at his cost and to the satisfaction of the Engineer.

3. Demolition of Building Components

- 3.1 The Contractor shall demolish walls, floors skirting, cutting of plaster, removing of doors, windows, ventilators, concrete/ masonry works and other associated parts to the line and depth as shown on the Drawings or as directed by the Engineer. Explosives shall not be used to remove the plain and reinforced cement concrete or any other material whatsoever. Manually or where required mechanically operated breakers, concrete saws, chipping hammers or other approved methods shall be employed for cutting. Care shall be taken that existing services and structures are not damaged. It shall be the responsibility of the Contractor to replace at his cost any services, Structures damaged by the Contractor due to his negligence during cutting operations or thereafter until the whole of cut parts areas are restored to original condition to the satisfaction of the Engineer.

4. Removal of Existing Services/ Utilities/Finishes

- 4.1 The Contractor shall mark all the services/ utilities falling within the Contract area. After getting approval from the Engineer, the contractor shall remove all such Services/utilities/finishes as per the requirement specifications of the relative department whose utilities/services finishes are being removed/ shifted.

5. Disposal

- 5.1 All debris materials resulting from demolition / dismantling works shall be disposed off to places designated by the Engineer in the manner of disposition required and directed by the Engineer.
- 5.2 All useable materials resulting from demolition and removal shall remain the property of the Employer and shall be stacked at

designated places.

6. Measurement and Payment

6.1 General

Except otherwise specified herein or elsewhere in the Bill of Quantities/Contract Documents no measurement and payment will be made for the under mentioned items related to this section. The cost thereof shall be deemed to have been included in the quoted unit rate of the other items of the Bill of Quantities under this section.

6.1.1 Temporary diversion and safety measures.

6.1.2 Loading, unloading, transportation and disposal of demolished dismantled/removed/useable material to the place designated by the Engineer.

6.1.3 Permissions/approvals, if required, from the relative department.

6.1.4 Stacking of all useable material to the place designated by the Engineer.

6.1.5 Earth work

6.1.6 Shifting of Existing lines, Sewer line, and water supply lines or rerouting the same as per new design and drawing.

6.1.7 Shifting of Existing Generators, Transformers, Panels, Switch boards and all electrical / plumbing accessories including motors / pumps as per new design and drawing.

6.2 Dismantling of Tile Floors/Dado/Skirting / Wall fly proof jali

6.2.1 Measurement

Measurement for acceptably completed works of dismantling and removal of existing tile floors/dado/skirting/wall/fly proof jali and staking of useable material at designated places will be made on the basis of actual area in square foot of dismantled floor/dado/skirting/wall/fly proof jali as directed by the Engineer.

6.2.2 Payment

Payment will be made for acceptably measured quantity of dismantled tile floor/dado/skirting/wall/fly proof jali on the basis of unit rate per square foot quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item. If this item is not covered in the BOQ the cost thereof shall be deemed to have been included in the quoted unit rate of other items of bill of quantities.

6.3 Removal of Doors and Windows with Chowkhats

6.3.1 Measurement

Measurement for acceptably completed works of removal of existing doors/windows with chowkhats and staking of useable material at designated places will be made on the basis of actual number of removed doors/windows with chowkhats as directed by the Engineer.

6.3.2 Payment

Payment will be made for acceptably measured quantity of removal of existing doors/windows with chowkhats 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. If this item is not covered in the BOQ the cost thereof shall be deemed to have been included in the quoted unit rate of other items of bill of quantities.

6.4 RCC Slab

6.4.1 Measurement

Measurement for acceptably completed works of removal of existing RCC slab will be made on the basis of actual volume in cubic feet of dismantled concrete as directed by the Engineer.

6.4.2 Payment

Payment will be made for acceptably measured quantity of dismantling of existing RCC slab on the basis of unit rate per cubic feet quoted in the Bill of Quantities full compensation for all the works related to the item.

6.5 Removing / Chipping of Plaster (Int. / Ext.) at any level at any height.

6.5.1 Measurement

Measurement for acceptably completed works of removing and chipping of existing Plaster and debris to be shifted out side the premises / at designated places will be made on the basis of actual area in square foot of removed plaster as directed by the Engineer.

6.5.2 Payment

Payment will be made for acceptably measured quantity of removing / chipping of existing plaster on the basis of unit rate per square foot quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item. If this item is not covered in the BOQ the cost thereof shall be deemed to have been included in the quoted unit rate of other items of bill of quantities.

6.6 Removing / Electrical / Plumbing fitting and fixtures at any level at any height.

6.6.1 Measurement

Measurement for acceptably completed works of removing of Electrical / Plumbing fitting and fixtures and stacked at designated places will be made on the basis of actual in Nos. of removed items as directed by the Engineer.

6.6.2 Payment

Payment will be made for acceptably measured quantity of removed fittings and fixtures on the basis of unit rate per Nos. quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item. If this item is not covered in the BOQ the cost thereof shall be deemed to have been included in the quoted unit rate of other items of bill of quantities.

SECTION – 6 EARTH WORK

1. Scope of Work

The work under this section of the specification consist 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, 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 inquiries 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 prevent 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 6-inch shall be trimmed carefully to a smooth and level surface. Immediately after trimming to the final elevation, a layer of blinding concrete shall be placed to the thickness shown on the drawings. 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 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.
- 4.15 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.
- 4.16 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,.

- 4.17 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.

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. Fill and Backfill

- 6.1 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.

- 6.2 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.

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.

- 6.3 Material for backfilling shall be as approved by the Engineer and shall be placed in layers not exceeding 6 inches 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.

- 6.4 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.

- 6.5 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.

- 6.6 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.

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 wall.

7. 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.

8. Disposal of Surplus Excavated Material

- 8.1 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.
- 8.2 The disposal of surplus/unsuitable excavated material shall include loading, unloading, transporting, stacking, spreading and leveling as directed by the Engineer.

9. Measurement and Payment

9.1 General

Except otherwise specified herein or elsewhere 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.

- 9.1.1 Timber shoring, planking, strutting and providing slope for upholding the sides of excavations.
- 9.1.2 Any fill with approved material necessitated by over excavation due to fault or convenience of the Contractor except under structural members.
- 9.1.3 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.
- 9.1.4 Specified foundation bed preparation.
- 9.1.5 Excavation involved in providing adequate working space around sides of foundation and service line trenches.
- 9.1.6 Providing approved quality fill/backfill material obtained from excavated material as designated by the Engineer.
- 9.1.7 Rolling, leveling, watering & compacting the fill and backfill to required density.
- 9.1.8 All laboratory and field tests stipulated in these specifications.
- 9.1.9 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.
- 9.1.10 De-watering to keep the foundations dry during construction.
- 9.1.11 All cost inclusive of borrow area's royalty charges
- 9.1.12 Testing of Sub-grade material equal to or greater than CBR value 10%
- 9.1.13 Providing and testing of sweet earth.

9.2 Excavation

9.2.1 Measurement

Quantities of excavation shall be, circulated / 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.

9.2.2 Payment

Payment will be made for acceptably measured quantity of excavation on the basis of unit rate per cubic feet quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item, including but not limiting to back filling.

9.3 Backfill/Fills

9.3.1 Measurement

Measurement for acceptably completed backfill/fill works will be made on the basis of number of cubic feet of compacted back fill / fill in position in accordance with the lines, levels and grade as shown on Drawings or as directed by the Engineer.

9.3.2 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.

SECTION – 7 FORM WORK

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 roof and floor and at any height in connection with the supply and installation of formwork for the purpose of shuttering in concreting work, complete in strict accordance with this section of the specifications and the applicable drawings and subject to the terms and conditions of the Contract. The works include all formwork required at any floor and at any height required for the completion of the work as per drawings/specifications.

2. General

It shall be the responsibility of the Contractor to perform the work by engaging well-trained & experienced staff or by the sub-contractor who shall have enough number of well-trained and experienced staff to coordinate his activities with the other operations. However the Contractor shall be responsible for the quality of work performed by the sub-contractor -as per the requirements of these specifications.

3. Materials

The Contractor shall use the following formwork materials for different purposes as stated below:

3.1 Timber

Form framing, sheathing and shoring.

3.2 Plywood

Form sheathing and panels.

3.3 Steel

Heavy forms and false Work Column and joint forms Permanent forms
Welding of permanent forms

3.4 Form Ties Anchors and Hangers

For securing formwork against. placing loads and pressures.

3.5 Coatings

To facilitate form removal.

3.6 Steel Joists

For formwork support.

3.7 Steel frame shoring

For formwork support.

4. Delivery And Storage

4.1 Delivery

The delivery of formwork materials shall be done in such a manner that damage can be prevented.

4.2 Storage

Formwork should be stored, after cleaning and preparing for re-use if used before, in. such a manner that access to all different materials is available.

Material which can be affected by weathering :)hall be stored in appropriate building or under covers and shade.

5. Workmanship

- 5.1 Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete and shall have sufficient rigidity to maintain specified tolerances.

Where required details and locations of special forms to be used are set out on the drawings. The Engineer shall refuse any formwork in any part of the building, which has been constructed with a non-approved formwork. The Engineer shall refuse any concreting which will not be perfect or may not conform to the approved model.

- 5.2 Earth cuts shall not be used as forms for vertical surfaces of reinforced concrete work unless required as such or permitted by the Engineer.

- 5.3 Mud centering shall not be permitted without the prior approval of the Engineer.

- 5.4 Formwork shall be of wrought timber steel, plywood, proprietary building boards and such special materials, as may be shown on the drawings or approved by the Engineer, which give the required finish to the surface of concrete. Wooden formwork shall be free from loose knots and shall be well seasoned.

The responsibility of the safe design of the formwork shall be entirely that of the Contractor.

- a) No wooden props, bamboo, ballies etc., shall be used as supports to beams or roofs and floors. Only steel pipe scaffoldings (tubular) to be used for all works.
- b) No wooden formwork shall be allowed to be used in columns, roofs and floors and beams etc. All the form work shall be of steel as approved.
- c) Only wooden planks of approved quality and thickness of 2 inches minimum on the sides of beams shall be allowed.
- d) All the erected formwork shall be inspected and approved in all respects by the Engineer or his representative prior to concreting.
- e) Where concrete will be exposed to view, special care shall be taken in the selection of the form material and the construction of the forms, to the end that the concrete will be smooth, uniform in texture, true in line and face and free from honey-combing and other projections. All sides and joints on the forms shall be flush (without lipping) and inconspicuous, wood used for such work shall be thoroughly cleaned before each reuse and shall be free from cracks, splinters, nails, or other defects effecting the appearance of the concrete.

- 5.5 The formwork shall conform to the shape, lines and dimensions as

shown on the plans and be so constructed as to remain sufficiently rigid during the placing and compacting of the concrete, and shall be sufficiently tight to prevent loss of liquid from the concrete. The design and Engineering of the formwork, as well as its construction, shall be the responsibility of the Contractor. Where necessary, to maintain the specified tolerances, the formwork shall be cambered to compensate for anticipated deflections in the formwork due to the weight and pressure of the fresh concrete and due to construction loads. The Contractor shall establish and maintain in an undisturbed conditioned until final completion and acceptance of the project, sufficient control points and benchmarks to be used as references for checking upon tolerances.

- 5.6 Forms for architectural concrete shall be designed to produce the required finish or finishes. Deflection of facing materials between studs as well as deflection of studs and wailers shall be limited to 0.0025 times the span or as otherwise specified. Forms shall be designed to permit easy removal. Prying against the face of the concrete shall not be allowed. Only wooden wedges shall be used.
- 5.7 Where natural plywood-form-finish, grout-cleaned-finish, smooth-rubbed- finish, scrubbed-finish or sand-floated-finish is required, forms shall be smooth (faced with plywood, liner sheets, or pre-fabricated panels) and true to line, in order that the surfaces produced will require little dressing to arrive at true surfaces. -Where any as-cast finish is required, no dressing shall be permitted in the finishing operation.
- 5.8 Where as-cast surfaces, including natural plywood-form-finish are specified, the panels of material against which concrete is cast shall be orderly in arrangement, with joints between panels planned in approved relation to openings, building corners, and other architectural features.
- 5.9 Where panels for as-cast surfaces are separated by recessed or otherwise emphasized joints, the structural design of the forms shall provide for locating form ties, where possible, within the joints so that patches of tie holes will not fall within the panel areas.
- 5.10 Forms shall not be re-used if there is any evidence of surface wear and tear or defect, which would impair the quality of the surface finish. Forms shall be thoroughly cleaned and properly coated with form oil before re-use.
- 5.11 The formwork shall be designed so that the soffits of slabs and sides of beams, columns and walls may be removed first, leaving the forms to the soffits of beams and their supports in position.
- 5.12 Forms shall be sufficiently tight to prevent loss of mortar from the concrete. Unless otherwise specified in the Contract Documents chamfer strips shall be placed in the corners of forms to produce beveled edges on permanently exposed surfaces. Interior corners on such surfaces and the edges of formed joints will not require beveling unless required by the Contract Documents.
- 5.13 Positive means such as wedges or jacks for accurate adjustment and for proper removal of shores and struts shall be provided and all settlement shall be monitored during concrete placing operation. Forms shall be securely braced against lateral deflections.
- 5.14 Where concreting of thin members is required to be carried out within

formwork of considerable depth, temporary openings in the sides of the formwork shall be provided where necessary to facilitate the placing and consolidation of concrete. Small temporary openings shall also be provided at the bottom of the formwork for columns, walls and deep beams to permit the cleaning out of debris and observation immediately before concrete is deposited.

- 5.15 Form ties shall be constructed so that the ends or end fasteners can be removed without causing appreciable spalling at the faces of the concrete. After the ends or end fasteners of form ties have been removed, the embedded portion of the ties shall terminate not less than 2 diameter or twice the minimum dimension of the tie from the formed faces of concrete to be permanently exposed to view except that in no case shall this distance be less than 3/4 inch. When the formed face of the concrete is not to be permanently exposed to view, form ties may be cut off flush with the formed surfaces. Precaution shall be taken not to rotate form ties. Through bolts may be permitted provided that they are greased to allow for easy withdrawal and the holes subsequently made good. Through bolts are not to be used on water-retaining structures and basement walls.
- 5.16 At construction joints contact surface of the form sheathing for flush surfaces exposed to view shall overlap the hardened concrete in the previous placement by no less than 1. Inch. The forms shall be held against the hardened concrete to prevent offsets or loss of mortar at the construction joint so as to maintain a true surface.
- 5.17 Wood forms for wall opening shall be constructed to facilitate loosening, if necessary to counteract swelling of the forms.
- 5.18 Wedges used for final adjustment of the forms prior to concrete placement shall be fastened in position after the final check.
- 5.19 Formwork shall be so anchored to shores or to other supporting surfaces or members that upward or lateral movement of any part of the formwork system during concrete placement will not occur.
- 5.20 Runways or planks for moving labour and equipment shall be provided with struts or legs and shall be supported directly on the formwork or upon the structural member without resting on the reinforcing steel.
- 5.21 All surfaces of forms and embedded materials shall be cleaned of any accumulated mortar or grout from previous concreting and of all other foreign material before placing fresh concrete.

Forms shall be sufficiently tight to prevent leakage of grout or cement paste. Board forms having joints opened by shrinkage of the wood shall be removed and replaced. Plywood and other wood surfaces not subject to shrinkage shall be sealed against absorption of moisture from the concrete by either:

- 1. A field applied, approved form oil or sealer, or
- 2. A factory applied non-absorptive liner .

When forms are coated to prevent bond with concrete, it shall be done prior to placing of the reinforcing steel. Excess coating material shall not be allowed to stand in puddles in the forms nor allowed to come in contact with the concrete against which fresh concrete will be placed. Care shall be taken that such approved composition is kept out of contact with the reinforcement. Whereas-cast finishes are required,

materials, which will impart a stain to the concrete shall not be applied to the form surfaces. Where the finished surface is required to be painted, the material applied to form surfaces shall be compatible with the type of paint to be used.

- 5.22 For reinforced concrete, in no circumstances shall forms be struck until the concrete attains 75% of ultimate strength.

The strength referred to shall be that of concrete using the same cement and aggregates, with the same proportions, and cured under conditions of temperature and moisture similar to those obtaining in the work. Where possible, the formwork should be left for longer time as it would assist the curing.

In normal circumstances (generally where temperatures are above 20° C and where ordinary cement is used, forms may be struck after expiry of the following periods. Walls, columns and vertical sides of beams. 48 hours or as may be decided by the Engineer.

Side of slab (shores or props left under)	6 days.
Beams soffits (shores or props left under)	12 days.

Removal of shores or props to slabs.

Spanning up to 12 feet.	10 days.
Spanning over 12 feet.	16 days.

Removal of shores or props to beams.

Spanning up to 18 feet.	18 days
Spanning over 18 feet.	25 days

For rapid hardening cement 3/7 of the above period will be sufficient in all cases except vertical sides of slabs, beams and columns which should be retained for a minimum of 24 hours.

The number of shores or props, their sizes and disposition shall be such as to be able to safely carry the full dead load of the slab and beams, as the case may be.

Proper allowance shall be made for the decrease in rate of hardening of concrete in cold weather and the above minimum duration must be increased when the mean daily temperature is below 20° C.

- 5.23 When repair of surface defects or finishing is required at an early age, forms shall be removed as soon as the concrete has hardened sufficiently to resist damage from removal operations.
- 5.24 Top forms on sloping surfaces of concrete shall be removed as soon as the concrete has attained sufficient stiffness to prevent sagging. Any needed repairs or treatment required on such sloping surfaces shall be performed at once and be followed by the specified curing.
- 5.25 Wood forms for wall openings shall be removed as soon as this can be accomplished without damage to the concrete.
- 5.26 All formwork shall be removed without such shock or vibration as would damage the reinforced concrete. Before the top plank and struts are removed, the concrete surface shall be exposed where necessary in order to ascertain that the concrete has sufficiently hardened. Proper precautions shall be taken to allow for the decrease

in the rate of hardening that occurs with all cement in the cold weather.

- 5.27 When reshoring or repropping is permitted or required, the operations shall be planned in advance and shall be subject to approval. While reshoring is underway no live load shall be permitted on the new construction. In no case during reshoring shall concrete in beam, slab, columns or any other structural member be subjected to combined dead and construction loads in excess of the load permitted by the Engineer for the developed concrete strength at the time of reshoring.

Reshores shall be placed as soon as practicable after stripping operations are complete but in no case later than the end of working day on which stripping occurs.

Reshores shall be tightened to carry their required loads without overstressing the construction. Reshores shall remain in place at least until tests representative of the concrete being supported have reached the strength specified in sub-clause 5.23 hereof.

- 5.28 Floors supporting props or shores under newly placed concrete shall have their original supporting props or shores left in place or shall be reshored. The reshoring system shall have a capacity sufficient to resist the anticipated loads and in all cases shall have a capacity equal to at least one half the capacity of the shoring system above. The reshores shall be located directly under a shore position above unless other locations are permitted.

The reshoring or re-propping shall extend over a sufficient number of storey's to distribute the weight of newly placed concrete, forms, and construction live loads in such a manner that the design superimposed loads of the floors supporting shores or props are not exceeded.

- 5.29 It is generally desirable to give forms for reinforced concrete an upward camber to ensure that the beams or slabs (specially cantilever slabs) do not have a sag when they have taken up their deflection, but this should not be done unless permitted by the Engineer.
- 5.30 No loads, other than man and light plant required in connection with the actual work in hand, shall be allowed on suspended floors until 28 days after concreting where ordinary Portland Cement is used and 14 days when rapid hardening Portland Cement is used.
- 5.31 Prior to placing concrete, all forms shall be inspected and all debris and extraneous matter removed. The form oil or release agent shall not react with concrete to affect the strength nor shall it give any colour.

6. Measurement and Payment

No payment will be made for the works involved within the scope of this section of the specifications unless otherwise specifically stated in the Bills of Quantities or herein.

The cost thereof shall be deemed to have been included in the quoted unit rate of relevant items of the Bills of Quantities.

SECTION – 8 REINFORCEMENT

1. Scope

The work under this section of specifications consists of furnishing, cutting, fabricating, bending and placing steel reinforcement in concrete structures or elsewhere as shown on the drawings or as directed by the Engineer. The scope of this section of specification is covered with detailed specifications as laid down herein.

2. Applicable Standards

Latest editions of the following Pakistan, British and ASTM Standards are relevant to these specifications wherever applicable.

British Standard

B.S 4449 Carbon steel bars for the reinforcement of concrete.

B.S 4466 Specifications for bending dimensions and scheduling of bars for the reinforcement of concrete.

ACI Standard

ACI315 Details and detailing of concrete reinforcement.

ACI318 Building Code Requirements for Reinforced Concrete and commentary.

ASTM Standard

A 82 Cold - Drawn steel wire for concrete reinforcement.

A 305 Minimum requirement for the deformations of deformed steel bars for concrete reinforcement.

A 615 Deformed Billet Steel Bars concrete Reinforcement.

In addition to the above, the latest editions of other Pakistan Standards, British standards, American Concrete Institute Standards, American Society for Testing and Materials Standards and other standard as may be specified by the Engineer for Special Material and construction are also relevant.

3. Material

3.1 Unless otherwise specified, all steel bars for reinforcement of concrete shall be conforming to ASTM A615, Grade 60 deformed hot rolled billet steel bars with minimum yield strength of 60,000 Psi (414Mpa).

3.2 Reinforcement shall be free from all loose or flaky rust and mill scale, or coating, Including ice, and any other substance that would reduce or destroy the bond.

4. Compliance With Specifications

The Contractor shall submit certificates of compliance from the manufacturer stating that the supplied reinforcement conforms to the specifications. In addition, wherever and as directed by the Engineer, conformance of the supplied reinforcing bars with the specifications shall be demonstrated by the Contractor through laboratory tests, in accordance with the relevant standards.

5. Delivery & Storage

5.1 Delivery

Steel reinforcement bars shall be kept in bundles firmly secured and tagged. Each bar or bundle of bars shall be identified by marks as per relevant BS standards.

5.2 Storage

The method of storage shall be approved by the Engineer. Reinforcing bars shall, be stored in racks or platforms above the surface of ground and shall be protected against scaling, rusting, oiling, coatings, damage, contamination and structural defects prior to placement in works. Bars of different diameters and grades shall be so labeled and kept separately.

6. Bar Bending Schedules

The Contractor shall prepare bar bending schedules of all the reinforcing steel bars and these bar bending schedules shall be submitted to the Engineer for his approval. The Contractor shall obtain approval of the bar bending schedules before starting actual bar bending works.

The Engineer's approval, however, will not relieve the Contractor of his responsibility in this regard.

7. Fabricating, Bending & Placing

- 7.1 Reinforcement is to be accurately placed as shown in the drawings, and secured against displacement by using 16 gauge G.I wire ties or suitable slips at intersections and supported from the formwork by using concrete, metal or plastic chairs and spacers or hangers of an approved pattern.

Where concrete blocks are used for ensuring the cover, they shall be made of mortar not leaner than 1 part of cement to 2 parts of sand.

Where the concrete surface will be exposed to the weather in the finished structure, the portions of all accessories in contact with the form work shall be galvanized or shall be made of plastic.

- 7.2 Bars used for concrete reinforcement shall be fabricated in accordance with the dimensions shown in the bar bending schedule approved by the Engineer.
- 7.3 The cutting tolerance for all bars shall be + 25 mm
- 7.4 Fabrication tolerances shall be as per ACI-315
- 7.5 Placing tolerances shall be as per ACI-318 & 317.
- 7.6 Bars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items. If bars are moved more than one bar diameter or enough to exceed the above tolerances, the resulting arrangement of bars shall be subject to approval of Engineer.
- 7.7 Vertical bars in columns shall be offset at least one bar diameter at lapped splices. To ensure proper placement, templates shall be furnished for all columns dowels.
- 7.8 Reinforcement shall not be bent or straightened in a manner that will injure the material. No bars shall be bent twice in the same place, nor shall they be straightened after bending. Unless permitted by Engineer, reinforcement shall not be bent after being partially

embedded in hardened concrete.

- 7.9 No splice of reinforcement shall be made, except as shown on the working drawings.
- 7.10 Welding of reinforcement shall not be done unless permitted and approved by the Engineer.
- 7.11 Exposed reinforcement intended for bonding with future extensions is to be effectively protected from corrosion. Protection is also to be provided to reinforcement partly built into concrete where the exposed part is to be built into later concrete.
- 7.12 No concreting is to be carried out until the reinforcement has been checked and approved by the Engineer.
- 7.13 All detailing shall be done as per ACI-315, ACI-318 and ACI-350R, as and where required.
- 7.14 Standard or actual weight whichever is lesser shall be used for calculation of weight.

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 Bill of Quantities. The cost thereof shall be deemed to have been included in the unit rate of the respective items of the Bill of Quantities.

8.1.1 Providing and installing chairs, supports, hooks, hangars, spacers, binding wires, corrosion protection and laps not shown on Drawings including wastage and rolling margin.

8.1.2 Testing of mild and deformed steel bars.

8.2 Reinforcing Bars

8.2.1 Measurement

Measurement for acceptably completed works of reinforcement bars shall be made by weight according to bar bending schedules approved by the Engineer.

8.2.2 Payment

Payment will be made for ascertained measured quantity of reinforcement on the basis of unit rate per metric ton quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

SECTION – 9 PLAIN AND REINFORCED CONCRETE

1. Scope

The work under this section of the specification consists of furnishing all plant, labour, equipment, appliances and materials and in performing all operations in connection with the supply and installation of plain and reinforced concrete work complete in any floor and at any height as per drawings except where specifically stated in the relevant item of Bill of Quantities, in strict accordance with this section of the specifications and the applicable drawings, and subject to the terms and conditions of the Contract. The scope of this section of specification is covered with detailed specifications as laid down herein.

2. General

- 2.1 Full co-operation shall be given to trades like electrical, mechanical and other services.
- 2.2 Suitable templates or instructions or both shall be provided for setting out items not placed in the forms. Embedded items and other materials for mechanical and electrical operations shall have been completed, inspected, tested and approved before concrete is placed.
- 2.3 For special concrete finish and for special methods of construction (e.g. slip forms), formwork shop drawings shall be designed and prepared by the Contractor, at his own cost. Approval of shop drawings as well as that of actual samples of concrete finish shall be obtained before work is commenced.

3. Applicable Standards

Latest editions of the following Pakistan, British and ASTM Standards are relevant to these specifications wherever applicable.

3.1 Pakistan Standards

PS 177 PS 232 PS 243 PS 279	Compaction proctor test. Portland Cement (ordinary & rapid hardening). Natural aggregates for concrete.
PS 280	Abrasion of coarse aggregates by the use of Los Angeles machine
PS 281	Determination of aggregate/crushing value.
PS 282	Organic impurities in sand for concrete aggregates.
PS 283	Material finer than No. 200 B.S. test sieve in aggregates, method of test for. Soundness test for aggregates by the use of sodium sulphate or magnesium sulphate. Sampling aggregates for concrete.
PS 284	Sampling aggregates for concrete.
PS 285	Sieve or screen analysis of fine and coarse aggregates. Description and

	classification of mineral aggregates.
PS 286	Sampling fresh concrete.
PS 421	Sampling fresh concrete.
PS 422 PS 560	Slump test for concrete.
	Making and curing concrete
	compression test specimen in the
	field. Sulphate-resistant Portland
	cement type 'A' and sampling fresh
	concrete in the laboratory.
PS 612	Mixing and sampling fresh concrete in
	the laboratory.
PS 716	Compacting factor test for concrete.
PS 717	Definitions and terminology of
	cements.
PS 746 PS 849	Making and curing concrete
	compression test cubes.

3.2 **ASTM (American Society for Testing and Materials)**

B 370 C 33 Copper sheet and strip for building construction. **Concrete Aggregates.**

C40	Organic impurities in sand for concrete.
C87	Effect of organic impurities in fine aggregates on of mortar.
	Soundness of aggregates.
	Ready mixed Concrete.
C88	Compressive strength of hydraulic cement mortars.
C94	Material finer than NO.200 (0.075mm) sieve.
	Light-weight pieces in aggregates.
C109	Concrete and concrete aggregates.
C117	Specific gravity and absorption of coarse aggregate.
C123	Specific gravity and absorption of fine aggregate.
C125	Resistance to abrasion of small size coarse aggregates.
C127	Sieve or screen analysis of fine and coarse aggregate. Clay
	lumps and friable particles in aggregates.
C131	Slump of Portland Cement Concrete.
C136	Aggregate for masonry mortar.
C142	Portland Cement.
C143	Water retention by concrete cunning material
C144	Sheet material for curing concrete.
C150	Air content or hydraulic cement mortar.
C156	Density of hydraulic cement.
C171	Time of setting of hydraulic cement by vicat needle.
C185	Air entraining admixtures for concrete.
C188	Potential reactivity of aggregate.
C191	Liquid membrane-forming compounds for curing concrete.
C260	Lightweight aggregates for structural concrete.
C289	Lightweight aggregates for concrete masonry.
C309	Lightweight aggregates for insulating concrete.
C330	Chemical admixtures for concrete.
C331	Resistance to abrasion of large size coarse aggregates.
C494	Unit weight of structural lightweight concrete.
C535	Aggregate sampling.
C567	Preformed expansion joint filler for concrete.
D75	Concrete joint sealer (hot poured elastic type).
D994	Preformed expansion joint filler for concrete paving and
	structural construction.

D1190	
D1751	Preformed sponge rubber and cork expansion joint fillers for concrete paving and structural construction.
D1752	
D1850	Concrete joint sealer (cold application type).
E11	Wire cloth sleeves for testing purposes.
E96	Water vapor transmission of materials in sheet form.
E154	Materials for use as vapor barrier under concrete slabs.
E337	Relative humidity by wet and dry bulk psychomotor.

3.3 ACI (American Concrete Institute)

3.3.1 Recommended practice for selecting proportions for normal and heavy weight concrete.

214 Recommended practice for evaluation of strength test result of concrete

301 Specifications for structural concrete for buildings.

304 Recommended practice for measuring, mixing, transporting and placing concrete.

305 Hot weather concreting.

308 Recommended practice for curing concrete.

309 Recommended practice for consolidation of concrete.

318 Building code requirements for reinforced concrete.

347 Recommended practice for concrete for work.

512 Precast structural concrete in building.

517 Low pressure steam curing.

533 Fabrication, handling and erection of Precast concrete wall panels.

3.4 British Standards

BS 12 BS Portland cement, ordinary and rapid hardening.

410 Test Sieves.

BS 812 BS 882 Methods for the sampling and ~sting of mineral aggregates, sands and fillers.

BS 1305 Coarse and fine aggregates from natural sources.

BS 1881 Batch Mixer.

BS 3148 Methods of testing and sampling concrete.

BS 3837 Tests for water for making concrete.

BS 5328 Expanded polystyrene boards.

BS 3869 Structural Concrete.

BS 3927 Rigid expanded polyvinyl chloride for thermal insulation.

BS 4027 Phenolic foam materials for thermal insulation and building applications. Sulphate-resisting Portland cement.

BS 8110 Structural use of concrete.

CP 114 Structural use of reinforced concrete in buildings.

CP 116 Structural use of Precast concrete.

CP 5337 The structural use of concrete for retaining aqueous liquids

In addition, the latest editions of other Pakistan and British Standards, American Concrete Institute Standards, American Society for Testing and Materials Standards and other Standards as may be specified by the Engineer for special Materials and Construction are also relevant.

4. Materials

4.1 Aggregates

- 4.1.1 The sources of supply of all fine and coarse aggregates shall be subject to the approval of the Engineer.
- 4.1.2 All fine and coarse aggregates shall be clean and free from clay, loam, silt and other deleterious matter. If required, the Engineer reserves the right to have them washed by the Contractor at no additional expense. Coarse and fine aggregates shall be delivered and stored separately at site. Aggregates shall not be stored on muddy ground or where they are likely to become dirty or contaminated.
- 4.1.3 Fine aggregate shall be hard coarse sand, crushed stone or gravel screenings shall conform to requirements of PS 243 and/or BS 882 and/or ASTM C 33. Only fine aggregate of grading zones 1 to 3 (BS 882) shall be used.
- 4.1.4 Coarse aggregate shall be gravel or crush stone of hard, durable material free laminated structure and conforming PS 243 and/or BS 882 and/or ASTM C 33 graded as follows for use in mass concrete as in foundations:

Total Pressure B.S.Sieve	Percent by weight
3 inc. (76.2mm)	100
1.5 inc. (38.10mm)	95-100
0.75 inc. (19.05mm)	30-70
0.38 inc. (9.52mm)	10-35
0.19 inc. (4.76mm)	0-5

Coarse aggregate for all cast-in-place concrete other than mass concrete as for foundations shall be graded with the following limits:

Total Passing B.S. Sieve	Percent by weight
1.5 in. (38.10 mm)	100
0.75 in. (19.05 mm)	95-100

- 4.1.5 Wherever feasible, the nominal maximum size of aggregate for cast-in-place reinforced concrete slabs and other members shall be 3/4 inch. If there are difficulties in placing such a concrete the maximum size may be restricted to 1/2 inch provided the requirements for strength are satisfied. The grading requirements of 1/2 inch or 3/8 inch down aggregate shall be agreed to with the Engineer as per relevant ASTM/BS standards.
- 4.1.6 The nominal maximum size of the aggregate for Precast concrete shall not be larger than one fifth of the narrowest dimension between sides of forms, or one-third of the depth of

slabs or three-fourths of the minimum clear distance between reinforcing bars or between bars and forms, whichever is least. In Precast columns the nominal maximum size of the aggregate shall be limited as above but shall not be larger than two-thirds of the minimum clear distance between bars.

- 4.1.7 Coarse aggregates in Precast concrete of normal weight may be of one maximum size for all concrete placed in 1 day when quantities to be placed are too small to permit economical use of more than one mix design.

When a single mix design is so used, the maximum nominal size shall be as required for the most critical condition of concreting, in accordance with the requirements of clause (4.1.6) above.

- 4.1.8 Except where it can be shown to the satisfaction of the Engineer that a supply of properly graded aggregate of uniform quality can be maintained over the period of the work, the grading of the aggregates shall be controlled by obtaining the 3/4" maximum nominal size, the different sizes being stocked in separate stock piles and recombined in the correct proportion for each batch at the batching plant. The materials shall be stock-piled for a period before use so as to drain nearly to constant moisture content (as long as site and other conditions permit, preferably for at least a day). The grading of the coarse and fine aggregates shall be tested at least once for every 100 tons supplied, to ensure that the grading is uniform and same as that of the samples used in the preliminary tests.

- 4.1.9 For use in fire proof concrete, the aggregates shall be fire clay and semi-acidic fine ground. The use of broken fire clay bricks as coarse aggregate and waste of semi-acidic refractory particles as fine aggregate can be allowed.

4.2 Cement

- 4.2.1 The cement shall be fresh and of approved origin and manufacture. It shall be one of the following as may be specified by the Engineer.

Ordinary or Rapid Hardening Portland cement complying with the requirements of PS 232 or BS 12 or ASTM C 150.

Sulphate Resisting Portland/Cement complying with the requirements of PS 612 or BS 4027 or ASTM C 150.

- 4.2.2 Unless otherwise specified, ordinary Portland Cement complying with the requirements of BS 12 shall be used.

- 4.2.3 For all fair faced concrete it will be necessary to use approved cement with a view to obtain light shade concrete as approved by the Engineer.

- 4.2.4 The Contractor shall supply to the Engineer at fortnightly intervals, test certificates with the appropriate standard in respect of the samples of cement from the work-site. These tests shall be carried out in a laboratory approved by the Engineer.

- 4.2.5 Only one brand of each type of cement shall be used for

concrete in any individual member of the structure. Cement shall be used in the sequence of receipt of shipment, unless otherwise directed.

- 4.2.6 There shall be sufficient cement at site to ensure that each section of work is completed without interruption.
- 4.2.7 Cement reclaimed from cleaning of bags or from leaky containers shall not be used.
- 4.2.8 The Contractor shall provide and erect (at his cost) a suitable plain, dry, well ventilated, weatherproof and water proof shed of sufficient capacity to store the cement.
- 4.2.9 Cement shall be used as soon as possible after delivery and cement which the
- 4.2.10 Engineer considers has become stale or unsuitable through absorption of moisture' from the atmosphere or otherwise shall be rejected and removed immediately from the site at the Contractor's expense. Any cement in containers damaged so as to allow the contents to spill or permitting access of the atmosphere prior to opening of the container at the time of concrete mixing shall be rejected and removed immediately from the site at the Contractor's expense.
- 4.2.11 The mixing together of different types of cement will not be permitted.

4.3 Water

Only clean water from the city supply, tube well installed at the site or from other sources approved by the Engineer shall be used. The Contractor shall supply sufficient water for all purposes, including mixing the concrete, curing, "d cleaning plant and tools. Where doubt exists as to the suitability of the water, it shall be tested in accordance with BS 3148. Where water can be shown to contain any sugar or an excess of acid, alkali or salt, the Engineer may refuse to permit its use.

In case of doubt, the Engineer may require that concrete mixed with water proposed to be used should not have a compressive strength lower than 90 percent of the strength of concrete mixed with distilled water.

4.4 Additive

All additives such as foaming and water proofing agents shall be from a manufacturer approved by the Engineer.

Air Entraining Admixtures shall conform to APM C 260. Other Admixtures shall conform to ASTM C494.

5. Nominal Concrete Mixes

5.1 Proportions of Mix

5.1.1 Cement and aggregates:

Cement, fine aggregate and the coarse aggregate shall be weighed separately. The proportions of cement to fine aggregate and coarse aggregate shall be adjusted so as to

provide the concrete of the required crushing strength when tested as set out in Table 1.

- 5.1.2 The Contractor shall regulate and arrange mixing of the ingredients for the designed mix of the concrete by weight batching. The cost of designing the mix shall be borne by the Contractor.

5.1.3 Water / Cement ratio:

The quantity of water used shall be just sufficient to produce dense concrete of adequate strength and workability for its purpose. For all external work and foundations the water/cement ratio should not exceed 0.55 for concrete Class A, B and C.

5.1.4 Workability:

The workability shall be controlled by direct measurement of the water content, allowance being made for any water in the fine and coarse aggregates. The concrete shall be just sufficiently workable to be placed and compacted, without difficulty, by the available means.

'Workability' shall be determined by either the slump or compaction factor tests as directed by the Engineer and these shall be performed in accordance with the methods given in PS 422 to PS 177 or ASTM C 143.

The slump or compaction factor for each class of concrete shall be determined during the preliminary Test mixes and the value obtained shall not be modified without the written consent of the Engineer. Unless otherwise permitted or specified, the concrete shall be proportioned and produced to have a slump of 3 inch or less for consolidation by vibration. A tolerance of up to 1 inch above- the indicated maximum shall be allowed for individual batches provided the average for all batches or the most recent 10 batches tested, which ever is fewer, does not exceed the maximum limit. Concrete of lower than usual slump may be used provided it is properly placed and consolidated.

5.2 Strength requirements for concrete :-

- 5.2.1 Portland cement concrete when aggregates comply with BS 882.
- 5.2.2 Concrete made with Portland cement shall comply with the strength Table 1 columns 4&6 (Works Test).

Table 1: Strength requirements for Portland concrete with aggregates complying with BS. 882.

Class Min Cement per of concrete	Min Cube Crushing of Strength at 28 days (psi)	Min. water per 110 lb.	Class Min Cement per of concrete
--	---	---------------------------	--

	(lb)	bag of (gallon)	
1	2	3	4
A	30.00	4350	4.40
B	22.00	3750	5.06
C	18.00	3000	5.28
D	13.00	1550	7.05
E	9.50	1000	7.27

Note: Conversion Factors. 1 psi = 0.06897 MPa 1 gal = 4.54 liter

1 lb. = 0.4537 Kg. 1cu.ft. = 0.028 cum.

5.2.3 The strengths given in Table 1 are based on the assumption that average temperature is 20 degree C. Where accurate records of temperature are kept, allowance may be made for change of temperature or the cubes may be tested at the equivalent maturity.

5.2.4 Unless otherwise stated, the types of concrete shall be classified on the basis of compressive strength requirements. The Contractor shall provide Mix design by weight for each class of concrete.

Manufacture 12 test cubes for each 3 mix design batches (6 x 6 x 6) inches in accordance with the Mix design batching by weight and test 3 cubes each at 3,7,14 & 28 days intervals in the presence of Engineer's Representative and submit all relevant data and results of tests for approval of the Engineer. The Contractor shall obtain approval from the Engineer in writing for each Mix design before producing the actual concrete for the Works.

No payments for producing the Mix design, manufacture of test cubes and testing shall be paid. The Contractor shall include this cost in the relevant item of concrete.

5.3 Batching

5.3.1 All cement, including cement supplied in bulk, shall be batched by weight. A bag of cement may be taken as weighing 110 lb. with the prior approval of the Engineer.

5.3.2 Aggregates shall be batched by weight, due allowance being made for water content. Aggregates may be batched by volume through conversion of weigh batching, only with the prior permission of the Engineer. The apparatus for weight batching may be an integral part of the mixer or a separate unit of a type approved by the Engineer. It shall be accurate within 2% and shall be checked for accuracy at least once a week.

5.3.3 The quantity of additives i.e. foaming and water proofing agents etc. shall be as prescribed by the manufacturer or as directed by the Engineer.

5.3.4 Where the batching plant is of the type in which cement and aggregates are weighed in the same compartment. the cement shall be introduced into the compartment between two sizes of aggregates.

5.3.5 Each batch shall be so charged into the mixer that some water

will enter in advance of the cement and aggregates. Water shall continue to flow for a period, which may extend to the end of the first 25 percent of the specified mixing time. Controls shall be provided to prevent batched ingredients from entering the mixer before the previous batch has been completely discharged.

5.4 Mixing

The concrete shall be mixed in an approved batch mixer conforming to the requirements of BS 1305. It shall be fitted with the manufacturer's plate stating the rates, capacity and the recommended number of revolutions per minute and shall be operated in accordance therewith. It shall be equipped with a suitable charging mechanism and an accurate water-measuring device. The mixer shall be capable of thoroughly combining the aggregates, cement and water into a uniform mass within the specified mixing time and of discharging the concrete without harmful segregation.

- 5.4.1 Mixing shall continue for the period recommended by the mixer manufacturer or until there is apparently a uniform distribution of the materials and the mass is uniform in colour, whichever period is longer. If it is desired to use a mixing period of less than 1-1/2 minutes, the Engineer's approval shall be obtained in writing.
- 5.4.2 Controls shall be provided to ensure that the batch cannot be discharged until the required mixing time has elapsed. At least three quarters of the required mixing time shall take place after the last of the mixing water has been added.
- 5.4.3 The interior of the mixer shall be free of accumulations that will interfere with mixing action. Mixing blades shall be replaced when they have lost 10 percent of their original height.
- 5.4.4 Concrete shall be mixed only in quantities for immediate use. Concrete which has set shall not be re tempered, but shall be discarded.

5.5 Transporting:

- 5.5.1 The concrete shall be transported from the place of mixing to the place of final deposit as rapidly as practicable by means, which will prevent segregation or loss of ingredients. All skip vehicles, or containers used for transporting the concrete shall be thoroughly cleaned.
- 5.5.2 During hot or cold weather, concrete shall be transported in deep containers, on account of their lower ratios of surface area to mass, which reduces the rate of loss' of water, by evaporation during hot weather and loss of heat during cold weather.

5.6 Placing

- 5.6.1 Before placing of concrete, formwork shall have been completed; water shall have been removed; reinforcement shall have been secured in place; expansion joint material, anchors and other embedded items shall have been kept in position; and the entire preparation shall have been approved by the Engineer.

No concrete is to be placed into the foundation trenches until the ground to receive the same has been examined and approved by the Engineer for this purpose.

5.6.2 Concrete shall be deposited continuously, or in layers of such thickness that no concrete will be deposited on concrete, which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, construction joints shall be located as shown in the Contract Documents or as approved by the Engineer. Placing shall be carried out at such a rate that the concrete which is being integrated with fresh concrete is still plastic. Concrete which has partially hardened shall not be deposited. Temporary spreaders in forms shall be removed when the concrete placing has reached an elevation rendering their services unnecessary. They may remain embedded in the concrete only if made of metal or concrete and if prior approval has been obtained.

5.6.3 The actual sequence of construction proposed by the Contractor shall be subject to the Engineer's approval before construction starts on any part of the structure, and this sequence shall not be varied without the Engineer's approval.

5.6.4 The concrete after it has been mixed shall be placed as soon as it is practicable. Once the concrete has left the mixer, no more water shall be added, although the concrete may be mixed or agitated to help maintain workability. The concrete shall not be used if, through any cause, the workability of the mix at the time of placing is too low for it to be compacted fully and to an acceptable finish by whatever means available.

The time between mixing and placing should be reduced, if the mix is richer or the initial workability of the mix is lower than normal, or if a rapid hardening cement or an accelerator is used, or if the work is carried out at a high temperature or exposed to a drying atmosphere.

The Contractor shall ensure that the delay between mixing and placing including consolidation does not exceed 45 minutes under any circumstances. Any concrete which does not satisfy this requirement shall be rejected.

5.6.5 Concrete shall be deposited as nearly as possible in its final position to avoid segregation due to re handling or flowing. In no circumstances may concrete be railed or made to flow along the forms by the use of vibrators. Concreting shall be carried on as a continuous operation using methods, which shall prevent segregation or loss of ingredients.

5.6.6 The free fall of concrete shall not be allowed to exceed 6 feet. Where it is necessary for the concrete to be lowered more than this depth, it is not to be dropped into its final position, but shall be placed through pipes fed by a hopper. When a pipe is used for placing concrete the lower end shall be kept inside or close to the freshly deposited concrete. The size of the pipe shall be not less than 9 inch in diameter.

5.6.7 'Mass-concrete' shall be placed in layers approximately 18 inch

thick. Vibrator heads shall extend into the previously placed layer.

- 5.6.8 The workmen carrying concrete to the site, and all other workmen moving about on the reinforcement before the concrete is placed, shall move only along runways or planks placed for the purpose and no person shall be allowed to walk on the reinforcement itself.
- 5.6.9 Prior to the laying of concrete on load bearing masonry walls, bearing plates and at other points, as may be directed by the Engineer, the surface will be brought to a true, hard and smooth level surface using cement sand mortar in the ratio of 1 volume of cement to 3 volumes of sand. Two layers of building paper weighing .082 lb./will then be laid flat to separate the concrete from the surface on which it is to be laid.

5.7 Construction Joints

- 5.7.1 Concreting shall be carried out continuously up to construction joints, the position and arrangement of which shall be predetermined by the Engineer.
- 5.7.2 Joints not shown on the drawings shall be so made and located as to least impair the strength of the structure and shall need prior approval of the Engineer. In general, they shall be located near the middle of the spans of slabs and beams unless a secondary beam intersects a main beam at this point, in which case the joint in the main beam shall be offset a distance equal to twice the width of the secondary beam. Joints in walls and columns shall be at the underside of floors, slabs or beams and at the top of footings or floor slabs. Beams, brackets, columns capitals, haunches and drop panels shall be placed at the same time as slabs. Joints shall be perpendicular to the main reinforcement.
- 5.7.3 All reinforcing steel shall be continued across joints. Keys and inclined dowels shall be provided as directed by the Engineer. Longitudinal keys at least 1-1/2 inches deep shall be provided in all joints in walls and between walls and slabs or footings.
- 5.7.4 When the work has to be resumed; on a surface which has hardened, such surface shall be roughened in an approved manner which will expose the aggregate uniformly and will not leave laitance, loosened particles of aggregate or damaged concrete at the surface.
- 5.7.5 The hardened concrete of construction joints and of joints between footings and walls or columns, between walls or columns and beams or floors they support, joints in un-exposed walls and all others not mentioned herein shall be dampened (but not saturated) immediately prior to placing of fresh concrete.
- 5.7.6 The hardened concrete of joints in exposed work, joints in the middle of beams, and slabs; and joints in work designed to contain liquids shall be dampened (but not saturated) and then thoroughly covered with a coat of cement grout similar in proportions to the mortar in the concrete. The grout shall be as thick as possible on vertical surfaces and at least 1/2 inch thick

on horizontal surfaces. The fresh concrete shall be placed before the grout has attained initial set.

- 5.7.7 Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle, and brushed, care being taken to avoid dislodgment of particles of aggregate. The surface shall then be coated with neat cement grout. The first layer of concrete to be placed on this surface shall not exceed 6 inch in thickness, and shall be well rammed against old work, particular attention being paid to corners and closed spots. 5.7.8 Stop ends for movement joints or construction joints shall be made by splitting them along the lines of reinforcement passing through them, so that each portion can be positioned and removed separately without disturbance or shock to the reinforcement or the concrete. Stop ends made of expanded metal or similar material may only be left permanently in the concrete with prior written approval of the Engineer. Where such stop ends are used, no metal may be left permanently in the concrete closer to the surface of the concrete than the specified cover to the reinforcement.

5.8 Expansion Joints

Expansion joints shall be provided wherever indicated on the Drawings or as directed by the Engineer. In no case shall the reinforcement, corner protection angles, or other embedded items be permitted to extend continuously through any expansion joint.

All expansion joints shall be carefully placed so as not to be displaced during concreting. The method of placing the expansion joints shall be strictly in accordance with the Drawings and/or as directed by the Engineer. All materials for use in the expansion joints shall have prior approval of the Engineer before placing order for supply.

5.9 Embedded Items

- 5.9.1 The material, design and location of water stops in joints shall be as indicated in the Contract Documents. Each piece of pre molded water stop shall be of maximum practicable length in order that the number of end joints will be held to a minimum. Joints at intersections and at ends of pieces shall be made in the manner most appropriate to the material being used. Joints shall develop effective water-tightness fully equal to that of the continuous water stop material, shall permanently develop not less than 50 percent of the mechanical strength of the parent section and shall permanently retain their flexibility.
- 5.9.2 Electric conduits and other pipes which are planned to be embedded shall not, with their fittings, displace more than four percent of the area of the cross section of a column on which Stress is calculated or which is required for fire protection. Sleeves, conduits, or other pipes passing through floors, walls, or beams shall be of such size or in such location as not to impair unduly the strength of the construction; such sleeves, conduits, or pipes may be considered as replacing structurally in compression the displaced concrete/ provided that they are not exposed to rusting or other deterioration, are of uncoated or galvanized iron or steel not thinner than standard steel pipe, have a nominal inside diameter not over 2 inch and are spaced

not less than three diameters on centers. Except when plans of conduits and pipes are approved by the Engineer, embedded pipes and conduits other than those merely passing through, shall not be larger in outside diameter than one third the thickness of the slab, wall, or beams in which they are embedded nor so located as to impair unduly the strength of the construction. Sleeve pipes, or conduits of any material not harmful to concrete and within the limitations of this section may be embedded in concrete with the approval of the Engineer provided they are not considered to replace the displaced concrete.

- 5.9.3 All sleeves, inserts, anchors, and embedded items required for adjoining work or for its support shall be placed prior to concreting. All Contractors whose work is related to the concrete or must be supported by it shall be given ample notice and opportunity to introduce and/or furnish embedded items before the concrete is placed.
- 5.9.4 Expansion joint material, water stops and other embedded items shall be positioned accurately and supported against displacement. Voids in sleeves, inserts and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids.

2.2 Pre-Cast Concrete

Pre-cast concrete units shall be fair faced, cast to the sizes and dimensions as indicated on the Drawings. The concrete used for pre-cast units shall conform to the specifications laid down for cast in situ reinforced cement concrete unless otherwise required and directed by the Consultant.

The Contractor shall be required to submit a sample of pre-cast unit for the approval of the Engineer; all pre-cast units shall strictly conform to the approved sample.

Pre-casting platform of the size and at the location approved by the Engineer shall be constructed. The concrete in one pre-cast unit shall be placed in one operation, in accordance with the details shown on the Drawings.

The material and design of formwork and the method of pre-casting the units shall be approved by the Engineer. The erection/installation and removal of the pre-cast units from the pre-casting platform shall not be permitted until and unless they are properly cured to the satisfaction of the Engineer.

All pre-cast units shall be smoothly finished to the required lines, grades, angles, etc. Holes, grooves, pockets and hooks shall be provided as shown and/or as directed by the Engineer. The units shall be properly stacked on a platform without causing any cracks and damages. Curing of all the pre-cast units shall be done in accordance with the relevant BS code/approval of the Engineer.

2.2.1 Erecting Pre-cast Units

All the pre-cast units shall be transported and erected into position in a manner as approved by the Engineer.

The Contractor shall submit his proposal in this regard and obtain approval from the Engineer in advance.

2.2.2 Lifting Beams

The Contractor shall use lifting beams at his own cost for erecting pre-cast members where the Engineer so directs. Lifting beams shall be supplied and erected by the Contractor, at his own cost, at all points where lifting is necessary for maintaining the plant but is inaccessible to mobile/cranes or, alternatively, covered by overhead traveling cranes. The Contractor, however, is to supply the trolleys and erect them on the lifting beams, and to test operation of installed equipment.

3. Cement Concrete Pavements

For all concrete work relevant specifications of this section shall apply.

3.1 Side Forms and Construction

Side forms shall be of steel or any other suitable material and of a design as approved by the Engineer.

In general, only materials and methods that have proved their acceptability by past performance will be considered. All form shall be constructed so that they can be removed without hammering or prying against the concrete.

Horizontal joints in the forms will not be permitted. Forms shall be thoroughly cleaned and oiled with linseed/mineral oil shall be given two coats of niter-cellulose lacquer each time they are used.

The forms shall be set on a thoroughly compacted base true to line and level and firmly secured in position by appropriate methods. Conformity with the alignment and levels shown on the Drawings shall be checked as and when required by the Engineer. Where necessary corrections shall be made immediately before placing the concrete; where any form has been disturbed it shall be reset and rechecked.

Pavements shall be constructed in panels of sizes as shown on the Drawings. The panels shall be laid alternately, the adjoining panels being concreted when the side forms are struck and the jointing materials placed, inspected and approved by the Engineer. Each panel is to be concreted in one operation and no interruptions shall be permitted during the operation. The concrete shall be tipped from the trolley slightly in advance of the working place and then shoveled into position. The spreading shall be carried out very carefully. Compaction shall be done by means of vibrators compactors of approved surface vibrators. If a vibrators compactor is used, it shall be operated on the concrete and will not be allowed to strike or displace the forms. The spreading and compacting, of the successive layers shall proceed without interruptions and as quickly as practicable so as to ensure that the slab is ' monolithic throughout its depth.

The wearing surface shall be laid while the base concrete is still wet and screeded to line and level. When the initial set takes place the surface shall be troweled smooth with a steel trowel to provide a dense closed surface.

All the joints shall be carefully formed as shown on the Drawings or as directed by the Engineer. The joint filler together with performed groove

shall provide complete separation of adjacent slabs. The joints shall all be sealed with bitumen as shown on the Drawings and as directed by the Engineer.

3.2 Protection and Curing

General Requirements:

Concrete shall be protected adequately from injurious action by sun, rain, flowing water and mechanical injury, and shall not be allowed to dry from the time it is placed until the expiry of the minimum curing periods specified hereinafter. Water curing shall be accomplished by keeping the surface of the concrete continuously wet by covering with water or with approved water saturated covering. Where wood forms are left in place for curing, they shall be kept sufficiently damp at all times to prevent openings at the joints and drying out of the concrete. All portions of the structure shall be kept moist for the full curing periods, specified hereinafter.

When liquid membrane curing compound is used the surface of the concrete shall be protected from traffic or other abrasive action, that may break the membrane, for the full period of curing. The membrane curing compound shall be colorless or light colored and shall be approved by the Engineer and shall comply with ASTM Designation C 309.

Curing Periods:

The curing period shall be at least 10 days, or as directed by the Engineer.

Removal of Forms:

The Contractor shall exercise great care in avoiding damage to joints, arises, dowel bars etc., while removing the forms. Under no circumstances will the use of pry bars between the forms and pavement be permitted. Side forms shall not be removed until at least 40 hours have elapsed from the time of completing the concreting of the slab, which they contain. In no case shall forms be removed until the concrete has hardened sufficiently to permit removal without damage to the concrete. Concrete work shall be protected from injury resulting from the storage or movement of material during construction.

3.3 Finishing

All unformed surfaces shall be finished with a wood float except as otherwise specified. Visible vertical surfaces shall have all projections and irregularities removed. The entire surface shall be rubbed if required by the Engineer, with a No. 16 carborundum brick, or other abrasive until even, smooth and of uniform appearance, and shall be shed clean. Plastering of surface, application of cement or other coating will not be permitted.

All exposed corners shall be chamfered, 1"x 1" (2.5 cms x 2.5 cms) unless otherwise mentioned or shown on the plans or directed by the Engineer. Concrete surfaces which will be covered with other materials shall be screeded without floating.

3.4 Spreading, finishing and floating of concrete in pavements

General Requirements

The striking of, compacting and floating of concrete shall be done by mechanical methods, if approved by the Engineer. Where the Engineer determines that it is impracticable to use mechanical methods, manual methods of spreading, finishing and floating may be used on pavement lines as indicated on the Drawings.

Mechanical Methods

The concrete shall be spread uniformly between the forms, immediately after it is placed, by means of an approved spreading machine. The spreader shall be followed by an approved finishing machine equipped with two oscillating or reciprocating screeds. The spreading machine or the finishing machine shall be equipped with vibrating equipment that will vibrate the concrete for the full paving width. Internal vibrators shall be used adjacent to the longitudinal edge of the pavement. These vibrators shall be attached to the rear of the spreading machine or to the finishing machine. Vibrators shall not rest on new pavements or side forms or in contact with any dowel bars and the arrangement of power supply to the vibrators shall be such that when the motion of machine is stopped, vibration shall cease. The rate of vibration shall be not less than 8000 vibrations per minute. The concrete shall be spread to full width before being struck off and compacted so that the surface will conform to the finished grade and cross-section as shown on the plans and at the same time leave sufficient material for the floating operation. The spreading & finishing machine shall move over the pavement as many times and at such intervals as may be required by the Engineer to ensure thorough compaction.

Except as otherwise specified, after the pavement has been struck off and compacted, it shall be finished with an approved longitudinal float. The Contractor may use a longitudinal float composed of one or more cutting and smoothing floats suspended from and guided by rigid frame. The frame shall be carried by four or more visible wheels riding on and constantly in contact with the forms.

The contractor may use a longitudinal float which works with a sawing motion, while held in a floating position parallel to the road centre line and passing gradually from one side of the pavement to the other. Movements ahead, along the centre line of the road, shall be in successive advances of not more than half the length of the float.

Instead of using other type of longitudinal float a single machine, which will affect satisfactory compaction, finishing and floating may be used. This machine may be towed by a spreading machine. This combination, finishing floating machine shall be equipped with screeds and vibrators as hereinafter specified for spreading and finishing machine. Floating shall be accomplished by means of a non-oscillating float held in a suspended position from the frame.

If any spreading, finishing and floating equipment is not maintained in full working order or if the equipment as used by the Contractor proves inadequate to obtain the results prescribed, such equipment shall be improved or satisfactory equipment substituted or added at the direction of the Engineer.

Manual Methods

When striking-off and compacting by manual methods is permitted, the concrete shall be leveled and then struck-off to such an elevation that, when properly compacted, the surface will conform to the required grade' and cross-section. The strike board shall be moved forward with a combined longitudinal and transverse motion, the manipulation being such that neither ends is raised from the side forms during the process. While striking off, a slight excess of concrete shall be kept in front of the cutting edge at all times. Prior to tamping, the concrete along the forms shall be thoroughly spaded or vibrated. The entire area of pavement shall be tamped or vibrated in a manner that will ensure maximum compaction. The concrete shall be brought to the required grade and shape by the use of a tamper consisting of a heavy plank whose length exceeds the width of the pavement by 1 foot or by the use of a mechanical vibrating unit spanning the full width of the spread. The tamper shall be constructed with properly trussed roads to stiffen it and prevent sag and shall be shod with a heavy strip or metal for a tamping surface. The tamper shall be moved with a combined tamping and longitudinal motion, raising it from side form and dropping it so that the concrete will be thoroughly compacted and rammed into place. A small surplus material is compacted and rammed into front of the tamper or vibrating unit and tamping or vibrating shall continue until the true cross-section is obtained and the mortar flushes slightly to the surface.

On grades in excess of 5 percent where hand methods are permitted, a light strike board shall follow at a speed of 25 ft to 50 ft per hour back of the heavy strike board, and shall be used in the same way, so as to remove waves caused by flow of concrete.

Where hand tamping is permitted, not less than two strike boards or tampers shall be used for production in excess of 350 CU.ft. After the concrete has been compacted, it shall be smoothed with a wooden float where necessary, as directed by the Engineer.

Longitudinal Floating

Manual floats shall be at least 12 ft. in length not less than 6 inches in width and shall be properly stiffened to prevent bending or warping. In using the float, it shall be held parallel to centre line of the pavement at all time and shall be moved laterally across the pavement from one side or edge to the other until all high areas are cut down and floated into depressions, leaving a surface that is smooth and true to grade. Batch transverse passage of the longitudinal manual float shall lap the proceeding passage by half.

First Straight Edge Testing

Immediately following final floating the entire area of the pavement shall be tested with a 10-ft. (approx. 3. meters) straight edge. Any depressions found shall be immediately filletted with fresh concrete which shall be struck off, compacted and finished. High areas shall be worked down and refinished. The straight edge testing and refloating shall continue until the pavement has the required surface contour.

After the first straight edge testing and when most of the water sheet has disappeared from the surface, and just before the concrete becomes non-plastic, the surface shall be dragged with a strip of

burlap (coarse canvas) 3 ft. to 10 ft. wide and having a length 4 ft. more than the width of the slab. The burlap shall be dragged along the surface of the pavement in a longitudinal direction. Burlap shall be clean and kept free from coatings of hardened concrete. It shall be moist at the time of use.

Second Straight Edge Testing:

After the concrete has hardened sufficiently to permit walking on it, the surface of the pavement shall again be tested with a 1 a-ft. straight edge. Any portion of the pavement which shows a variation from the testing edge of more than 1/8 inch shall be corrected by cutting, or shall be removed and replaced at the expense of the Contractor.

3.5 Expansion and Construction Joints

- i) All the expansion and contraction joints shall be carefully formed as shown on the Drawings or as directed by the Engineer. As regards dowel bars and joint assemblies, such stakes, brackets or other devices shall be used, as necessary to keep the entire joint assembly in true vertical and horizontal position. The joint filler together with the preformed groove shall provide complete separation of adjacent slabs. The joints shall all be sealed with the specified non-extruding sealing compound set in a 3/4 inch wide preformed chase as shown on the Drawings. The preformed chase shall be thoroughly cleaned of all dust, debris, stones or other hard material prior to its sealing. The riser of all joints shall be rounded to a radius as shown on the Drawings before the concrete hardens.
- ii) The joints sealing compound shall be hot poured bitumen or approved sealing compound for concrete pavements complying with BS-2499 for hot tropical climates and heavy duty industrial site subject to severe exposure. All joints to be filled with flex cell expansion joint filler, or an approved elastic, compressible, durable and rot-proof equivalent of sufficient rigidity to enable it to be satisfactorily installed in the joint and resist deformation during the passage of the concreting equipment. The filler is to be of the same thickness as the joint Width. Holes to accommodate the dowel bars shall accurately be drilled or punched out. Where shown on the Drawings, dowel bars of required diameter shall be placed at the specified spacing. The bars shall be lubricated with an approved lubricant. One end of the dowel bar at expansion joints shall be provided with a closely fitting sleeve 3 inch long, consisting of bitumen coated plastic or other approved material to permit expansion. A loose plug 1 inch deep of approved compressible filling material shall be inserted into the sleeve as shown on the Drawings at the end of the bar. All the dowel bars shall be mild steel bars of the size shown on the Drawings and shall conform to the requirements as specified in the section 'Concrete.
- iii) Contraction joints shall be provided as shown on the Drawings. The assembly and method of constructing the expansion joints/contraction joints shall be subject to the approval of the Engineer.

3.6 Consolidation

- 3.6.1 All concrete shall be consolidated by vibration, spading, rodding or forking so that the concrete is thoroughly worked around the reinforcement, around embedded items and into corners of forms, eliminating all air or stone pockets which may cause honeycombing, pitting, or planes of weakness. Internal vibrators shall have a minimum frequency of 8000 vibrations per minute and sufficient amplitude to consolidate the concrete effectively. They shall be operated by competent workmen. Use of vibrators to transport within forms shall not be allowed. vibrators shall be inserted and withdrawn at points approximately 18 inch apart. At each insertion, the duration shall be sufficient to consolidate the concrete but not excessive so as to cause segregation, generally from 5 to 15 sec. A spare Vibrator shall be kept on the job site during all concrete placing operations.

Where the concrete is to have an as-cast finish, a full surface of mortar shall be brought against the form by the vibration process, supplemented, if necessary, by spading to work the coarse aggregate back from the formed surface.

- 3.6.2 If there is any tendency for the mix to segregate during consolidation, particularly if this produces excessive laitance, the mix proportions shall be modified to effect an improvement in the quality of the concrete to the satisfaction of the Engineer and in conformity with the provisions of Clause 5.
- 3.6.3 Vibrator shall not be allowed to contact the formwork for exposed concrete surfaces.
- 3.6.4 Mechanical vibrators shall be of a type suited in the opinion of the Engineer to the particular conditions.
- 3.6.5 Over-vibration or vibration of very wet mixes is harmful and should be avoided.

3.7 Curing and Protection

- 3.7.1 Beginning immediately after placement, concrete shall be protected from premature drying, excessively hot or cold temperatures and mechanical injury and shall be maintained with minimum moisture loss at a relative constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing shall be subject to approval of the Engineer.
- 3.7.2 For concrete surfaces not in contact with forms, one of the following procedures shall be applied immediately after completion of placement and finishing: Ponding or continuous sprinkling. Application of absorptive mats fabric kept continuously wet. Application of waterproof sheet materials approved by the Engineer. Application of other moisture-retaining covering as approved. Application of a curing compound conforming to ASTM C 309. The compound shall be applied in accordance with the recommendations of the manufacturer immediately after any water sheen, which may develop after finishing has disappeared from the concrete surface. It shall not be used on any surface against which additional concrete or other material is to be bonded unless it is proved that the curing compound will not prevent bond, or

unless positive measures are taken to remove it completely from areas to receive bonded applications.

- 3.7.3 Moisture loss from surfaces placed against wooden forms or metal forms exposed to heating by the sun shall be minimized by keeping the forms wet until they can be safely removed. After form removal the concrete shall be cured until the end of the time prescribed for curing.
- 3.7.4 Curing in accordance with sub-clause 5.13.1 & 5.13.2 above shall be continued for at least 10 days in the case of all concrete except concrete with rapid-hardening Portland Cement for which the period shall be at least 3 days. Alternatively, if tests are made of cubes kept adjacent to the structure and cured by the same methods, moisture retention measures may be terminated when the average compressive strength has reached 70 percent of the minimum specified works cube strength. If one of the first four curing procedures of sub-clause 5.13.2 is used initially, it may be replaced by one of the other procedures of that sub-clause any time after the concrete is one day old provided the concrete is not permitted to become surface dry during the transition.
- 3.7.5 When the mean daily outdoor temperature is less than 5 degree C (41 deg. F) temperature of the concrete shall be maintained between 10 and 20 degrees C (50 to 68 deg. F) for the required curing period of sub-clause 5.13.4.
- When necessary, arrangements for heating, covering insulation or housing t/ie. Concrete work shall be made in advance of placement and shall be adequate to maintain the required temperature without injury due to concentration of heat. Combustion heaters shall not be used during the first 24 hours unless precautions' are taken to prevent exposure of the concrete to exhaust gasses, which contain carbon dioxide.
- 3.7.6 During hot weather when necessary, provision for wind-brakes, shading for spraying, sprinkling, ponding or wet covering with a light coloured material shall be made in advance of placement. Such protective measures shall be taken as quickly as concrete hardening and finishing operation will allow.
- 3.7.7 Changes in temperature of the air immediately adjacent to the concrete during and immediately following the curing period shall be kept as uniform as possible and shall not exceed 3 deg. C (37 deg. F) in anyone hour or 10 degree C (50 deg. F)in any 24 hour period.
- 3.7.8 During the curing period, the concrete shall be protected from damaging mechanical disturbances, such as load stresses, heavy shock and excessive vibrations. All finished concrete surfaces shall be protected from damage by construction equipment, materials or methods by application of curing procedures, and by rain or running water. Self-supporting structures shall not be loaded in such a way as to over stress the concrete.

3.8 Works in Extreme Weather

- 3.8.1 Unless adequate protection is provided and approval is obtained from the Engineer, concrete shall not be placed during rain. Rainwater shall not be allowed to increase / ease the mixing water nor to damage the surface finish.
- 3.8.2 When the temperature of the surrounding air is expected to be below 5 deg. C during placing or within 24 hours thereafter, the temperature of the plastic concrete, as placed, shall be no lower than 13 deg. C for sections less than 12 inch in any dimension nor 10 deg. C for any other sections.

When necessary, concrete material should be heated before mixing and carefully protected after placing, in general, heating or mixing water alone to about 60 deg. C may be sufficient for this purpose. Dependence should not be placed on salt or other chemicals for the prevention of freezing. No frozen material or materials, containing ice shall be used. All concrete damaged by frost shall be removed. It is recommended that concrete exposed to the action of freezing weather should have entrained air and the water content of the mix should not exceed 5.5 gallon/bag of cement.

If water or aggregate is heated above 38 deg. C the water shall be combined with the aggregate in the mixer before cement is added.

Cement shall not be mixed with water or with mixtures of water and aggregate having a temperature greater than 38 deg. C.

- 3.8.3 During hot weather, the temperature of the concrete as placed shall not be so high as to cause difficulty from loss of slump, flash set, or cold joints and should not exceed 32 deg. C. For massive concrete, this temp. should not exceed 21 degree C. When the temp. of the concrete exceeds 32 degree C, precautionary measures approved by the Engineer shall be put into effect. When the temperature of the steel is greater than 50 deg. C, steel forms and reinforcement shall be sprayed with water just prior to placing the concrete. The ingredients shall be cooled before mixing, or flaked ice or well crushed ice of a size that will melt completely during mixing may be substituted for all part of the mixing water if, due to high temperature, low slump, flash set or cold joints are encountered. Other precautions recommended by ACI Standard 305-72 shall also be adopted.

4. EST of Concrete Quality

- 4.1 The Contractor shall provide samples of concrete for testing at the Engineer's direction. Proper facilities shall be provided for making and curing the test specimens in accordance with PS 560 and PS 849. A competent person shall be employed by the Contractor whose first duty shall be to supervise all stages in the preparation and placing of the concrete. All Test specimens shall be made and site tests carried out under his direct supervision.
- 4.2 Preliminary cube tests and works cube test shall be performed in accordance with PS 560 and PS 849 at the discretion of the

Engineer. Works transverse tests shall be performed in accordance with sub-clauses 208 c and 610 d of CP 114. The standard of acceptance for preliminary and works tests shall be as given below.

- 4.3 The usual test for concrete with maximum size of aggregate up to 1-1/2 inch is the 6 inch cube tested in compression. Details of making and curing compression test cubes are given in PS 560, PS 849 and BS 1881 and details of the testing are given in Part 8 of BS 1881.

For all grades of concrete, preliminary cube strength test with the mixes and materials to be used shall be performed in accordance with PS 560, PS 849 and BS 1881 before the work is begun and subsequently whenever any change is to be made in the materials or in the proportions of materials to be used, or as required by the Engineer. The strengths shall comply with the standard of quality specified in accordance with Table 1 for preliminary tests. The cost of such testing shall be borne by the Contractor.

- 4.4 Test sample shall be taken at the mixer or as directed by the Engineer. The test specimens shall be cured in accordance with PS 560, PS 849 and BS 1881. Records shall be kept of all test cubes identifying the mix used the section of work for which the concrete was used and the date poured. !
- 4.5 Five test cubes are to be tested for compressive strength as specified in BS 1881. These tests shall be carried out at site or in a laboratory approved by the Engineer. Two cubes shall be tested at the age of seven days and three at 28 days and the strengths determined are to comply with the standard of quality specified. The laboratory tests shall be carried out by an independent organization, such as Government Testing Laboratory or such other undertakings approved by the Engineer. The original test reports received from the above authorities should be submitted to the Engineer.
- 4.6 For all grades of concrete, the appropriate strength requirement shall be considered to be satisfied if none of the strengths of the cubes is below the specified cube strength or if the average strength of the three cubes is not less than the specified cube strength and the difference between the greatest and the least strength is not more than 20% of the average.
- 4.7 When the results of works cube tests show that the strength of any concrete is below the minimum specified, the Engineer may give instructions for the whole or part of the work concerned to be removed and replaced at the expense of the Contractor. The Contractor shall bear the cost of any other part of his, or any other contractor's work, which has to be removed and replaced as a result of the defective concrete. If any concrete is held to have failed, the Engineer may order the proportions of that class of concrete to be changed in order to provide the specified strength.

5. Finishing of Formed Surfaces

5.1 General

- 5.1.1 After removal of forms, the surfaces of concrete shall be given one or more of the finishes specified below in locations designated by the Contract Documents.

5.1.2 When finishing is required to match a small sample furnished to the Contractor, the sample finish shall be reproduced on an area at least 100 Sq. ft. in an inconspicuous location designated by the Engineer before proceeding with the finish in the specified location.

5.1.3 Allowable deviations from plumb or level and from the alignment profile grades, and dimensions are specified in clause 9. Tolerances for concrete construction and defined as tolerances that are to be distinguished from irregularities in finish as described herein. The finish requirements for concrete surfaces shall be as generally specified in this clause and as indicated on the Drawings. Finishing of concrete surfaces shall be performed or, by workmen who are skilled in concrete finishes. The Contractor shall keep the Engineer advised as to when finishing of concrete will be performed. Unless inspection is waived in each -specific case, finishing of concrete shall be performed only in the presence of the Engineer. Concrete surfaces will be tested by the Engineer where necessary to determine whether surface irregularities are within the limits herein after specified. Surface irregularities are classified as abrupt or gradual.

Offsets caused by displaced or misplaced form sheeting or lining or sections, or otherwise defective form lumber will be considered as abrupt irregularities, and will be tested by direct measurements. All other irregularities will be considered as gradual irregularities, and will be tested by use of a template, consisting of a straight edge or the equivalent thereof for curved surfaces. The length of the template will be 6.5 ft. for testing of formed surfaces and 10ft. for testing of unformed surfaces.

5.2 As-cast Finishes

Unless otherwise specified or indicated on the Drawings the classes of finish shall apply as follows:

5.2.1 Rough form finish:

No selected form facing materials shall be specified for rough form finish surfaces. Tie holes and defects shall be patched. Fins exceeding 1/4" in height shall be chipped off or rubbed off. Otherwise, surfaces shall be left with the texture imparted by the forms.

5.2.2 Fair face finish:

Fair face finish applies to concrete formed surfaces, the appearance of which is considered by the Engineer to be of special importance, such as surfaces of structures prominently exposed to public inspection. Surfaces of concrete structures requiring fair face finish is shown in the Drawings. Surface irregularities, measured as described in sub-clause 7.2.1, 'Rough form finish', shall not exceed 1/4 inch for gradual irregularities and 1/8 inch for abrupt irregularities, except that abrupt irregularities will not be permitted at construction joints. Abrupt irregularities at construction joints and elsewhere in excess of 1/8 inch and gradual irregularities in excess of 1/4 inch shall be reduced by grinding so as to conform to the

specified limits. Abrupt irregularities at construction joints shall be ground on level of 1 to 20 ratio of height to length.

Unless otherwise approved, repair of imperfections in formed concrete shall be completed within 24 hours after removal of forms. The form facing material shall produce a smooth, hard, uniform texture on the concrete. It may be plywood, tempered concrete-form-grade hardboard, metal, plastic paper, or other approved material capable of producing the desired fair face finish. The arrangement of the facing material shall be orderly and symmetrical, with the number of seams kept to the practical minimum. It shall be supported by studs or other backing capable of preventing excessive deflection. Material with raised grain, torn surfaces, worn edge, patches, dents, or other defects which will impair the texture of the concrete surface shall not be used. Tie holes and defects shall be patched. All fins shall be completely removed.

5.2.3 Architectural Finish Concrete:

Architectural finish concreting formed surfaces as shown on the Drawings IS required by. The Engineer where the architectural appearance of surfaces of structures exposed to public view is of special consideration and importance. The Contractor shall use approved special material for formwork and design the forms in conformity with the specified architectural patterns, textures and finishes in order to obtain first class architectural finish on formed concrete surface without any defect, irregularities, blemishes, imperfections and encrustation's.

Samples:

Submit to the Engineer a minimum of two units or portions of units of each precast item required. Each pair of samples when accepted will describe the allowable limits between which variations can be acceptable.

Similar samples of in-situ concrete for approval by the Engineer submit two samples, 2 Sq. ft. of each type of exposed in-situ concrete. All in-situ samples will remain at the construction site.

Sample approvals of precast & in-situ concrete:

These samples will be reviewed and approved on the basis of colour, dimensional accuracy, and finish of surfaces and general appearance. The same requirements for sample approval will be required for both precast and in-situ concrete exposed surfaces.

Forms:

The contractor must maintain the forms unusually tight and braces to prevent movement, mal-alignment and bleeding that will result in sand streaks, honeycomb, fins, stain or unsightly appearance. / .

If wood forms are chosen to be used by the Contractor they shall be constructed of 3/4 inch minimum thickness plywood

constructed in a fashion to allow many re-uses with all surfaces sealed with a polyurethane varnish.

Edges, surfaces and corners of forms shall be sealed to prevent loss of any matrix or unequal absorption of water. Corners of wood forms shall be filled with suitable compound and all contact surfaces sealed with a polyurethane varnish.

Re-use of forms shall be subject to approval by the Engineer.

Curing:

Curing shall be done in shade (out of direct sunlight) and shall be for a minimum period of 4 days.

Finishing Procedures:

"Finishing procedures for filling air void smooth finished concrete developed by a formed surface":

While the concrete surface is still damp (not more than three days after removal of forms), apply a thin coat of medium consistency neat cement slurry by means of bristle brushes to provide a bonding coat within any pits or blemishes in the parent concrete; avoid coating large areas of the finished surface. Before slurry has dried or changed colour, apply a dry (almost crumbly) grout comprised of one part cement, of the type and brand of cement used in the original concrete, to one and one-half parts clean masonry sand with f3 fineness modulus of approximately 2.25 and complying with the gradation requirements of the ASTM Specifications C 144. Mix proper amounts of white cement and colouring with the parent mortar to produce a satisfactory colour match with the parent concrete after hardening. Use samples previously prepared.

Apply the finishing grout uniformly with damp (neither dripping wet nor dry) pads of coarse burlap approximately 6 inch square used as a float. Scrub the grout well into the pits to provide a dense mortar in all the imperfections to be filled. Allow the mortar to partially harden, from one to two hours, depending upon the weather. Avoid direct hot sunlight. If the air is hot and dry, keep the concrete surface damp during this period using a fine fog spray. When the grout has hardened sufficiently so it can be scraped from the surface with the edge of a steel trowel without damaging the grout from the small pits or holes, cut off all that can be removed with a trowel without delay; next allow the surface to dry thoroughly and rub it vigorously with clean, dry burlap to completely remove any dried grout. No visible film of grout shall remain after this rubbing. Complete the entire cleaning and grouting operation for the grout to dry after it has been cut with the trowel, so it can be wiped off clean with the burlap.

On the day after the repair work, the concrete surfaces should again be wiped off clean with dry burlap to remove any inadvertent dust; leave no built-up surfaces on the parent surfaces. Employ, if possible, a used piece of burlap containing old hardened mortar to act as a mild abrasive. Use of fine abrasive stone if needed to remove any remaining built-up film without breaking through the surface film of the original

concrete. Such scrubbing should be light and sufficient only to remove excess material without working up a lather of mortar or 'changing the texture of concrete.

Following the final brooming or stoning operation, provide a thorough wash down with stiff bristle brushes 10 remove all extraneous materials and spray the concrete surface with a fine fog spray periodically to maintain a continually damp condition for at least three days after application of the pit repair grout.

Rust Stains:

All rust stains are to be removed employing the following procedure:

The rust stain shall be soaked for 10 minutes with a solution of 0.055 lb. of sodium citrate in 0.33 lb. water "(brushing the solution at short intervals is satisfactory). Then the surface is sprinkled with crystals of sodium hydrosulfite and covered with a paste of Fuller's Earth and water. On a vertical surface, the paste is applied with a trowel, with the crystals first sprinkled on the paste so they will be in direct contact with the stain. The paste is allowed to dry for 10 minutes then scraped off and the treatment repeated if necessary.

Repairing of Formed Surfaces:

It is the intention of Specification to require form mixture of concrete and workmanship so that concrete surfaces, when exposed, will require no patching. Any concrete which is not formed as required and conforming to approved samples or for any reason is out of alignment or level or shows a defective surface, shall be removed from the job by the Contractor at his expense unless the Engineer grants permission to repair the defective area. Permission to patch any such area shall not be considered a waiver of the Engineer's right to require a complete removal of defective work if the repair does not, in his opinion, satisfactorily restore the quality and appearance of the surface. The Engineer shall be the sole judge of acceptability of appearance.

5.3 Finishes of Unformed Surfaces:

5.3.1 Monolithic Concrete Floor Finish

Where monolithic concrete floor finish is shown on the Drawings, placing shall proceed continuously for the full thickness of the course or RCC slab without change in concrete mix. Mixing water shall be the minimum required for proper placing, and will be as specified by the Engineer. After placing, floors, and other surfaces shall be floated with a wood float to a true surface and to elevation as shown on the Drawings. Where indicated on the Drawings, floor surfaces shall be steel trowel finished. Troweling shall be the minimum amount consistent with . maintaining a smooth dense surface, and shall not be done until the mortar has hardened sufficiently, to prevent excess fine material from being worked to the surface, and shall produce a dense uniform surface, free from blemishes and trowel marks.

Gradual surface irregularities shall not exceed 1/16 inch. The addition of water, dry cement, or dry cement mortar, to the surface of the concrete to facilitate finishing will not be permitted.

5.3.2 Equipment Foundations'

Unless otherwise specified, exposed, surfaces of equipment foundations shall be given steel trowel finish to produce a surface similar to the specified concrete floor finish.

6 Repair of Surface Defects

6.1 General

6.1.1 Any concrete failing to meet the specified strength or not formed as shown on drawings, concrete out of alignment, concrete with surfaces beyond required tolerances or with defective surfaces which cannot be properly repaired or patched in the opinion of the Engineer shall be removed at Contractor's cost. The Engineer may reject any defective concrete and order it to be cut out in part or in whole and replaced at the Contractor's expense. All ties and both less and all repairable defective areas shall be patched immediately after form removal.

6.2 Repair of Defective Areas

6.2.1 All honeycombed and other defective concrete shall be removed down to sound concrete. The area to be patched and an area at least 6 inch wide surrounding it shall be dampened to prevent absorption of water from the patching mortar. A bonding grout shall be prepared using c. mix of approximately 1 part cement to 1 part fine sand passing NO.25 BS Sieve and shall then be well brushed into the surface.

6.2.2 The patching mixture shall be made of the same material and of approximately the same proportions as used for the concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of not more than 1 part cement to 2-1/2 parts sand by damp loose volume. White Portland cement shall be substituted for a part of the gray Portland cement on exposed concrete in order to produce a colour matching the colour of the surrounding concrete, as determined by a trial patch.

6.2.3 The quantity handling of mixing water shall be no more than necessary for allowed and placing. The patching mortar shall be mixed in advance and of to stand with frequent manipulation with a trowel, without addition placing water, until it has reached the stiffest consistency that will permit

6.2.4 After surface water has evaporated from the area to be patched, the bon coat shall be well brushed into the surface. When the bond coat begins to loose the water sheen, the premixed patching mortar shall be applied. The mortar shall be thoroughly consolidated into place and struck off so as to leave the patch slightly higher than the surrounding surface. To permit initial shrinkage, it shall be left undisturbed for at least 1 hour before

being finally finished. The patched area shall be kept damp for 7 days. Metal tools shall not be used in finishing a patch in a formed wall, which will be exposed.

- 6.2.5 Where as-cast finishes are specified, the quantity of patched area shall be strictly limited. The combined total of patched areas in as cast surfaces shall not exceed 2 sq.ft. in each 1000 sq.ft. of as-cast surface. This is in addition to form tie patches, if the project design permits ties to fall within as-cast areas.
- 6.2.6 Any patches in as-cast architectural concrete shall be indistinguishable from surrounding surfaces. The mix formula for patching mortar shall be determined by trial to obtain a good colour match with the concrete when both patch and concrete are cured and dry. After initial set, surfaces of patches shall be dressed manually to obtain the same texture as surrounding surfaces.
- 6.2.7 Patches in architectural concrete surfaces shall be cured for 7 days. Patches shall be protected from premature drying to the same extent as the body of the concrete.

6.3 Tie and Bolt Holes

After being cleaned and thoroughly dampened, the tie and bolt holes shall be filled solid with patching mortar. If architectural appearance requires, these holes may be filled partially creating the desired round clear holes pattern on surfaces exposed to view.

6.4 Proprietary Materials

If permitted or required by the Engineer, proprietary compounds for adhesion or as patching ingredients may be used in lieu of or in addition to the foregoing patching procedures. Such compounds shall be used in accordance with the manufacturer's recommendations with prior approval of the Engineer.

Where tolerances are not stated in the specifications or drawings for any individual structure or feature thereof, maximum permissible deviations from established lines, grades and dimensions shall conform to the following. The Contractor is expected to set and maintain concrete forms so as to ensure complete work within tolerance limits. These allowable tolerances shall not relieve the Contractor of this responsibility for correct fitting of indicated materials. These tolerances are not cumulative.

6.5 Variation from the plumb (or the specified batter for inclined walls.)

- 6.5.1 In the lines and surfaces of columns, piers, walls and in arises:
In any 10 feet of length or height In any storey or 20 feet length
Maximum for the entire length or height. In any bay or 20 feet
maximum 1/4 inch Maximum for the entire length or height 1/2
inch
- 6.5.2 Variation from the level or from the grades indicated on the drawings.
- 6.5.3 In floors, ceilings, beams soffits and in arises measured before removal of supporting shores.
In any 10 feet of length 1/4 inch

	In any bay or in any 20 feet length	38 inch
	Maximum for the entire length	3/4 inch
6.5.4	For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines.	
	In any bay or 20 feet length	1/4 inch
	Maximum for the entire length	1/2 inch
6.6	Variation of the linear building lines from established position in plan and related position of columns, walls and partitions.	
	In any bay or 20 feet of length	Maximum for the entire length 1/2 inch
		1 inch
6.7	Variation in the sizes and locations of sleeves, floor openings and wall openings. Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs And walls.	
	Minus	1/4 inch
	Plus	1/2 inch
	9.6 Footing	
6.7.1	Variation in dimensions in plan	Minus 1/2 inch
	Plus (plus variation applied to concrete only, not to reinforcing bars or dowels).	2 inch
6.7.2	Misplacement or eccentricity	
	2 percent of the footing width in the direction of misplacement but not more than (applies to concrete only, not to reinforcing bars or dowels).	1/2 inch
		2 inch
6.7.3	Thickness Decrease in thickness	5%
6.7.4	Increase in Specified thickness	No limit
6.8	Variation in Steps	
6.8.1	In a flight of stairs	
	Rise	+1 / 8 inch-
	Tread	+1 / 4 inch-
6.8.2	In consecutive steps	
	Rise	+1 / 16 inch-
	Tread	+1 / 8 inch-
6.9	'Tolerances for Precast concrete construction'	
	Forms must be true to size and dimensions of concrete members shown on the plans and be so constructed that the dimensions of the finished products will be within the following limits at the time of placement of these units in the structure, unless otherwise noted' on structural-architectural drawings:	
6.9.1	Overall dimensions of members	1/16 inch per 10 feet
6.9.2	Cross-sectional dimensions	Sections less than

	3 inch.	1/16 inch
	Sections over 3 inch and less than 18 inch.	1/8 inch 1/4
	inch	
	Sections over 18 inch.	1/8 inch
6.9.3	Deviations from straight line in long sections.	1/16 inch
	per	
	Not more than	10 feet
	per	+1/16 inch
		10 feet span
	Maximum differential between adjacent units in erected position	1/4 inch

7 Acceptance of Structure

7.1 General

- 7.1.1 Completed concrete work which meets all applicable requirements will be accepted subject to the other terms of the Contract Documents.
- 7.1.2 Completed concrete work which fails to meet one or more of the requirements and which has been repaired to bring it into compliance will be accepted subject to the other terms of the Contract Documents.
- 7.1.3 Completed concrete work which fails to meet one or more of the requirements and which cannot be brought into compliance may be accepted or rejected as provided in these Specifications or in the Contract Documents. In this event, modifications may be required to assure that remaining work complies with the requirements.

7.2 Dimensional Tolerances

- 7.2.1 Formed surfaces resulting in concrete outlines smaller than permitted by the tolerances of clause 9 shall be considered potentially deficient in strength and subject to the provisions of sub clause
- 7.2.2 Formed surfaces resulting in concrete outlines larger than permitted by the tolerances of clause 9 may be rejected and the excess material shall be subject to removal. If removal of the excess material is permitted, it shall be accomplished in such a manner as to maintain the strength of the section and to meet all other applicable requirements of function and appearance. Permission is required if excess material is to be removed in accordance with this clause. 10.2.3 Concrete members cast in the wrong location may be rejected if the strength, appearance or function of the structure is adversely affected or if misplaced items interfere with other construction.
- 7.2.3 Inaccurately formed concrete surfaces exceeding the limits of Clause 9 or of Clause 5.6 of Section 'Formwork' and which are exposed to view, may be rejected and shall be repaired or removed and replaced if required.

7.3 Appearance

- 7.3.1 Architectural concrete with surface defects exceeding the limitations of Sub-clause 5.6 of Clause 5 of the Section, 'Formwork' shall be removed and replaced.
- 7.3.2 Other concrete exposed to view with defects which adversely affect the appearance of the specified finish may be repaired only by approved methods.
- 7.3.3 Concrete not exposed to view is not subject to rejection for defective appearance.

7.4 Strength of Structure

- 7.4.1 The strength of the structure in place will be considered potentially deficient if it fails to comply with any requirements" which control the strength of the structure, including but not necessarily limited to the following conditions. Concrete strength requirements not considered to be satisfied in accordance with Clause 6 hereof.
- 7.4.2 Reinforcing steel size, quality, strength, position or arrangement at variance with the requirements as listed under specification of 'Reinforcement' or in the Contract Documents. Concrete which differs from the required dimensions or location in such a manner as to reduce the strength. Curing less than that specified. Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development. Mechanical injury, construction fires, accidents of premature removal of formwork likely to result in deficient strength. Poor workmanship likely to result in deficient strength.

Structural analysis and/or additional testing may be required when the strength of the structure IS considered potentially deficient.

Core tests may be required when the strength of the concrete in place is considered potentially deficient.
- 7.4.3 If core tests are inconclusive or impractical to obtain or if structural analysis does not confirm the safety of the structure, load tests may be required and their result evaluated in accordance with British Standard BS 8110 or ACI Standard 318.
- 7.4.4 Concrete work judged inadequate by structural analysis or by results of a load test shall be reinforced with additional construction if so directed by the Engineer or shall be replaced, at the Contractor's expense.
- 7.4.5 The Contractor shall pay all costs incurred in providing the additional testing and/or analysis required by this section.
- 7.4.6 The Employer will pay all costs of additional testing and/or analysis which is made at his request and which is not required by these Specifications, or by the Contract Documents.

8 Testing of Material

- a) A site laboratory shall be established by the Contractor for all the required testing of concrete, aggregates and other materials etc. All tests shall preferably be done at site. Only the test which are not possible to be carried out in the site laboratory shall be referred to the laboratory approved by the Engineer. All testing charges thereof shall be borne by the Contractor.

For testing of reinforcement steel bars, the samples shall be referred to the laboratory approved by the Engineer at the cost of the Contractor.

- b) Cement shall be tested as prescribed in -STM C -150.
c) Aggregates shall be tested as prescribed in British Standard BS 812 - 882. addition fine aggregate shall be tested for organic impurity in conformance with ASTM Standard CAO.

9 Measurement and Payment

9.1 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.

9.1.1 Providing, fixing, striking, etc. of formwork.

9.1.2 Providing, placing and fixing of anchor bolts or any other embedded parts.

9.1.3 Providing and installing all type of joints in concrete structure, including expansion joints.

9.2 Plain and Reinforced Concrete

9.2.1 Measurement

Concrete shall be measured as executed but no deduction shall be made for the following: Volume of any steel embedded in the concrete.

Volume occupied by water pipes, conduits etc. not exceeding 10 square inches each in cross-sectional area.

Voids not exceeding 4 square inch in work given in square feet. If any void exceeds 4 square inch, total void shall be deducted.

Voids, which are not to be deducted as specified above, refer only to openings or ,vents which are wholly within the boundaries of measured areas. Openings or vents which are at the boundaries of measured areas shall always be subject to deductions irrespective of size.

Concrete work shall be classified and measured separately as listed under items of Bills of. Quantities. Junction between straight and curved works shall in all cases be deemed to be included with the work in which they occur.

Measurement of walls shall be taken between attached columns piers or pilaster. The thickness of attached columns, piers or pilaster shall be taken as the combined thickness of the wall and the columns, piers or pilaster.

Attached or isolated columns, piers, pilaster, and the like (except where caused by openings) having a length on plan not exceeding four times the thickness shall be classified as columns. Those having a length over four times the thickness and are caused by openings in wall shall be classified as walls.

Columns shall be measured from the top of footing/footing beams or floor surfaces to the underside of beams or slabs as the case maybe. Where the width of beams is less than the width of columns, the extra width at the junction shall be included in the beams.

The depth of the beams shall be measured from bottom of the slab to the bottom of the beams except in case of inverted beams where it shall be measured from top of slab to the top of beam. The cross-section of the beam shall be the actual cross-section below or above the slab. .

Measurement of acceptably completed works of plain and reinforced cement concrete will be made on the basis of number of cubic feet concrete placed and compacted in position within the neat lines of the structure as shown on the Drawings or as directed by the Engineer.

9.2.2 Payment

Payment will be made for the acceptable measured quantity of plain and reinforced cement concrete 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.

9.3 M16 Hilti System Dowels

9.3.1 Measurement

Measurement of acceptably completed works of drilling and fixing of anchoring dowels as per M16 Hilti's System HIT-HY150 injection adhesive with HAS rod will be made on the basis of number of dowels drilled and fixed in position as shown on the Drawings or as directed by the Engineer.

9.3.2 Payment

Payment will be made for the acceptable measured quantity of drilling and fixing of anchoring dowels as per M16 Hilti's System HIT-HY150 injection adhesive with HAS rod, on the basis of unit rate per number quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

9.4 For Mortar

9.4.1 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		

Sand up to .0025 inch shall not be more than 8% by weight of the total.

9.4.2 **Cement:**

Cement shall be Sulphate Resistant conforming to BS-12.

9.4.3 **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.

9.4.4 **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.

9.4.5 **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.

9.4.6 **Reinforcement:**

For reinforcement refer specification section no. 2200.

10 Concrete Block Making

- 10.1 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.
- 10.2 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 polyethylene sheeting. After 10 days water curing period the blocks shall be air-dried. Under no circumstances will blocks be used in the work until they are completely dry. During curing period no surfaces of the block will be allowed to dry.
- 10.3 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. Care shall be exercised in the handling of all concrete blocks. No damaged blocks shall be used in the work.
- 10.4 The hollow blocks shall be manufactured as per pattern shown on the drawing. These block units shall be provided by the Contractor for use where required in building structures from approved type of materials. Units shall have uniformly fine smooth surfaces of uniform colour. These shall be free of any honey combing or other imperfections or deformations, all edges true and straight, and at right angles with each other and without any chipped or otherwise broken edges.
- 10.5 The blocks cast on different dates shall be stacked separately and must be labeled showing the date on which they were cast.
- 10.6 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.

11 Properties of Blocks

- 11.1 All blocks shall be of the size and shape required to complete the work shown in the Drawings or as instructed by the Engineer.
- 11.2 The cement, sand and coarse aggregate shall be volume batched and their proportion may be adjusted so as to provide the concrete of the required strength when tested and shall be mixed in a concrete mixer in accordance with clause 5.4 of the section 'Plain and Reinforced Concrete'.
- 11.3 All blocks shall comply with ASTM C145 198,8 edition. The compressive strength of various solid and hollow block shall be as follows:

S. No	Type of Concrete Masonry ASTM 1988 Edition	Compressive Average of 3 Units	Strength Psi Individual Unit (MPa)	Location
1	Solid load bearing	1800 (12.4)	1500 (10.4)	Exposed to frost action
2	Masonry Unit	1200 (8.30)	1000 (6.90)	

3	(ASTM-C-145) Solid/Hollow non	600(4.14)	500 (3.45)	Not exposed to moisture & weather
4	load bearing Masonry units (ASTM-C-90) Hollow load bearing masonry	1000 (6.90)	800 (5.50)	Exposed to moisture & weather
5	(ASTM-C-90)	700 (4.80)	600 4.10	Not exposed to moisture &

11.4 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.

11.5 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.

11.6 All properties or specifications of blocks, not explained in these Specifications shall comply with the requirements of ASTM C145 1988 edition as directed by the Engineer.

12 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/dm²/ min. or that the Contractor is able to adjust it so that it does not exceed this value on site.

13 Soluble Salt Content

For exposed block work, 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 and 0.03, percent respectively when ascertained in accordance with BS 3921, at the cost of the Contractor.

14 Reinforcing and Anchors of Block Masonry

Unless otherwise stated reinforcing and anchors shall conform to under mentioned sizes:

14.1 Joint reinforcing shall be 1.32mm (0.05-inch) diameter mild steel wire. Mesh design, galvanized after fabrication. Steel wire woven into 12mm mesh 75mm wide. Reinforcing bar anchors shall be 250mm dia. deformed bar minimum 10 inch long.

14.2 Two 6mm dia bar shall be provided at every fourth course for anchoring of block masonry to columns. Two # 10 bars at every fourth horizontal course shall be provided for anchoring masonry walls to plinth beam/floor beam, as shown on the drawings.

14.3 Dovetail anchors and slots (if used as an alternate anchorage) shall be not less than 18 gauge galvanized steel.

15 Erection

- 15.1 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.
- 15.2 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.
- 15.3 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.
- 15.4 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.
- 15.5 The block work shall be carried up in a uniform manner and no portion shall be carried more than one meter above the adjoining one at any time. All masonry shall be kept strictly true and square and the whole properly bonded together and leveled round each floor.
- 15.6 Sleeves, Chases, holes, sinking and mortices for other trades shall be correctly located and formed to the sizes as required by the relevant trades. Chiseling of completed walls or the formation of holes shall only be carried out.
- 15.7 Walls of blocks indicated, as being non-load bearing shall be constructed on the concrete floor slab unit after the floor formwork is struck and the concrete has obtained sufficient strength to support their weight Too thing into load-bearing walls shall not be permitted.
- 15.8 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.
- 15.9 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.
- 15.10 Care shall be taken during construction of cavity walls so as to avoid the filling up of cavity with mortar. G.1. flashing and weep holes shall be provided where ever 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.

16 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.

17 Jointing

Jointing is the forming of joints as work proceeds. Joints shall be as follows:

- 17.1 Exterior exposed joints shall be tightly formed to a weather joint with the point of the trowel.
- 17.2 Interior exposed joints shall be tightly formed to a concave joint
- 17.3 Joints which are subsequently covered with plaster or other finish materials shall be struck flush.

18 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 meter. The maximum tolerance in the length, height or width of any single masonry unit shall be! 3mm.

19 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 manufacturers specifications and shall be laid at required levels as per drawings and instructions of the Engineer. The D.P.C shall be tamped consolidated, leveled, edges and corners made to the requirements of concerned drawings including finishing and curing complete.

20 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.

21 Reinforced Hollow Block Masonry

Where specified on the Drawings, reinforced hollow block masonry shall be provided. Horizontal and vertical reinforcement shall be cold worked deformed bar. Two bars of No. 8 (8mm) diameter shall be provided at every third horizontal course at 600mm centers, while the vertical reinforcement shall be two bars of No. 12 (12mm) diameter at 800mm centers. Bars shall be anchored and held firmly vertical in respective beams and columns in the manner shown in shop Drawings. The reinforced hollow part of the block wall shall be solidly filled with Class 'D' concrete at intervals of one meter maximum height as the

laying of block masonry work proceeds. The filled concrete shall be consolidated thoroughly by rodding to avoid formation of voids. Contractor shall submit shop drawings of anchoring and placing of reinforcement in hollow block masonry for approval of the Engineer.

22 Curing and Repairs

- 22.1 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.
- 22.2 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.

23 Masonry Short of Height

In case of different thickness of slab in different areas or rooms or for any other reasons, whatsoever if chiseling 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 wall masonry. Similarly where the lintel heights are such that the Contractor has to chisel the masonry or provide cast-in-place concrete to make up the height of the course, no payment will be made for chiseling, but where such cast-in-place concrete is provided, payment for the same will be made at the unit rate of masonry.

24 Measurement and Payment

24.1 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.

24.1.1 Chiseling of masonry, wherever required

Providing and fixing all joints reinforcing bars dovetail anchors, Cement sand mortar used in laying blocks, curing of masonry works and making of weep holes, Wastage of material etc.

Providing and filling Class 'D' Concrete in the cavity of hollow block masonry.

Providing and laying damp proof courses including damp proof materials and GI sheet flashing within cavity wall.

24.2 Solid Block Masonry

24.2.1 Measurement:

Measurement for acceptably completed works of respective type of solid block masonry will be made on the basis of number of cubic feet provided and installed in position as shown on the

drawings or as directed by the Engineer. Each measurement shall be taken to the nearest W'. All opening\$ left in the masonry wall shall be deducted.

24.2.2 Payment:

Payment will be made for acceptable measured quantity of respective type of solid block masonry work 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.

SECTION – 10(a) BLOCK MASONRY

6.1 SCOPE

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

The work under this section includes the block maosnry in foundations, walls and partitions both load bearing and non-load beraring.

6.2 MATERIALS

6.2.1 BLOCKS.

All blocks shall be sound, of well burnt clay, uniform in shape and size, when struck , the block should produce ringing sound. The block shall be free from flows, cracks, shipped corners, nodules of line, kankar, other blemishes and salt. When the block is soaked in water for one hour, it should not absorb more than one sixth of its own weight. Blocks of only one size shall be used in the works. Blocks from different kilns not having the same size and colour shall not be accepted. The minimum compressive strength of the blocks tested in accordance with B.S. 1257 shall be 1300 psi subject to the condition that average compressive strength of five blocks tested shall not be less than 1500 psi.

6.2.2 Cement

Cement shall be Ordinary Portland Cement as specified in respective section.

6.2.3 Aggregates

Aggregates used shall meet the requirements specified under respective concrete section. All the aggregates dry and properly screened from approved source, shall also be acceptable for block making.

6.2.4 Block Masonry Units

- i) Concrete masonry blocks shall be made on the project site and shall be of the sizes required as per drawings and/or as directed by the Consultants and shall generally conform to the requirements of British Standard 2028, 1364:1968 until and unless specified or otherwise in the specifications.
- ii) The block shall be solid as required and shall be carefully made so that they are true in line and face with square corners and free from all defects. The ends of the blocks, masonry, shall be double grooved or as directed by the Consultants.
- iii) The blocks shall be cured by keeping moist continuously for a period of at least ten (10) days and then shall be allowed to dry in shade for at least twenty (20) days before used in masonry.
- iv) All blocks shall have clean cut straight and true edges, smooth dense faces of uniform appearance without voids, honeycombs, projections and shall be free from cracks spalls, chips, rugged edges or other defects detrimental to their use.
- v) Where blocks are to be plastered or rendered, the blocks surface shall have a coarse texture suitable for bonding the plaster as approved by the Engineer.
- vi) All blocks shall be stacked at site in a quantity not exceeding 5,000 blocks in each stack. The stacking shall be done in such a manner as to avoid smearing of the blocks in the lowest part of the stack with clay. Blocks smeared with clay show very poor bond with mortar sand, therefore, any blocks thus affected be rejected out of hand without recourse. When transported to the site the blocks shall not be dumped from the vehicle, the blocks shall be manually unloaded and stacked as aforesaid.

6.2.5 CEMENT MORTAR FOR MASONRY

Proportion

Cement Mortar shall be composed of one part of Ordinary Portland Cement to 6 (six) parts of all block masonry walls. Hand mixing, when permitted by the Engineer shall be done on clean hard platform as

much as required for immediate use with only just sufficient water, to produce mortar of a proper consistency. If directed by the Engineer, the mixing shall be done by mechanical mixers. Sand shall be of an approved quality and shall pass 100% through 3/16 inch sieve.

SECTION – 10(b) BRICK MASONRY

1. Scope

The work covered by this section of the specifications consists of furnishing all plant, labour, equipment, appliances, and materials and in performing all the operations in connection with masonry work, complete in strict accordance with the specifications herein and the applicable drawings subject to the terms and conditions of the contract. The work under this section includes the brickwork in foundations, walls and partitions both load bearing and non-load bearing.

2. Materials

2.2.1 Bricks

All bricks shall be sound, of well burnt clay, uniform in shape and size, when struck, the brick should produce ringing sound. The brick shall be free from flows, cracks, and shipped corners, nodules of line, kankar, other blemishes and salt. When the brick is soaked in water for one hour, it should not absorb more than one sixth of its own weight. Bricks of only one size shall be used in the works. Bricks from different kilns not having the same size and colour shall not be accepted. The minimum compressive strength of the bricks tested in accordance with B.S. 1257 shall be 1300 psi subject to the condition that average compressive strength of five bricks tested shall not be less than 1500 psi.

2.2.2 Cement

Cement shall be Ordinary Portland Cement as specified in respective section.

2.2.3 Aggregates

Aggregates used shall meet the requirements specified under respective concrete section. All the aggregates dry and properly screened from approved source, shall also be acceptable for block making.

2.2.4 Brick Masonry Units

- i) Concrete masonry blocks shall be made on the project site and shall be of the sizes required as per drawings and/or as directed by the Consultants and shall generally conform to the requirements of British Standard 2028, 1364:1968 until and unless specified or otherwise in the specifications.
- ii) The brick shall be solid as required and shall be carefully made so that they are true in line and face with square corners and free from all defects. The ends of the bricks, masonry, shall be double grooved or as directed by the Consultants.
- iii) The blocks shall be cured by keeping moist continuously for a period of at least ten (10) days and then shall be allowed to dry in shade for at least twenty (20) days before used in masonry.
- iv) All bricks shall have clean cut straight and true edges, smooth dense faces of uniform appearance without voids, honeycombs, projections and shall be free from cracks spalls, chips, rugged edges or other defects detrimental to their use.

- v) Where bricks are to be plastered or rendered, the bricks surface shall have a coarse texture suitable for bonding the plaster as approved by the Engineer.
- vi) All bricks shall be stacked at site in a quantity not exceeding 5,000 bricks in each stack. The stacking shall be done in such a manner as to avoid smearing of the bricks in the lowest part of the stack with clay. Bricks smeared with clay show very poor bond with mortar sand, therefore, any bricks thus affected be rejected out of hand without recourse. When transported to the site the bricks shall not be dumped from the vehicle, the bricks shall be manually unloaded and stacked as aforesaid.

SECTION – 11 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, mill work, construction assembly, surface finish treatment and building in of all cabinet type items, supports etc. of wood or metal and incidentals, associated woodwork appurtenances, 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. Materials

2.1 Timber

2.1.1 Hard Wood:

Hard wood shall comprise of Oak, beech, Walnut Mahogany, Teak, Iroko and Sheesham.

2.1.2 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.

2.1.3 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 first class quality properly seasoned, free from large or loose dead-knots, open shakes and excessive sapwood. The scantlings of all timbers shall be brig t: 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.

2.1.4 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.

2.1.5 Adhesive:

The adhesives shall conform to the requirements of BSI No. 745 "Animal Glues for Wood" manufactured by M/s Host shall be considered approved for this Project or as directed and approved by (he Engineer.

2.1.6 Nails and Screws:

All nails and screws shall comply with requirements of BSI NO. 1202 and BSI NO. 1210 respectively.

2.1.7 Ply Wood

The ply wood shall comply in all respects with BSI No. 1455:1963. All the ply wood shall only be obtained from KDC Board (Pvt.) Limited, Jhelum as approved by the Engineer.. All plywood shall be manufactured with phenol pharamaldehyde or any other approved water proof adhesive but not with urea pharamaldehyde.

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.

2.1.8 High Density Fibre (MDF) Board

Medium density fibre board to be used on the project shall be LASANI of thicknesses as specified in the drawings. 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 farmica in approved colour and texture in factory as specified elsewhere.

3. 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.

4. 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 mortising, 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.

5. Protection Of Materials

All materials and assembled units shall be protected from weather and stored in such a way as to prevent decay, warping and attack by fungus and termites.

6. Wooden Doors

6.1 Materials

6.1.1 First class Deodar wood as approved by the Engineer shall be used for door frames and door shutters except the core of shutters which shall be partial wood as specified and shown on drawings.

6.1.2 Architraves, beads, lippings shall be of Deodar wood of specified sizes and fixed as per details shown on Drawings.

6.2 Ground, Blocking & Nailing Strips

6.2.1 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:

6.2.2 To steel--- by means of 3/8" diameter bolts spaced not over 3 feet.

6.2.3 To brick wall by the use of cut nails spaced not more than 1.5 feet apart and driven directly into the block. .

6.2.4 To poured concrete --- by means of 1/4" diameter galvanized expansion bolts spaced not more than 1.5 feet part or by any approved method.

6.3 Exterior and Interior Door Frames

All exterior and interior door frames shall be fabricated of wooden sections of first class deodar wood frame as shown on drawings.

All exposed surfaces of frames and architraves/beads shall be painted with synthetic matt finished enamel paint of approved shade as per the instructions of the Engineer.

The door frames shall be secured in place by means of 4 inches screws and matching Rawal plugs and built into the plastered masonry after the same has dried 4 number screws in each jamb and 2 number for upto 3.5 feet width and 3 number for upto 5 feet width of doors in the head shall be used.

6.4 Door Shutters

The shutters will be fixed to the frames with approved quality fittings as per hardware schedule.

6.5 Squareness Maximum diagonal difference 1/8" (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).

Doors, shutters shall be fabricate in a workman like manner strictly to the correct sizes and shapes as shown on the Drawings or as directed by the Engineer.

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. The door shutters shall be built in sections, properly jointed and glued together.

The surfaces shall be prepared for painting or polishing. All door shutters shall be paneled, fabricated from first class deodar wood as shown on drawing . Fitting, Hanging and trimming All the doors shall be fitted, hung and trimmed as Here in after specified and as indicated on the Drawings.

Doors shall have a clearance of 1/8" at sides and top unless otherwise directed by the Engineer and shall have 3/16" 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.

6.6 Hardware

Hardware shall be of best quality local make extra heavy duty and first class finished material except door locks and door closures which shall be imported of Japanese origin as per attached hardware schedule. 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.

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.

6.7 Quality Assurance

6.7.1 Tolerances: Doors shall be fabricated to following tolerances
Size: Plus or minus 1/16 in overall dimensions Maximum
Warp: 1/8"

6.8 Submittal

- 6.8.1 Provide manufacturer's literature completely describing products.
- 6.8.2 Provide shop drawings showing door types, details and locations, referred to the door type and hardware group shown on door and hardware schedules.
- 6.8.3 Provide certificates stating that doors were constructed with timber of the Species specified having moisture content and meeting equilibrium and relative humidity requirements.
- 6.8.4 Submit samples of plywood for selection of colour and grain.
- 6.8.5 Procurement of materials shall be made only after the shop drawings and samples have been approved by the Engineer.

6.9 Product Delivery, Storage and Handling

- 6.9.1 Deliver and store products in waterproof, protective containers with seals unbroken and labels intact until time to use.
- 6.9.2 Keep products dry, stack products off ground on level platforms, fully protected from weather, including direct sunlight.
- 6.9.3 Identify type, size and location of each door before delivery in order to permit installation at correct location.

6.10 Installation

- 6.10.1 Install doors at correct openings and assure smooth swing and proper closer with frames.
- 6.10.2 Install finish hardware in accordance with manufacturer directions.
- 6.10.3 Hardware shall be carefully and securely fitted. Upon handing over the work, hardware shall be demonstrated to operate freely. Keys shall be placed into a respective locks and upon acceptance of the work keys shall be tagged and delivered to the Engineering work at site.

7. Wooden Railing

Material for wooden hand railing in stairs shall be superior quality teak wood/ deodar wood & 1/2 inch dia mild steel pipes. It shall be fabricated and installed in accordance with the design shown on the drawings/details and as per the instructions of the Engineer. Sample of railing shall be fabricated & mock up samples installed at locations designated by the Engineer for approval, prior to s

Shop/detail drawing indicating the basic details at various locations including details at turnings shall be submitted by the Contractor for Engineer's approval. Hand railing shall be installed to line level and plumb. The surface of railing in stairs shall be prepared for polishing. The railing shall be polished/painted with clear lacquer and the steel surfaces shall be painted with matt finished enamel paint.

8. SS & Glass Railing

Material for hand railing in stairs shall be 3" dia stainless steel pipe handrail, 1" dia stainless steel balustrades, W' thick unbreakable Security glass and clamps including all fixing accessories complete in all respect as shown on the drawings, It shall be fabricated and installed in accordance with the design shown on the drawings/details and as per the instructions of the Engineer. Sample of railing shall be fabricated & mock up samples installed at locations designated by the Engineer for approval, prior to starting work at site. Shop/detail drawing indicating the basic details at various locations inclu9ing details at turnings shall be submitted by the Contractor for Engineer's approval. Hand railing shall be installed to line level and plumb.

9. Defective Work

In the event of non-conformance to specification and drawings, the wood works shall be rejected by the Engineer and the Contractor shall remove and replace the rejected work by new work of same specifications.

10. Surface Preparation

The surfaces of all wood works shall be prepared in the (manner as directed by the Engineer for polishing or painting.

11. Mock-Up Sample

After approval of shop drawings and tests etc., the contract 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.

12. Measurement & Payment

12.1 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.

12.1.1 Glazing where required and all finished hardware fittings in carpentry and joinery works, including locks, kick and push plate, architrave, beading, handles, locking arrangements etc.

12.1.2 Prime coat, painting with synthetic enamel paint/lacquer polish in carpentry and joinery works/hand railing.

12.1.3 Anti termite treatment to wood works and adhesives

12.1.4 SS / Steel balusters, steel base and steel strip for wooden railing.

12.1.5 Deodar wood blocking, shipping & base frame work in cabinets/hand railing.

12.1.6 SS Plate in the door bottom.

12.2 Wooden Door

12.1.1 Measurement

Measurement of acceptably completed works of all types of wooden doors will be made on the basis of net actual area in square feet fabricated 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.

12.1.2 Payment

Payment will be made for acceptable measured quantity of all types of wooden doors on the basis of unit rate per square feet

quoted in the Bill of Quantities against respective item and shall constitute full compensation for all the works including all hardware & fittings like locks, tower bolts, push plates etc. as per details mentioned in Volume III & IV of Tender & Contract Document related to the item.

SECTION – 12 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 aluminium. doors, windows, ventilators & louvers 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 Organization for Standardization)

1804	Doors Door	Terminology
6442	Leaves	Measurement of defects of general flatness
6443	Door	
6444	Leaves	Measurement of dimensions and defects of squareness.
	Door	
	Leaves	
6613	Windows & Doors	Test of behaviour under humidity variations (successive uniform climates) wind resistance tests. Air permeability test.

2.2 BSI (British Standard Institution)

1227 Hinges
4873 Aluminum alloy windows.

3. General

- 3.1 Door, Windows, ventilators, louvers and other items to be provided shall be aluminium, 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.
- 3.2 All the sections used for doors, windows, ventilators & louvers fly screens shall be of best quality aluminium 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.
- 3.3 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.

3.4 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.

3.5 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 aluminium 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.

The glass shall conform to specification laid down under chapter 'Glazing' and shall 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.

3.6 The structural shape of the Aluminium members shall be of uniform quality, colour temper, clean, round, commercially straight and free from injurious defects.

3.7 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.

Contractor shall, provide certificate signed by the manufacturer stating that each lot has been sampled, tested and respected and has met the requirements in accordance with these specifications and the same shall be furnished to the Engineer.

3.8 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 bill section.

4. Material

4.1 Frames/shutters

The frames of aluminium door, windows and ventilator shall be formed from rolled, strip or extruded aluminium. The thickness of sectional members shall be at least 1.6 mm. All outer / frame sections of open able / fixed windows. Ventilators and louvers curtain wall shall be 95 mm minimum in width. The Frames for doors and door/windows curtain wall shall be at least 97 mm in width.

- 4.2 As shown on the drawings, aluminium frames shall be provided as per international standard approved by the Consultant.
- 4.3 Fasteners shall be stainless steel of a type selected to prevent galvanic action with the components fastened.
- 4.4 Gaskets shall be vinyl glazing channel gasket to commercial standard CS-230-60.
- 4.5 Hardware shall be manufacturer's standard hardware. Flush to match doors, windows, ventilators and louvers finish. Floor mounted concealed type double action/swing imported door closures shall be provided to all doors. Heavy duty in-matching finish stays shall be provided to all open able windows, ventilators and louvers. Stays shall be attached to the window frame so as could be replaced easily.
- 4.6 Joint sealant shall be approved elastomer.
- 4.7 All Aluminium sections shall be powder coated in accordance with the standards of Aluminium Association of USA. The anodisation shall be of not less than 70-90 microns. The anodic oxide surface shall be properly sealed.
- 4.8 For powder coated finish aluminium sections to be coated shall be mill finish. The sections shall be firstly degreased with a degreasing chemical to remove all/any stains. The sections will then be given a chromating coating and electro static powder coating in the desired colour with a powder-coating machine. After colour coating the sections will be baked at baking temperature of 220 degree Centigrade for 25 minutes.
- 4.9 All sliding/open able windows shall be sliding/open able wire/fly screen shutters in window matching finish with wire/fly screen of size so as not to permit the entry of flies and mosquitoes. The wire mesh shall be 30 SWG. 14 mesh (14 x 14 openings per square inch).

5. Design Requirement

The Contractor shall design the installation to meet or excel the following requirements,

5.1 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.

5.2 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 pansion 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.

6. 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 aluminium.

7. Product Delivery and Storage

7.1 Deliver doors, windows, ventilator and louvers in a manner preventing damage to units,

7.2 Applicable Standards

Latest editions of following British Standards are relevant to these Specifications wherever applicable.

Store materials off the ground under cover in a manner preventing deterioration or All embedded parts and anchor bolts shall be delivered to the site carefully and keeping the fabricated shape and configuration. All these parts shall be suitably marked for identification.

SECTION – 13 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 addition of following British Standards are relevant to these specifications where ever applicable:

2.1 BSI (British Standards Institution)

952	Glass for glazing
5051	Security glazing part I & II
CP.152	Glazing

3. General

- 3.1 Each type of glass shall have the manufacturer's label on each pane, and the labels shall remain on the glass until final cleaning.
- 3.2 Glazing sealant shall be as recommended by the manufacturer for the particular application.
- 3.3 Spacer shims distance (pieces) shall be plasticized polyvinyl chloride (PVC). Thickness shall be equal to space shown on drawings between glass and rebates bead or cleat. Depth shall give not less than 1/4" cover of glazing sealant.
- 3.4 Contractor shall submit samples for each type of glass, minimum 4' x 4' in size with protective edges. Samples of glazing sealant minimum 0.1 liter of specified types shall be submitted.
- 3.5 Contractor shall submit 1 feet long sample c; each type of glazing gasket.
- 3.6 Contractor shall also submit printed materials manufacturer's installation instructions for specified glazing gaskets, compounds sealants and accessories including description of required equipment and procedures and precautions to be observed.

4. Delivery Storage and Handling

- 4.1 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.

Contractor shall store the materials in original unopened containers with labels intact/protected from ground contact and from elements which may damage glass.

Contractor shall handle the materials in a manner to prevent breakage of glass and damage to surfaces.

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.

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.

Trim and clean excess glazing materials from surrounding surfaces immediately after installation and eliminate stains and discolorations.

Cure glazing sealants and compounds in compliance with manufacturer's instructions to obtain high early bond strength internal cohesive strength and surface durability.

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.

No glazing shall be considered complete until and unless paint and other stains have been removed from the surface of the glass and checked by the Engineer for water tightness.

5. Protection and Cleaning of Glazing

- 5.1 Remove all smears labels and excess glazing sealant, leave clean inside and outside free from scratches. The Contractor shall be responsible for the protection of installed glass. Before final acceptance, damaged or broken glass shall be removed and replaced with the new glass at no additional expense to the Employer and replaced with new glass at no additional aged or broken glass shall be removed.
- 5.2 All glass surfaces shall be washed clean both inside and outside within two weeks prior to final acceptance by the Consultant.

6. Measurement and Payment

No payment shall be made for the works involved within the scope of this section 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.

SECTION – 14 BITUMEN COATING

1. Scope

The work under this section of the Specifications consists of furnishing all plant, labor, equipment, appliances and materials and in performing all operations related to 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. Submittal

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

3. Materials

3.1 Bitumen 10/20 grade.

4. Delivery Storage and Handling

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

5. Preparatory Work

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

6. Bitumen Coating/Painting In Foundation Sub-Structures, Under Floors

a) Bitumen Painting:

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 or asphalt oil used at the rate of not less than 1.08 gallon /10 square meter. Two coats of hot bitumen paint shall be applied at the rate of 1.0 kg/ Sq.m. each coat. The first coat shall be allowed to dry for about 6 hours before applying the second coat. During operation of painting great care shall be taken to avoid air bubbles. The manufacturers shall be taken to avoid air bubbles. The manufacturer's instructions and Engineer's directions shall be followed.

7. Measurement and Payment

7.1 General

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

7.1.1 All preparatory work, scrapping, scratching, cleaning, cant strips, gravel strips, etc.

7.1.2 Coats of bitumen.

7.2 Bitumen Painting/Coating

7.2.1 Measurement

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

7.2.2 Payment

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

SECTION – 15 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. General

- 2.1 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.
- 2.2 Plastering shall not commence until all electric conduits, drainage and sanitary pipes, inlets to tanks, brackets, clamps, doors and window frames and all sort\$ 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.
- 2.3 Sample of materials shall be submitted to the Engineer for his approval prior to use in the works.

3. Material

- 3.1 Cement for plaster shall be Ordinary Portland Cement (B.S 12 or P.S 232) or Sulphate resisting cement (B.S 4027 or P.S. 612) as specified 'and shall conform to requirements specified in the section "Plain and Reinforced Concrete"'.
and shall conform to requirements specified in the section "Plain and Reinforced Concrete".
- 3.2 Sand for plaster shall coy with the requirements of BS 1199, BS 1200 or the draft Pakistan Standard "Sand for Plaster" as directed by the Engineer.
- 3.3 Water for plaster shall conform to requirements specified in the section for "plain and reinforced concrete".
- 3.4 All materials and workmanship for plaster, not explained in these Specifications, Shall comply with the requirements of relevant BS CP 211 and CP 221 as directed by the Engineer.

4. Proportioning and Mixing

- 4.1 Measurement of materials by volume shall be by containers of known capacity to maintain consistent proportions. No lumpy or caked material shall be used. Mixing equipment boxes and tools shall be clean. Materials shall be proportioned as specified on the Drawings, in the Bill of Quantities or as directed by the Engineer. Mixing shall be continuous until all ingredients are evenly distributed and thoroughly mixed.
- 4.2 Only limited water shall be added for proper workability and such quantity of ortar shall be prepared which can be consumed in thirty minutes after preparation. Preparation of mortar in bulk quantity for use during the entire day or for any other time more than that stipulated above is expressly prohibited. Retempering shall not be permitted and all mortar which has begun to stiffen shall be discarded.
- 4.3 Plaster ingredients shall be thoroughly mixed either by hand on a clean cement concrete platform or by a mechanical mixer, as directed by the Engineer.

5. Preparation of Surface to be Plastered

- 5.1 Concrete surface to be plastered shall be cleaned to remove all grease, form oil and other surface impurities, which will otherwise adversely affect the adhesion of plaster to the surface concerned. The surface of all-concrete ceilings, beams and columns shall be lightly hacked by approved means to give the required key for plastering.
- 5.2 All masonry surfaces to be plastered shall be cleaned to remove all matter, which will otherwise adversely affect the adhesion of plaster to the surface concerned. The surface shall be washed with clean water and kept damp for 24 hours before further treatment. The surface thus prepared shall be treated uniformly with cement and sand slurry. The slurry to be used shall be one part cement to one part sand by volume with water added to make a stiff creamy mix. The slurry shall be applied with a stiff brush on surface, which has previously been well wetted. The surface so treated shall be left to cure for 3 days.

6. Application of Plaster

- 6.1 The plaster of thickness less than the specified thickness shall be rejected. If the plaster is to be more than 1/2" thick, it shall be done in two coats. The surface of first coat shall be made rough before the second coat is applied. The plaster shall not have wavy surface and shall be perfectly in plumb. The edges and corners shall represent a straight line. The plaster shall be kept wet continuously for at least ten (10) days. No extra payment shall be allowed for jambs, junctions, corners, edges, round surfaces or for more than one layer of plaster required due to any unevenness in the work done by the Contractor. The plasterwork is to cover all conduits, pipes etc fixed in the walls and ceiling. Wherever specified, metal lath shall be nailed firmly before plastering is commenced. The plaster surface shall be tested frequently with a 10 feet straight edge and plumb bob.
- 6.2 Plaster containing cracks, blisters, pits, discoloration or any defects shall not be acceptable. Any such plaster or loose plaster shall be removed & replaced with plaster in conformity with these specifications and as additionally directed by the Engineer. Contractor shall cut out and patch all defective work at his own cost. All damaged plaster shall be patched as directed by the Engineer. Patching plaster shall match appearance of and shall be finished level with adjoining plaster.

7. Metal Lath

Metal lathing shall be fabricated from sheet steel and shall be of uniform quality and free from flaws broken strands, cracks and corrosive pitting, shall be rectangular and true to shape and shall comply with BS-1369.

All lathing shall be galvanized. Where plastering material depends entirely on the lathing for its key, these shall be not less than two complete mesh openings per 1-1/8" in one direction and the width of the aperture shall not be less than 3/16".

Sheets shall not be less than 1.6 kg/sq.m when fabricated, using 0.7 mm thick steel sheet. Where used on smooth surfaces to form a key it shall be not less than 1.2 kg/sq.m when fabricated, using 0.5 mm thick steel sheet. Tying wire shall be 1.2 mm diameter galvanized annealed iron wire.

Sheets shall be welded to angle iron frame as shown on drawings. 8.

8. Angle and Beads

Angle beads, stop beads, depth gauge beads, edging profiles, plaster dividing profiles, interior angle profiles, plaster borders and the like shall all be manufactured from sheet steel and

galvanized after fabrication, all beads shall be perforated at edges to ensure good adhesion of the plaster work. Thickness and dimensions shall suit particular locations and plaster thickness.

All angle beads, stop beads, depth gauge beads and the like are to be fixed in accordance with the manufacturer's instructions, at all corners, stops, joints, etc. as per directions of Engineer In charge.

9. Internal / External Plaster

9.1 Where specified in the Drawings external surface shall have an average 20mm thick. plaster finish, consisting of a base coat of 1:4 cement sand mortar in Grey cement and the finish coat of smooth plaster as shown on the Drawings and as directed by the Engineer.

9.2 Where specified in the Drawings all internal plaster shall have an average 12mm thick consisting of base coat of 1 :3:1:4 cement sand mortar in grey cement and finish coat of smooth plaster as shown on the Drawings and as directed by the Engineer.

9.3 Stucco Plaster

Wherever specified in the drawings external stucco plaster shall consist 'of 1 :2, one part white cement & 2 parts approved shade of marble chips zero size mixed with approved pigment to achieve desired shade. Wherever shown on drawings, grooves shall be provided with aluminum U/Y channels. The contractor shall prepare mockup samples of stucco plaster for the approval of Engineer. The plaster shall be applied with machines and the final rough surface/texture/shade shall be as per the approved sample, direction and approval of the Engineer-In charge.

10. Cleaning and Protection

10.1 Rubbish and debris shall be removed as necessary to make way for work of other trades and as directed by the Engineer. As each room or space is completed all rubbish, debris, scaffolding and tools should be removed to leave the room clean.

10.2 Prior to plastering all aluminum windows, finished metals should be covered by sheet of plastic or tarpaulin to protect it from damage.

10.3 Protect finished plaster from injury by any source. Contractor shall also protect walls, floors and work of other trades from Plastic materials.

11. Tolerances

Surfaces of plaster work shall be finished with a true plane to correct line and level with all angle and corners to a right angle unless otherwise specified and with walls and reveals plumb and square.

Maximum permitted tolerances shall not exceed 1/8" in 6 feet variation from plumb or level in any exposed line or surface and 1/16" variation between planes of abutting edges or ends.

12. Measurement and Payment

12.1 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. 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.

12.1.1 Metal lath over reinforced concrete and masonry joint.

12.1.2 Joints, junctions, corners, beads, drip course edge, roundings, and aluminum UN channels in grooves. Etc.

12.1.3 More than one layer due to any unevenness in the finished works and base coat plaster in stucco plaster including marble chips/colour pigments.

12.1.4 Cutting & patching of all defective works.

12.1.5 Surface preparation, cleaning and protection as specified.

12.1.6 Marble chips & pigments in stucco plaster.

12.1.7 Roughning of first coat of plaster before application of 2nd coat incase where overall required plaster thickness exceeds 1/2 inch.

12.2 Plain Plaster/Stucco plaster Measurement

Deductions shall not be made for ends of joints, beam posts, etc., and openings not exceeding 5 square feet 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 5 square, feet 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 plaster will be made on the basis of number of square feet of the surface area plaster as shown on the Drawings, or as directed by the Engineer.

12.3 Payment

Payment will be made for acceptable measured quantity of plaster 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.

SECTION – 16 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 Consultant/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 cementitious screed and mortar beds and backings, mixed and proportioned by volume shall be as follows: -

Grey ordinary Portland : 1 part

Cement Sand Water : 3 parts

: 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 well 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.

6. Product Delivery, Storage and Handling

6.1 Material shall be delivered in original; unopened, protective packaging, with manufacturer's labels indicating brand name, pattern, size, thickness and fire rating.

- 6.2 Material shall be stored in original protective packaging to prevent soiling, physical damage or wetting.
- 6.3 Cartons shall be stored in the installation area, opened at each end to stabilize moisture content and temperature, for 48 hours prior to installation.

7. Job Site Conditions

- 7.1 Work which will be concealed by false ceilings shall be completed, tested, inspected and accepted before ceiling work is started.
- 7.2 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.
- 7.3 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.

8. 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.

8.1 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 direction 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.

8.2 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.

9. Fixtures

Light fixtures shall be installed as per approved pattern and supported in accordance with manufacturer's recommendations.

10. 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.

11. Measurement and Payment

11.1 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.

Aluminum approved suspension system including main channels, main tee/cross tee bars, wall moulding and edge trims, hanger strips and accessories hold down clips, Aluminum tiles / strips etc. complete for aluminum tile / strips ceiling.

11.2 False Ceiling

11.2.1 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 of false ceiling provided and installed in position as shown on the Drawings or as directed by the Consultant/Engineer.

11.2.2 Payment

Payment will be made for acceptable measured quantity of respective type of false ceiling on the basis of unit rate per square feet quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

SECTION – 18 FLOOR AND WALL FINISHES

1. Scope

The work under this section of the Specification 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 installation of cement concrete floors and floor finishes including bases, skirting and external surface treatments, 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. Aterial

2.1 Cement

Cement shall be ordinary Portland cement conforming to B.S. 12 or PS 232.

2.2 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

B.S. Sieve	Grading Zone 1	Grading Zone 2
3/8" (9.53 mm)	100	100
3/16" (4.765 mm)	90-100	90-100
No. 7	60-95	75-100
No. 14	30-70	55-90
No. 25	15-34	35-59
No. 52	5-20	0-10
No. 100	0-10	

2.3 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:

B.S. Sieve	% Passing by weight
1" (25.40 mm)	100
3/4" (19.05 mm)	90-100
3/8" (9.53 mm)	20-55
3/16"(4.765 mm)	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 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.

2.4 Stone Ballast

Stone ballast to be used as soling shall comprise of strong, hard, durable stone of approved size. The stone shall be obtained from approved quarry and shall be sound, free from laminations and weak cleavages and shall conform to specifications of "Stone Soling".

2.5 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:

2.6 Ceramic/Porcelain tiles

Ceramic tiles shall be imported, premium quality, plain white/ coloured or printed. Porcelain tiles shall be imported Italian or Spanish or Granitto. The tiles shall be of sizes as specified on the drawings and shall conform. to BS 1281 as per samples.

2.7 Cleaning Compound

The compound used for all cleaning of terrazzo shall be an approved neutral chemical cleaner free from acid and alkali or any other material that will affect the colour or otherwise damage the terrazzo and shall not affect the conductivity of terrazzo floors.

2.8 PVC Vinyl Tiles

PVC vinyl tiles shall be imported best quality of size 300mm X 300mm Colour and shade shall be as per sample to be submitted by the Contractor and approved by the Engineer.

2.9 Division Strips

Division strips shall be of marble as approved by the Engineer. Standard division strips for floor finishes shall be not less than 5mm (3/16") in thickness and shall not be less than 1-3/4" in depth.

2.10 Marble Chips

Marble chips shall have an abrasive hardness of not less than 16, as determined by the test of wear resistance in National Bureau of Standards Reports MBS 98. Size shall vary from No. zero to 8.

2.11 Preservative Material

Preservative treatment for terrazzo floor shall produce a water-proof finish which will not be impaired by immersion in water at room temperature for a period of 2-1/2 hours,

approximately 18 hours after the floor is finished by buffing, as specified. The preservative material shall not discolour the terrazzo nor leave a tacky or sticky finished film on the surface after buffing.

3. Cement Concrete Flooring

The materials for C.C flooring shall be same as already specified under clause 3, "Materials".

3.1 Composition of Concrete

Concrete shall be composed of Portland Cement, sand, coarse, aggregate and water, all well mixed and brought to the proper consistency. The Contractor shall mix the ingredients as indicated on the Drawings. The proportions of the various ingredients shall be determined from time to time during the progress of the work and tests shall be made of samples of the aggregates and the resulting concrete. The mix proportions and appropriate water-cement ratio will be determined on the basis of the production of concrete having required workability, density, impermeability, durability and required strength.

3.2 Mixing Concrete

The concrete ingredients shall be mixed in a batch mixer for not less than 1-1/2 minutes after all ingredients, except the full amount of water, are in the mixer. The Engineer reserves the right to increase the mixing time when the charging and mixing operations fail to produce a concrete batch in which the ingredients are uniformly distributed and the consistency is not uniform. The concrete shall be uniform in composition and consistency from batch to batch except when changes in composition or consistency are required. Water shall be added prior to, during and following the mixer charge. Excessive over-mixing requiring addition of water to preserve the required concrete consistency will not be permitted. The concrete ingredients shall be mixed by volumetric measurement in purpose made boxes approved by the Engineer.

3.3 Construction

The base course of the floor shall comprise of stone ballast of 2 inches (approx: 50 mm) mesh size. The base course shall be thoroughly compacted by suitable power rammers to the total consolidated thickness as shown on the Drawings and as approved by the Engineer. The interstices shall be filled with smaller size stones. The base course shall be blinded with sand and the whole surface watered. Over the well compacted base course, a layer of concrete of the required grade and thickness shall be laid, in panels of the sizes as indicated on the Drawing and as approved by the Engineer.

After the C.C bed has been cured, as directed by the Consultant/Engineer, it shall be roughened and well watered before floor finishing is laid. The floor finish shall comprise of cement concrete of required grade and shall be laid in panels to the required thickness as shown on the Drawings or as directed by the Engineer. The concrete after laying will be thoroughly rammed and mortar worked up to the top and smoothed with a steel trowel. The edge of each section into which the floor is divided should be defined by wooden screeds of the approved width and of a depth equal to the depth of the floor concrete.

Freshly placed concrete floor and completed floor portions as finished shall be protected to prevent loss of water by covering with damp hessian, water proof paper, damp sand or other

approved material, and shall be kept constantly damp for a period of four days or longer after concreting as directed by the Consultant/Engineer. The concrete shall be allowed to dry out slowly over a period of three days after wet curing is completed.

The expansion joints shall be filled in with hot bitumen, of the approved grade, as directed by the engineer.

4. Terrazzo Flooring

4.1 Mix

The terrazzo mixes shall be composed by weight as follows:

Plain terrazzo for all floors and bases indicated as terrazzo and not otherwise specified, shall be composed of one part cement, white or grey, and 2 parts of marble chips of the sizes and colours hereinafter specified.

4.2 Preparation for Terrazzo

The grade and thickness of concrete as shown on the Drawings shall be laid as under bed to receive terrazzo. The surface of the bed shall be roughened for bounding with the terrazzo finish. If the surface is too smooth it shall be roughened with a toothed chisel and, prior to laying the terrazzo the bed shall be cleaned of all dirt, oil grease and extra loose material.

4.3 Division Strips

Terrazzo floors and bases shall be divided up by marble strips of specified thickness and depth. The division strips between field work and borders shall have exposed tops in full width of the strips. The division strips shall be set immediately after the spreading of the under bed, the strips being partially embedded therein, securely anchored to the subfloor and grouted solid.

All division strips shall be set, straight to lines and to the proper level to ensure that the tops of the strips will show uniformly after grinding and smoothing operations are completed and joints and intersections shall be fitted tight. Strips shall be braced to prevent bulging during the placing of terrazzo.

Unless otherwise shown on the drawings, the divisions in field work of large areas shall not exceed 4 feet x 4 feet and in small areas shall not exceed 2 feet x 2 feet.

Edging strips shall be placed at doorways between terrazzo and other types of flooring and along the edges of all terrazzo bases or borders and adjoining other types of floor finishes or floor covering. The edging strips at doorways shall be placed in line with the step face of doors. All edging strips shall be anchored and grouted solid in the under bed or to the concrete sub-floor and braced to prevent bulging as specified for division strip.

4.4 Laying Terrazzo

4.4.1 The sub-surface shall be swept clean, thoroughly moistened, but not saturated, and slushed with a coating of neat cement grout approximately 1/8" in thickness. The under bed consisting of class 'C' cement concrete screed shall be spread and brought to a level not less than 3/4" below the finished floor level. The dividing strips shall be installed in the green under bed. The terrazzo mix shall be spread, tamped and rolled into a compact mass not less than 3/4" thick. After rolling additional aggregate mix shall be sprinkled over the surface to fill up all depressions, to take

up excess moisture and to permit the terrazzo to be trowelled to a level, dense and even surface, slightly above the finish line of floor. This level, shall allow for the surface grinding necessary to expose the specified area of aggregate, and to produce smooth, level floors free of waves and depressions.

4.4.2 Seasoning

The completed terrazzo shall be allowed to season for 6 days during which time it shall be kept moist by (1) covering with approximately 1" thickness of sand; or (2) covering with building paper or mats; or (3) sprinkling with water at every 10 hour interval.

4.4.3 Surface

Following the curing period, the terrazzo shall be machine ground to a true, even surface using a No. 24 grit followed by a No. 80 grit or finer abrasive stone. After the first grinding, the floors shall be thoroughly grouted with the same cement and colour composition as specified for the matrix of the terrazzo mix. The grout shall be of the consistency of thick cream, and shall be brushed over the floor to eliminate all pits and thoroughly fill the surface for final grinding.

4.4.4 Finishing

Not less than 72 hours after application, the grouting coat shall be removed by grinding. In the later stages of grinding, the grit stones or other abrasive used in the grinding machine shall be of a grain or fineness that will give the surface smooth finish. Small areas, inaccessible portions and corners which cannot be reached by the grinding machine shall be ground and rubbed by hand.

4.4.5 Protection

The walls and all surfaces of the finished work of other trades shall be properly protected from damage and spoiling during the process of grinding and washing of the terrazzo. After the finish grinding has been completed and the surface treatment applied, the terrazzo work shall be covered and protected with material approved by the Engineer until completion of the work of all other trades.

4.4.6 Cleaning and Coating

Prior to placing the protective covering, the terrazzo floor shall be approved by the Engineer. After the work of all other trades has been completed and the protective covering removed, all terrazzo work shall be washed with cleaning compound, mixed with warm water and using a fine abrasive where necessary to remove any stains or cement' smears. The terrazzo' shall be allowed to dry thoroughly and shall be given a sealing application of preservative material. The sealing material shall be applied in accordance with the manufacturer's directions, leaving all terrazzo work in clean condition as approved by the Engineer.

4.4.7 Dado/Skirting

The ingredients of dado/skirting shall be one part of cement and two parts of marble chips varying from Nos. zero to 2. Striking shall be laid over a base of plaster of specified thickness. The thickness of dado/skirting layer shall be as specified. The surface shall be grinded and polished to the satisfaction of the Engineer.

5. Installation of Tile Flooring

When setting out the tiles, care shall be taken to establish the correct elevation for the floor. A gauge rod shall be used, indicating the overall measurement of a given number of tiles with specified joint width to reduce cutting.

After the floor has been machine finished, it should be covered with white, non-staining sand or rags to protect it while other work is being done. After removal, the floor shall be thoroughly scrubbed.

5.1 General

The base shall be prepared by laying cement concrete of specified grade and of thickness as shown on the drawings, or specified in the Bill of Quantities.

The curing period of the setting bed shall be as directed by the Engineer. 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 1/2".

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 centre line of each space in an outward direction and the pattern should be made symmetrical with a minimum number of cut tiles as directed by the engineer.

Joints between the tiles shall be of uniform width. Tiles shall be cut with a suitable cutting tool and rough edges shall be rubbed smooth. Tiles shall be laid to the straight edges.

5.2 Ceramic/Porcelain Tiles

The ceramic/porcelain tiles shall be laid to the required lines, levels and grades over a setting bed of cement sand mortar comprising of one part of cement and 4 parts of sand by volume and the joints filled with neat white or grey cement including vertical and horizontal covers. The tile floor shall be kept wet for at least 72 hours and no traffic should be allowed on the tiles during curing period.

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.

6.1.1 Loss and wastage of material due to consolidation, erosion and settlement.

6.1.2 All type of joints (expansion, contraction and construction joint etc.).

- 6.1.3 Class 'C' cement concrete screed base and 1:4 cement sand mortar under floor.
- 6.1.4 Rough plaster base under skirting / dado.
- 6.1.5 Finishing/grinding, washing & polishing works of ceramic, concrete, terrazzo tile, terrazzo floors and marble tiles.
- 6.1.6 Marble strips in terrazzo floors
- 6.1.7 1 :2 and 1:4 cement sand rough cast plaster.
- 6.1.8 Sand cushion under concrete pavers
- 6.1.9 Adhesives used in the laying of PVC flooring.
- 6.1.10 Bedding / Jointing Material of Envicrete jali
- 6.1.11 Pigmented grouting
- 6.1.12 Cleaning of tiles after installation.
- 6.1.13 Bull-nozing, chamfering of edges of marble tops including base mortar and making holes for wash basin including all necessary fixing accessories.

6.2 Cement Concrete Floor

6.2.1 Measurement

Measurement of acceptably completed works of cement concrete floor steel trowelled finish will be made on the basis of net actual area in square feet 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 cement concrete floor steel trowelled finish on the basis of unit rate per square feet quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

6.3 Ceramic/Porcelain Tile Floor

6.3.1 Measurement

Measurement of acceptably completed works of ceramic/porcelain tile in floor will be made on the basis of net actual area in square feet-of floor laid in position as shown on the drawing or as directed by the Engineer.

6.3.2 Payment

Payment will be made for acceptable measured quantity of ceramic/porcelain tile floor on the basis of unit rate per square feet quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

6.4 Ceramic/Porcelain Tile Dado/Skirting

6.4.1 Measurement

Measurement to acceptably completed works of ceramic/Porcelain tile in dado/skirting will be made on the basis of net actual area in square feet of dado/skirting laid in position as shown on the Drawing or as directed by the Consultant/Engineer.

6.4.2 Payment

Payment will be made for acceptable measured quantity of ceramic/porcelain tile in dado/ skirting on the basis of unit rate per square feet quoted in the Bills of Quantities. The unit rate shall include all cost of cement, sand, mortar and shall constitute full compensation for all the works related to the items.

6.5 Terrazzo Flooring/Skirting

6.5.1 Measurement

Measurement of acceptably completed works of terrazzo flooring/skirting will be made on the basis of net actual area in square feet laid in position as shown on the Drawings or as directed by the Engineer.

6.5.2 Payment

Payment will be made for acceptable measured quantity of terrazzo flooring/skirting on the basis of unit rate per square feet quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

6.6 PVC Vinyl Tile

6.6.1 Measurement

Measurement of acceptably completed works of PVC vinyl tile flooring will be made on the basis of net actual area in square feet laid in position as shown on the Drawings or as directed by the Engineer.

6.6.2 Payment

Payment will be made for acceptable measured quantity of PVC vinyl tile flooring on the basis of unit rate per square feet quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

SECTION – 19 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 any floor and at any height in connection with surface preparation, mixing, painting concrete works, gates, frames, walls, ceilings 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.

2.1 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. Painting of building.CP2

3. Cleaning and preparation of metal surfaces

- 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 and structural steel work. Metal surfaces against, which concrete is to be placed will be furnished shop-painted and shall be leaned 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.

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 12" x 12" x 1/8" 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 and wood works will be the best available of its type and shall be approved by the Engineer prior to its procurement.
- 4.4 Approved quality Weather Shield Weather Coat paint shall be used for painting the exteriors of the structures or other surfaces where specified on the drawings as directed by the Engineer.
- 4.5 The plastic emulsion paint, vinyl emulsion paint or similar as approved by the Engineer shall be used for interior surfaces.
- 4.6 All material for Bitumen painting shall consist of Bitumen grade 10/20. It shall be used for foundations or wherever recommended by the Engineer.
- 4.7 Only paints manufactured by ICI, Berger or approved equivalent shall be used in this Project. All material shall be delivered to site in their original unbroken containers or packages & bear the manufacturer's name, label, brand & formula & will be mixed and applied in accordance with his directions.

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, aluminum, 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 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 bitumen painted shall be thoroughly cleaned of any accretion, dust, dirt etc. by scraping, wire-brushing or as directed by the Engineer. The surface shall be primed with a coat of asphalt oil used at the rate of not less than 0.50 pound

per square foot. 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.

Coats of Weather Shield Weather Coat 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/weather coat 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 synthetic enamel paint as per manufacturer's recommendation and instructions or after approval of the Engineer.
- 7.4 Plastic emulsion paint vinyl emulsion paint or matt enamel 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 Two coats of hot bitumen paint shall be applied to exposed concrete surfaces in contact with earth. The first coat shall be allowed to dry for about six hours before applying the second coat. During the operation of painting great care should be taken to avoid air bubbles. The manufacturers instructions and Engineer's directions shall be complied with.

8. Job Conditions

- 8.1 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.

- 8.2 Place drop cloths to adequately protect all finished work.
- 8.3 Remove and replace all items of finish hardware, device plates, accessories, lighting fixtures or other removable items.
- 8.4 In no case shall any finish hardware or other finished item that is already fitted into place be painted, unless otherwise specified.

9. Quality Assurance

All paint for anyone 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 anyone surface.

10. Schedule of Measurement Of Paint Area

- 10.1 Irrespective of prime coats and number of paint coats applied to exposed painting surface area of column, walls, projections, ceilings, false ceilings and other surfaces (Except gates, doors windows and ventilators) shall be measured as per actual paint surface area for single time only and paid in accordance with quoted rate of Bill of Quantities.

11. Measurement And Payment

11.1 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.

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.

11.1.1 Preparatory works, including .preparatory materials, scraping, scratching, sand blasting, clearjng, prime coating, priming, protection of finished works etc.

11.1.2 Polishing works, including preparatory materials, scraping, cleaning, sanding etc/

11.1.3 Painting work on steel & wooden surfaces.

11.1.4 Before application of paint on existing surface the old paint surface shall be removed existing paint filling of cracks, surface preparation and application of primer coat, if any.

11.2 Measurement

11.2.1 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.

11.2.2 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.

SECTION – 20 TEXTURED I GRAFFITO WALL COATING

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, and application of graffito wall coating as shown on the Drawings and/or as directed by the Engineer. The scope of this section of specifications is covered with detailed specifications as laid down herein.

2. General

- 2.1 Except as otherwise specified, all painting shall be applied in conformity with BS CP 231 "Painting of Building" as applicable to the work.
- 2.2 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.
- 2.3 Samples of all colours/coating, stains 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 . coating shall be on separate 300 x 300 x 3 mm tempered hard based panels. Manufacturer's colour chart shall be submitted for colour specifications.

3. Material

- 3.1 Material shall be acceptable, proven, top-grade products and shall meet or exceed the minimum standards of reputable manufacturers as approved by the Engineer.
- 3.2 The material for textured graffito coating shall be variable granular material and shall composed of Acrylic Copolymer Emulsions spherodial quartz various additives, metallic oxides, inerts of different granulemetries colouring agent, antibacterial and antibacterial agents.
- 3.3 All materials shall be delivered to site in their original unbroken containers or packages and bear the manufacturer's name, label, brand and formula and will be mixed and applied in accordance with his directions.

4. Surface Preparation

- 4.1 All oil, grease, dirt, dust, loose mill scale and any other foreign substance shall be removed from the surface to be coated. Following the solvent cleaning, the surfaces shall be cleaned by scraping, chipping, blasting, wire brushing or other effective means as approved by the Engineer.

In the event the surfaces become otherwise contaminated in the interval between cleaning and costing, recleaning will be done by the Contractor at no additional cost.

No work in this section shall be allowed until all surfaces or conditions have been inspected and approved by the Engineer.

The graffito coating material should be applied with stainless steel trowel and finished with plastic trowel in thickness as per manufacturer's specification. To get straight texture plastic trowel should be moved vertically and the trowel is to be rotated to obtain swirl texture.

5. Measurement And Payment

5.1 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 Bills of Quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of Bills of Quantities.

5.1.1 Preparatory works, including preparatory materials, scraping, scratching, sand paper rubbing, cleaning, protection of finished works etc.

5.1.2 Providing and applying rough plaster base Corner, pattas, rounding&, arches, borders, grooves etc.

5.2 Measurement

Measurement of acceptably completed works of graffiti coating to specified surfaces will be made on the basis of actual area in square foot of the surface coated as shown on the Drawing or as directed by the Engineer.

Payment

Payment will be made for acceptable measured quantity of coating to specified surfaces on the basis of unit rate per square foot quoted in the Bill of Quantities & shall constitute full compensation for. all the works related to the item

SECTION – 21 LIST OF APPROVED MANUFACTURES AND MAKE

CIVIL WORKS

- ORDINARY PORTLAND CEMENT Falcon Cement, Lucky Cement, DG Khan Cement.

• SULPHATE RESISTANT CEMENT	Falcon Cement, Lucky Cement, DG Khan Cement.
• STEEL	Amreli Steel & Razzak Steel.
• SAND	Bolari Sand.
• CRUSH AGGREGATES	Good Quality Crush from Kot Banglu Origin Origin or as approved by Consultant.
• TERMITE PROOFING WORK	Bi Flex FMC / or as Approved By Consultant.
• ALUMINIUM DOORS/WINDOWS	Pakistan Cables
• DOUBLE TEE RCC ROOF PANEL	M/s. Izhar Concrete Pvt Ltd, Izhar Group of Companies.
• GLAZED TILES	Master Tiles, Shabbir Tiles,
• PORCELAIN TILES	Imported of approved manufacturer (Nano Polish) approved by Consultant.
• INDUSTRIAL TILES	National Tiles, EMCO Tiles or as approved by Consultant.
• BOND FOR TILES	STILE BOND
• PAINT WEATHER SHIELD, SPD DISTEMPER, SYNTHETIC ENAMEL PAINT, MATT FINISH PAINT.	ICI /Berger / JOTUN
• PAINTS / PRIMER & PUTTY	ICI Pakistan Ltd, Berger Paints Pakistan Ltd.
• ALUMINIUM EXPANSION, JOINT COVER.STRIP FOR FLOORS/WALLS ETC	Balco, M/s. Chemi Tech. or As Approved By Consultant.
• HARDWARE & HANDLES	Bonco Brand.
• GLASS	Tinted Glass imported as approved or Ghani Glass as directed by Consultant.

• TEMPERED GLASS	Pakistan Safety Glass.
• LOOKING MIRROR	Imported Belgium Glass or As Approved By Consultant.
• VENITIAN BLINDS	Protector, MI Décor.
• FIBER GLASS SHEET (Hollow / Solid)	Toughlite Brand.
• GALVANISED IRON (GI) PIPE	M/s. I.I.L. or As Approved By Consultant.
• RCC PIPE	M/s. RAZIA Brand or As Approved By Consultant.
• UPVC PIPE	Dadex, Pak Arab, AGM.,EURO GULF Pipes
• JUMBOLON	M/s. Diamond Foam.
• CONSTRUCTION CHEMICALS	M/s. FOSROC , Mitchels & Co.
• STEEL GROUTING	M/s. Fischer , M/s. Hilti
• ALUMINIUM COMPOSITE PANEL (ACP) SHEETS	M/s. Dadex, M/s. Aluco MASTER
• ALUMINIUM SUSPENDED FALSE CEILING	DFB brand
• BITUMEN / ASPHALT	National Refinery/ Pak Hy Oils.
• BITUMINOUS MEMBRANE	Pak Hy Oils.
• MANHOLE COVER	C.M.P. or As Approved By Consultant.
• UPVC DOORS	M/s. Framez, / M/s. Auvitronics Pvt. Ltd.
• CONCRETE KERB BLOCKS	M/s. Envicrete, M/s. Izhar Crete, M/s. Magna Crete, M/s. Prime Crete.

- | | |
|---|---|
| <ul style="list-style-type: none">• CONCRETE HOLLOW BLOCKS / SPLIT BLOCKS | M/s. Envicrete, or equivalent approved by Consultant. |
| <ul style="list-style-type: none">• GRANITE / MARBLES | Marina Marble, POPULAR Marble or equivalent approved by Consultant. |
| <ul style="list-style-type: none">• CONCRETE BLOCKS | M/s. Envicrete / M/s. Bes Block Hub or equivalent approved by Consultant. |
| <ul style="list-style-type: none">• CONCRETE PAVERS | M/s. Envicrete, M/s. Izhar Crete, M/s. Magna Crete, M/s. Prime Crete. |

Contractor.

Engineer In-charge.

TECHNICAL SPECIFICATIONS FOR

PUBLIC HEALTH WORKS

SECTION – 1 : GENERAL SPECIFICATIONS OF PLUMBING WORKS

1.1 GENERAL

The stipulated therein, the direction as given below shall invariably be read with relevant clauses of Condition.

The materials used and workmanship shall be of highest quality and grade unless otherwise specified shall. Conform to the latest specifications of British Standards and Codes of Practice “Water Supply”, “Sanitary Pipe Work”, “Building Drainage”, “Surface Water and Sub-Soil Drainage” and applicable to details and work indicated on the Drawings and Bill of Quantities. In case of any discrepancy/ambiguity the decision of the Consultants shall be final, and the Contractor will act and perform accordingly.

1.2 DRAWINGS AND INFORMATION REQUIRED

- a) The Contractor shall submit shop drawings for the entire installation including installation details for all items require or asked for approval of the consultants.
- b) Approval by the Consultants of shop drawings for any material, device and layout, shall not relative the Contractor from the responsibility of furnishing same of proper dimension, size quantity and all performance characteristic to efficiently perform the requirements and intent of the contract Documents, Such approval shall not relive the contractor from responsibility for errors of any sort in the shop drawings.
- c) If the shop drawings deviate from the Contract Documents the Contractor shall advice the Consultants of the deviations in writing accompanying the shop drawings including the reasons for the deviations. At the start of the project the Contractor shall periodically and thereafter submit to the consultants a list of all shop drawings, which will be submitted in the course of the project. The list shall show the disposition of each item including date of submission approval etc. the list shall be kept up to date through the entire course of construction.

1.3 CLEANING AND PROTECTION

The Contractor shall be responsible for his work until its completion and final acceptance, and shall replace any of the same, which may be damaged, lost or stolen without any additional cost to the Owner.

The openings left in floor for passage of lines of soil waste, vent and supply pipes shall be covered and protected.

- a) The pipes shall be protected with suitable covering as soon as set. All open ends of pipes shall be closed by a plug fitting to prevent obstruction and damage. The use of new permanent water closets and other new plumbing fixtures during the progress of work is prohibited.
- b) As soon as installed, all metal fixtures trimmings shall be thoroughly covered by this Contractor with non-corrosive grease, which shall be maintained until all construction work is complete.

- c) Upon the completion of the work, all fixtures and trimmings shall be thoroughly cleaned and polished and left in first class condition.
- d) Prior to delivering the plant to the Owner the Contractor shall thoroughly clean all equipment fixtures, fittings etc.
- e) Before final connection are made and before operation of equipment and piping, all piping interior shall be thoroughly blowout, or washed out at least twice in a manner as directed by the Consultants all accumulation of dirt chips or other deleterious materials. Make all temporary connection and furnish all appliance required for the purpose of cleaning as no extra expense to the Owner.
- f) Before erection, all pipes, tubing, valves and fitting shall be thoroughly cleaned of oil, grease or other combustible by washing in a hot solution of sodium carbonate or tri-sodium phosphate mixed in the preparation of one pound to three gallons of water.

1.4 RECORD DRAWING

- a) During construction the contractor shall keep an accurate record of all deviations between the work as shown on the Contract Drawings and that, which is actually installed.
- b) The Contractor shall secure from the Consultants after approval of his Shop Drawings a complete set of drawings and not change thereon in ink.
- c) The Contractor shall make a complete record of all changes and revisions in the original design, which exist, in the completed work.

The cost of furnishing above prints and preparing these for record shall be deemed to be included in the tendered cost and its effect spread over other items of work, and as such items shall not be a subject to payment. When all revisions showing the work as finally installed are delivered to the consultants before final payment for the completed work will be made.

1.5 OPERATING AND MAINTENANCE INSTRUCTION

Three sets of operating and maintenance instruction covering completely the operation' and maintenance of all plumbing equipment, controls, heaters, pumps and the like shall be furnished to the Owners.

1.6 TESTS

- a) The entire system of drains, waste and vent piping inside the building shall be tested by the Contractor under a water test, which shall include the entire system from the lowest point 2to the highest pipes above the roof.
- b) The water test shall be made in accordance with all local requirements. Every portion of the system shall be tested to a hydrostatic pressure equivalent to at least 15 feet head of water. After fillings, the Contractor shall shut off water

supply and shall allow it to stand 2 hours under test during which time there shall be no less or leakage. This test procedure shall apply to C.I pipes.

- c) Interior and exterior water distribution systems shall be tested whole or in part to a pressure of at least 50 Psi gauge higher than their normal operating static or street main pressure, but no test shall be less than 150Psi gauge. Each test shall be conducted in the presence of the Consultants and shall run for the two hours with no less of pressure.
- d) The Contractor shall furnish and pay for device, materials supplies, labor and power required for all tests. All tests shall be made in the presence and to the satisfaction of Consultants.
- e) Defects disclosed by the test, shall be required or if required by the Consultants defective work shall be replaced with new work, without any extra charge to the Owner test shall be operated as directed until the work is proved satisfactory.
- f) Fixture shall be tested for soundness, stability of support and satisfactory operation.
- g) The Contractor shall notify the Consultants at least one week in advance of making the required tests. So the arrangements may be made for their presence to, witness the test.
- h) Equipment shall be tested in service and the Contractor shall demonstrate that the equipment performs the work intended for it and that it complies with the requirements of these specifications for such equipment, to the satisfaction of Consultant.

SECTION - 2 : WATER SUPPLY WORK

2.1 DESCRIPTION

Work in this section shall include all the M/S DEDEX TIGRIS GREEN (Polydex), GI. Pipe work up to 6" (150 mm) conforming to the code of Practice DIN-8077, 8078 & D1- 16962 for fittings, including all materials, plants, equipments, labor etc. to complete the work in close conformity with the plans and in accordance with the provisions included herein.

2.2 MATERIAL REQUIREMENTS FOR G.I PIPE

All uninstalled pipes and fittings used in the building work weather hidden in block/ concrete work or running under ground shall be of galvanized iron hot dipped in bitumen. Wrapped around with bituminous Hessian with final two coats of brush- applied bitumen. All un-insulated exposed pipes and fitting in the building shall be painted with prime coat of lead oxide primer and 2coats of enamel.

It shall be ensured that the fittings shall be tested by jointing at least 5% of them to straight pipes in pipe vices with sufficient pressure, to the satisfaction of the Consultants. Defective fittings invariably crack on application of the pressure. The fittings shall also be examined to detect blisters and minor cracks. The G.I. pipe, fittings and specials shall conform to the following specification.

- a) G.I. Pipe
-BS-1387
-Test Pressure
Class-M
700 Psi
- b) Malleable Iron (Galvanized Fittings (i.e. couplings, elbows, Tees etc.) for G.I. Pipes 2-1/2" and below shall be of at least same thickness and quality as G.I. Pipe.
- c) Cast Iron threaded flanges for jointing G.I. Pipe of dia 3" and above.

BS-10: 1962. Table D.

- d) Cast Iron flanged fittings, for G.I. Pipe 3" and above.

8S-2035, 1953: Class-B

Working Pressure 0400 ft. of water.

- e) Expansion Joints In G.I pipes

Adequate provision for expansion shall be provided on all pipe work as shown on the drawings. The Contractor shall obtain the Consultant's approval for the materials being used for a particular expansion joint. Following types of expansion joints shall be used on the locations, shown on drawings.

- i) Expansion loop for Horizontal G.I. Pipe of dia 2-1/2" or below.
- ii) Bellow Type Expansion Joints for G.I. Pipe of dia 3" and above.
- iii) Dresser coupling for all vertical G.I. Pipe risers.

- f) Cast iron Sluice Value (size 3" and above)
Cast iron body: Gunmetal spindle and sealing rings. BS-3464, flange to BS-1 0: 1962.
Test Pressure = 225 Psi.
- g) Copper alloy sluice value (size 2-1/2" and below) BS-1952: threaded ends.
Test Pressure = 225 Psi.
- h) Cast Iron Check Values' (Size 3" and above) Cast Iron body: Gunmetal door.
Test Pressure = 225 Psi.
- i) Copper Alloy Check Value (Size 2-1/2" and below). Threaded ends. Test Pressure = 225 Psi.
- j) C.I. globe values (Size 3" and above). Similar to Cast Iron Sluice Value.
- k) Copper alloy globe value (Size 2-1/2" and below). Threaded ends. Test Pressure = 225 Psi.
- l) Fire Hydrant shall conform to BS-750, with a body of Cast Iron and spindle of Manganese-bronze. The direction of closing shall be by clockwise rotation and the outlet shall have screwed joints for accommodating 2-1/2" dia hose connection.
- m) Double air Value Cast Iron body Max. Working head

Dia (in.)	2	3	4	6
Head (ft)	200	575	575	575

- n) Pressure Reducing Value

The valve shall maintain a constant downstream pressure regardless of changing flow rate and or/varying inlet pressures. It shall be spring loaded, hydraulically operated, pilot-controlled diaphragm-type globe valve. The valve shall have a single removable seat and resilient disc. The body and cover of valve shall be of cast iron for valves of size 3" or above and shall be of cast bronze for size 2-1/2" or below. The inlet and outlet of valve shall be threaded for size 2-1/2" or below and flanged for size 3" or above. The working pressure for valve shall be 175 psi minimum and the valve permit a convenient adjustment over a range of no less than 30 psi. The threaded valve shall be installed with two unions at its inlet and outlet ends of facilitate its removal. All pressure reducing valve assemblies will be installed with by pass line having globe valve/gate valves so that the removal of

P.R. valve for servicing/repair will not disturb the service of that circuit.

o) Strainer:

- i) The straight cast iron strainer shall be installed on the submerged end of suction pipe drawing water from ground water from reservoir. The strainer flange shall confirm to the specification of BS-10, 1962. Minimum length of strainer for the specified dia shall be as follows:

<u>Dia</u>	<u>Length</u>
3"	5-11/16"
5"	7-1/2"

- ii) The strainers shall have cast iron or bronze bodies suitable to withstand the working pressure, removable screens of copper, brass, nickel or stainless steel, flanged bodies with tapping of size 1-1/2" and above and of such a design as to allow blowing out of accumulated dirt and easy removal and replacement of strainer screen without disconnecting the main piping.

- q) Puddle plates of specified dia, shall be provided where G.I pipe crosses R.C.C wall retaining water or soil. 3/8" thick M.S square plate of size shown on plan, cut with a hole equal to external dia of pipe, shall be welded with the pipe with both ends of G.I. pipe provided with flanges, and the whole assembly shall be hot dipped galvanized before being cast in R.C.C. wall.

- r) Float Valve, Level Controller, and Flow Switch: Tender to provide specifications of items locally available.

- s) Pipe Sleeves for Cast iron pipes

The Contractor shall supply and install the pipe sleeves in R.C.C walls and sleeves. The pipe sleeves shall be located accurately and they shall be properly aligned and tied with the reinforcement bars so that the alignment and level is not disturbed during concreting.

The RCC wall pipe sleeves shall be fabricated from correct size Schedule 40

M.S. pipe. M.S. 3/8" thick sheet ring of sleeve size +6" shall be welded at the centerline of the sleeve to anchor the sleeve in RCC structure. After fabrication, the sleeve shall be heavily galvanized before installation. The inner galvanized surface shall be smooth.

RCC slab pipe sleeves shall be of construction as above but fabricated from 3", 4", 5", and 8" dia schedule 40 M.S. pipes and anchor ring shall be of 9-1/2", 10- 1/2", 11-1/2", and 14-1/2" dia respectively.

t) Pipe Seal for Cast iron Pipes:

All exterior openings provided for the passage of piping shall be properly sealed with snugly fitting collars of metal or other approved rat-proof material securely fastened into place.

2.3 **PRROPERTIES AND REQUIREMENTS FOR DADEX PIPE:**

2.3.1 Jointing And Installing: (Jointing Method Of Tigris Green)

A) Polyfusion Welding:

i) Preliminary Operations:

The surfaces of the pipes and fittings must be clean and without impurities. Pipes ends must be clean cut at right angles. It is recommended to cut 1 m from the pipe ends in order to prevent possible micro cracking due to incautious handling. Before carrying out the welding, check that Polyfusion device operates correctly and that it reaches the required welding temperature (260 C + 5).

ii) Welding:

Pipes and fittings are inserted up to the edge of the matrix and held steady without rotating. It is very important to stick to the heating times mentioned here below: -

Polyfusion welding times according to DVS 2207 norms.

Pipe (mm)	Heating (Min.)	Working time (Max.)	Cooling (Min.)
20	5	4	2
25	7	4	2
32	8	6	4
40	12	6	4
50	28	6	4
63	24	8	6

B) Welding By Means of Electro-Fusion Couples:

i) Preliminary Operations:

The pipe must be clean cut at right angle. The parts to be welded must be cleaned with emery cloth or a manual scraper and the inside of the fitting socket have to be degreased with the suitable cleaning liquid. The pipes must be perfectly aligned.

ii) Welding:

After having connected the following machine compatible with the electro-fusion couples and started up the welding process, you can verify the good results by checking if the two pins have come out of their seats.

Wait at least two hours from last welding before the system is put under pressure.

2.3.2 Tigris Green Equipment and Tools:

To install hydro-sanitary and heating system using Tigris Green pipes and fittings the use of the following specific equipment required:

Pipe Cutter	0-63
Polyfusion device	20-63 (feeding 200 V)
Male and female material	20-63
Welding machine for electro-fusion couples	20-225
Bench welding machine	20-75

2.3.3 Exposure to UV-rays:

It is recommended neither to store nor to install the product in places, which are directly exposed to Ultraviolet rays.

2.3.4 Bending:

Bending for pipes will not be allowed.

2.3.5 Threaded joints:

To ensure tightness, Teflon or similar product can be used.

2.3.6 Pipe Cutting:

Cutting should be carried out using tools, which ensure a clean cut free from burns and perpendicular to the axis.

2.3.7 Low Temperature:

A temperature below 0c following precautions have to be taken.
Pay attention when cutting pipe.

Check the cut make.

Avoid impacts and excessive strains.

Not to make elbows with very narrow radius.

In presence of cold draughts, welding must be carried out in protected areas, to avoid a quick cooling of the surfaces to be welded.

2.3.8 INSTALLING AND JOINTING KELEN:

1. Installing the pipes in short:

In practice the main riser can expand and contact laterally in the shaft between two floors if an anchor point is located next to the pipe that branches off from the main pipe. The distance between two anchor points in the shaft should not exceed 3.0 m. other methods can be used to accommodate the expansion such as expansion armor in the pipe branching off from riser.

2. Embedding the pipe:

Pipe work that is embedded in the wall, screed etc. is prevented from expanding. The pressure and tensile stress are absorbed without causing any damage to the

material. If the pipes are installed (in compliance with national standards) then the insulating material provides further room for expansion.

2.3.9 Exposed pipe work:

1. Preventing expansion by mechanical restraint d 20-50.
Steel channels (KE88) can also be used to support pipe work.

The hangers are fixed to the channels, which are in turn fixed to the pipes (e/g using cable ties). This practice reduces the expansion rate of plastic pipes to that of steel pipes.

2. Accommodating expansion by expansion loops d 63-110

All changes in direction of pipe work can be used to accommodate linear expansion. However, in some cases an expansion loop (U loop) is necessary. This method is primarily used for pipe sizes above d 50.

The anchor prints are positioned in such a way that the pipeline is divided into sections and the force of expansion can be guided in the desired direction.

Pipe support centers (in cm) for KELEN pipes transporting water.

<u>D mm</u>	<u>Pn 10</u>	20C <u>PN</u>	40C <u>PN20</u>	60C <u>PN20</u>	80C8 <u>PN20</u>
20	70	80	70	65	60
25	75	85	80	75	70
32	90	100	90	85	75
40	100	110	105	95	85
50	115	125	115	105	90
63	130	140	130	120	110
75	150	170	160	150	130
90	185	205	195	180	160
110	195	220	200	180	160
205	220				

The pipe and fittings are joined by a self-regulating Polyfusion welding machine, at a temperature of 260 C. Connect the machine to the electricity supply (220 V) and wait. When the green light starts to blink the welding temperature has been reached and work can begin.

2.3.10 Safety first:

Cut 4-5 from each end of the pipe (the ends may have slightly damaged during handling) for this purpose KELEN pipes is in 4.10 m lengths.

2.3.11 **WELDING PROCEDURE:**

1. Ensure that the surface of the pipe and fitting are clean and free of grease.
2. Mark the insertion depth(equal to the socket depth of the fitting) on the pipe.

3. Heat the pipe to the insertion depth and the fitting to the socket depth on the welding tools.
4. When the heating time has elapsed see table push the pipe and fitting together smoothly and evenly. The result is very strong and homogenous.
5. The position of the fitting can be adjusted for a few seconds immediately after the pipe and fitting have been joined. (See table)
6. Within a short period of time (See table) the joint is capable of withstanding a full load.
7. The low weight and high flexibility of the material makes it possible to weld whole sections of pipe work at the workbench. Take advantage of this and save much time.
8. Some joints will have to be made in the wall. Try to keep the area here the joint has to be made as accessible as possible.
9. Measure the correct length, not forgetting the depth of the pipe socket. Pipe secateurs are used for cutting pipes up to 40.mm. Pipes with larger diameter are cut with a wheel pipe cutter. If necessary the pipes can also be cut with fine metal saw. Don't forget to insulate the pipes specified. The pipes can be covered with elastic insulating tubes (Kelinfix, kelon etc.) before they are installed. This can of course be done later but it is more difficult when the pipes have already been installed in the wall.
10. The distance between the draw-off points at the wall can be set (in all standard distances) both horizontally and vertically with the template which is equipped with a spirit level.

2.3.12 KELEN WELDING MACHINE FOR LARGE DIAMETER:

1. Screw the heating elements for the desired diameter to the heating mirror.
2. Insert the reducers for the desired diameter in the clamp.
3. The clamps for the fitting are reversible. For d 20-d 40 use the small clamps and for dia 50 – 90 use large clamp. Secure the fitting in the clamp.
4. Select the centering bushing for the required dimension and release the centering lever.

Push the centering Bushing into the fitting and tighten the centering lever.

5. Pipe diameter Switch: This switch determines the insertion depth the pipe in the fitting. Set the required diameter.

The Welding Procedure:

1. Place the pipe in the clamp without tightening. Press down the spacing button and do not release. Move the sliding blocks with a hand wheel until the end of the

pipe is touching the end of the fitting. Release the spacing button and secure the pipe in the clamp.

2. Separate the two sliding blocks and pull down the welding mirror. Roll the two sliding blocks together until they are held by lock on the welding mirror. When the welding time has elapsed separate the sliding block and quickly remove the welding mirror.
3. Move the two sliding blocks together until the pipe diameter switch catches. Never cool the remove the welded joints. Once the cooling period has elapsed the joint is ready to withstand a full load.

2.3.13. Butt welding machine for KELEN pn 10 pipes:

1. Loosen the screws and fit the required reducers in the clamps.
2. The end of the pipe should protrude from the clamps by no more than 30 mm.
3. Connect the following machine and start the motor. Move the two pipes together and applying a little pressure until the pipes to remove the oxide layer at the weld zone (max. cutting thickness: 0.2mm). Ensure that the pipe ends are parallel to each other (max. divergence: 0.3 mm). The pipe ends must not be offset by more than 0.5 mm.

2.3.13 IMPORTANT:

The pipe ends must not be touched and must be welded immediately. If this is not possible and weld has to be made later then the welding zone must be cleaned and de-greased.

2.3.14 The welding procedure:

1. Before welding begins read from the manometer the pressure required for advancing the mobile part and add this to the working pressure given in the table.
2. Never cool the joint suddenly. If the weld has been made correctly a double bead should be visible around the whole circumference of the pipe.
3. Insert the heating element (Temp: approx. 250C). Press the pipe ends on the heating

element with the required joining pressure until a bead forms around the whole circumference of the pipe. During the reduced to the heating pressure once the heating time is over move the sliding blocks apart rapidly and remove the heating element.

4. The changeover time (time between removing the heating element and welding the pipes) should be as short as possible.
5. The welding pressure should be built-up as smoothly as possible during the specified pressure attainment time (mi.0, 15 n/nm²).
6. The welding pressure must be maintained during the cooling period.

2.3.15 Joining KELEN electro fusion Sockets:

1. Cut KELEN pipe square to the axis.
2. Scrape the KELEN pipe with an appropriate tool (blade or scraper). Ensure that only a thin layer is scraped from the surface and that the nominal diameter is not reduced.
3. Chamfer the KELEN pipe with an appropriate tool (blade or scraper).
4. Thoroughly clean the end of KELEN pipe and electro fusion socket where the weld is to be made. A cleaning tissue soaked in isopropyl alcohol is supplied with the electro fusion socket for this purpose. Do not use oil-based solvents for cleaning.
5. The operating instructions for the electro fusion socket-welding machine are located in the cover of the machine.
 - a. Connect the electricity supply (220+/- 10%, 50 Hertz.). Attention: Ensure that the cable is completely unrolled to avoid inductive loss of voltage.
 - b. Connect the welding cable to the socket.
 - c. Press the start button. The machine calculates the welding time.
 - d. When the welding time has elapsed the machine switches itself off.
 - e. If there is a defect establish the reason.
 - f. Press the reset button before each further welding procedure.
6. Ensure that the electro fusion socket is axial to the pipe and is subjected to stress or strain welding.
7. Ensure that no moisture is present either inside or outside the weld zone.
8. Ensure that the weld is not subjected to stress, impact or moisture or any other strain during the cooling period (allows at least 10 minutes for cooling).

9. Wait for at least one hour before operating the system.

2.3.16 FITTINGS:

The following fittings shall be used to time relevant pipes: -
(TIGRIS)

TIGRIS GREEN pipes PN 20 in 4m bars: -

Code (380 004, 380 005, 380 006, 380 007, 380 008, 380 009)

Coupler

Code (384 004, 384 005, 384 006, 384 007, 384 008, 384 009)

Electro-fusion coupler:

Code (384 104, 384 105, 384 106, 384 107, 384 108, 384 109)

Male/ female reducer

Code (380 554, 380 564, 380 565, 380 574, 380 575, 380 576,
380 585, 380 586, 380 587, 380 595, 380 596, 380 597, 380 598)

90 elbow:

Code (381 004, 381 005, 31 006, 381 007, 381 008, 381 009)

Male/Female 90 elbow

Code (381 244)

Female threaded 90 elbow

Code (381 014, 381 024, 31 015, 381 025, 381 026, 381 036)

Male threaded 90 elbow

Code (381 114, 381 124, 31 115, 381 125, 381 126, 381 136)

Female threaded 90 male elbow

Code (381 515)

Female threaded 90 male elbow with supporting device:

Code (381 304)

Male threaded 90 male elbow with supporting device:

Code (381 314)

45 Elbow:

Code (381 404, 381 405, 381 406, 381 407, 381 408, 381 409)

90 Joint with spigot and nut:

Code (381 624, 381 635, 381 646)

“Tee”

Code (383 004, 383 005, 383 006, 383 007, 383 008, 383 009)

Reduced "Tee" Fitting:

Code (383 545, 383 646, 383 656, 383 747, 383 757, 383 767,
383 858, 383 868, 383 878, 383 959, 383 969, 383 979, 383 989)

Male Threaded "Tee":

Code (383 114, 383 124, 383 115, 383 125, 383 126, 383 136)

Bypass Bend:

Code (381 804, 381 805, 381 806)

Cap

Code (384 604, 384 605, 384 606, 384 607, 384 608, 384 609)

Female Threaded "Tee":

Code (382 114, 382 124, 382 115, 382 125, 382 126, 382 136,
382 147, 382 158, 382 169)

Joint with spigot and nut:

Code (382 324, 381 324, 381 325)

(KELEN)

Pipe PN20

KE00 PN20 (d20-90)

SENSO-Pipe PN20

KE03 PN20 (d20-25)

Socket Coupling

KE20 PN20 (d20-90)

Elbow 90

KE20 PN20 (d20-25)

Elbow 45

KE70 PN20 (d20-25)

Elbow 90 (male/female) KE26

PN20 (d20-32)

Elbow 45 (male/female) KE27

PN20 (d20-25)

Equal tee

KE30 PN20 (d20-90)

Reducer tee

KE35 PN20 (d20-75)

Reducer (male/female) KE41

PN20 (d20-90)

End Cap

KE60 PN20 (d20-90)

Curved pipe

KE90 PN20 (d20-32)

Wall bracket 90

KE83 PN20 (d 20-25)

Value

KE50 PN20 (d 20-25)

Male adaptor

KE11 PN20 (d 32-75)

Female Adaptor

KE13 PN20 (d 20-32)

Female Adaptor

KE13 PN20 (d 32-75)

Elbows adaptor 90 (male)

KE21 PN20 (d 20-32)

Elbows adaptor 90 (female)

KE23 PN20 (d 20-32)

Tee (male thread)

KE33 PN20 (d 20-32)

Union (plastic-metal)

KE56 PN20 (d 20-90)

E-repair socket

KE17 PN20 (d 20-90)

Backing ring

KE18 PN20 (d 40-110)

Flange

KE19 PN20 (d 40-110)

Threaded connection for cavity walls

KE84 PN20 (1/2")

Stopper (short) (1/2: -3/4")

Stopper (long) (1/2:-3/4")

Poly fusion Welding programmed PN 10

Pipe PN10

KE02 PN10 (d 20-160)

SENSO- pipe PN10

KE04 PN 10 (d 20-25)

Socket coupling

KE10 PN10 (d 110)

Elbows 90

KE20 PN10 (110)

Elbows 45

KE70 PN10 (110)

Equal tee

KE30 PN10 (110)

Reducer (male/female)

KE41 PN10 (110)

E-repair socket KE17

PN10 (110)

Butt-welding programmed PN10 (Code ST)

Elbow 90

KE20 ST PN 10 (d110 -160)

Elbow 45

KE70 ST PN10 (d110-160)

Equal tee

KE30ST PN10 (d110-160)

Reducer

KE41ST PN10 (d110-160)

Backing ring

KE30ST PN10 (d110-160)

Flange

KE19St PN10 (d110-120)

Accessories

Template

KE86L

Plugs for template

KE86D

Pipe channel

KE88 (d20-90)

Flange seals

KE19A (d40-160)

2.3.17 Samples:

Samples of all materials shall be got approved use from the Chief Architect. Manufacture's test certificate shall be submitted to he Chief Architect stating that the pipes conform to the specified grade/test pressure.

Materials may further be got tested, it required by the Chief Architect at Contractor's cost. Rejected materials shall be removed to the Site of Works immediately type of materials as approve shall be used thought the works.

2.3.18 TESTING OF PIPE LINES:

No work shall be covered over or surrounded with concrete until is has been tested by the Contractor and in the pressure of Chief Architect and approved by him.

a) Water Pipes

After laying, jointing and anchoring, the main should be slowing and carefully charged with water, so that all air is expelled then allowed to stand full for several days before testing under pressure.

The test pressure should be applied by means of a manually operated test pump or, in the case of long main or mains of large diameters, by a power-driver test pump

which should be not be left unattended. In ensure case precautions should be taken to ensure that the required pressure is not exceeded. Pressure gauges should preferably be re-calibrated before the test.

The test pressure may be the maximum working pressure at the point of reading pipe 20 percent. The test pressure should be maintained by the pump for about one hour and if there is any leakage it should be measured by the quantity of water pumped into the main in that time. A general leakage of one gallon per inch of diameter per mile per 20 hours per 1000ft head may be considered reasonable, but any visible individual leak should be required.

Any defective pipe-length joints fittings, and valves any materials shall be replaced or defective work rectified by the Contractor and retested for acceptance, all at contractors cost.

2.4 CONSTRUCTION REQUIREMENTS

2.5 EXCAVATION & REFILLING OF TRENCHES FOR PIPE WORK

The trenches shall be set out to suit alignment to the pipelines. The trenches shall be carefully trimmed at sides and bottom so those pipelines when laid shall rest on the natural bed throughout the length. Shallow joints holes being left for the joints, where necessary. Where pipe line is to be laid in plains the depth of cover, i.e. the normal distance from ground level to other top of the pipe be kept at about 80 cm (2'-9") and shall not be less then 75 cm (2'-6") except due to special reasons the Consultants directs in writing to the contrary. The maximum depth of trench shall be taken as shown under,

I
For pipes up to &
including 38mm
50 cm Depth
(20")

II
For pipes 50 mm
to 75mm(2" to 3")
50 cm Depth
(22")

III
For pipes over
75mm (3") dia
60 cm depth
(24")

2.6 **FLANGES**

Flanged joints shall be provided at intervals of not more than 152m (500 Ft.). Each flanged joints shall be made by inserting an accurately cut disc of tough multiply rubber insertion about 3.2 mm (1/8") thick of approved quality between the flanges. The bolt holes in the rubber insert as well as in the flanges shall be drilled to template, the bolts and nuts for all flanged joints shall consists of British Standard mild steel, hexagonal, round and hexagonal. The bolts shall be pulled up gradually and evenly by the use of standard spanners, so as to ensure a perfect joint.

2.7 **BENDS,TEES AND OTHER SPECIALS**

Bends, tees and reducers and other specials shall be provided and joints as points as shown on t/le drawings or a directed by the Consultant. All charges in direction shall be effected by means of bends wherever practicable and the use of elbows shall be restricted on to cases where there is no room for bends. In such cases only round elbows will be allowed.

2.8 **TEST**

All pie lines in courses of or after laying and jointing but before being covered, shall be tested hydraulically, using a test Pump fitted with accurate pressure gauge to be approved by the Consultants to normal static pressure plus 50 Psi gauge but not less than 150 Psi i.e. all pipes, specials and fittings with their joints shall remain perfectly water under the full test head for a period of not less than two hours after the whole length of the pipe line has been examined and demonstrated to be water tight.

2.9 **PIPES ATTACHED TO WALLS OR CEILINGS**

- a) Provide suitable and substantial hangers and support for all horizontal and vertical line of approved types and make special vibration eliminating and flexible hanger shall be provided for all pipe work effected by moving machinery or expansion and construction including building expansion joints.

- b) Hot and cold horizontal piping shall be supported in accordance with following schedule.

<u>Pipe Size</u>		<u>Minimum Hangers Spacing</u>	<u>Road Size</u>
1)	1" and smaller	8 feet -0 inch	3/8"
2)	1-1/4" -2 inch	9 feet -0 inch	3/8"
3)	2-1/2" inch	10 feet -0 inch	1/2"
4)	6" and larger	12 feet -0 inch	1/2"

- c) Hanger shall be supported from approved concrete inserts in concrete slab for all pipes 2" and above. Inserts shall be as approved by the Consultants, and shall have space for nuts of all size. All inserts shall have a reinforcing rod of specified diameters to be installed through slot provided for this purpose, and the Contractor shall be responsible for its' being in place when concrete is poured. The Contractor should place alt inserts in pour for all, pipes which are to be hung, in ample time to allow the Contractor for general consideration to perform his work on schedule. If any pipe has to be hung is space where no inserts have been provided, the Contractor shall drill holes from below through concrete slabs and provide rods and hangers attached to not less then two approved type expansion shield each one cable of taking full maximum load. The rods and complete hangers shall be of adequate size to support the load, which they carry.
- d) Provided approved roller supports, floor stands wall brackets, masonry. Etc. for all lines running above the floors, and which can be properly supported by the floors of walls. Pipelines near wails may also be hung by hangers, carried from approved wall brackets at a higher level then the Pipe.
- e) No piping shall be hung from the piping of other traders or other pip in except for small water branches in toilet where other practice means of support can be found, in which case specific approval in the installation shall be obtained from the Consultants. Hangers shall not be fastened by means by vertical expansion bolts. Hanger shall b of heavy construction suitable for the size of pipe to be supported. All materials, except roller shall be a malleable iron or steel. Rollers shall be cast iron. Hanger shall be swivel split ring. Wrought pipe clamps, or adjustable type or as approved.
- f) Special care shall be taken in the placing of hangers at the top, bottom and in offsets of hot water risers, so as to allow for expansion for the vertical piping.

Vertical risers shall be securely supported from the building construction by means of pipe clamps at every floors, or as too short to connect to the building construction.-

- g) For cast iron huh and spigot pipe and fitting hangers shall be provided on not ore then 5 feet centers or a minimum of one hangers per each length of pipe. Where excessive numbers of fittings are installed between hangers, the Contractor shall provide additional hanger or reinforcing as required and to the satisfaction of the Consultant, security anchor fittings to the building construction changes of direction to eliminate all horizontal movement. The Contractor shall furnish and install steel channels and angles for piping support. Theses support will be required at those floors, which are not slabbed over and/or or where the building support. Theses support will be required at theses floors, which are not slabbed over and/or where the building structure is nor directly usable for pipe support.

2.10 PIPE SLEEVE

Every pipe line laid through any walls, floors, ceilings or roofs shall be arranged to pass through proper hot dipped galvanized sleeve pipes as approved by the Consultants or sample diameter embedded therein to enable the pipe lines to pass easily and freely. The length of every such sleeve pipe shall be of the full width or

thickness of the wall and in the case of roof, ceiling or floor, shall be at least 4 cm (1- 1/2") longer than the thickness thereof and shall project to that extent above the upper surface thereof unless the Consultants orders to the contrary.

2.11 DISINFECTION FOR WATER SUPPLY

After the testing of the pipe work has been satisfactorily completed and when approved by the Consultants, the Contractor shall disinfect the pipe lines by dispensing chlorine solution through the entire pipe network to obtain minimum chlorine content of 50 mg/liter for a contact period of at least 30 minutes. The procedure and equipment used to introduce, disperse and test the chlorine in the pipe shall be subject to approval by the Consultants.

2.12 MEASUREMENT

The pipe work 150mm (up to 6" dia) shall be measured in running foot and no separate measurement will be done for tees, bends, elbows, unions and other fittings. Unit of measurement for pipe work shall be taken along the centerline and unit of measurement will be one linear Ft.

2.13 PAYMENT

The rate shall include all cost of material i.e. pipe, fitting, jointing material, lubricant, sleeve pipes, hangers and clamps, and labor of every type and incidentals.

SECTION – 3 : PLUMBING AND SANITATION WORK

3.1 DESCRIPTION

Work under this section includes supplying and fixing all sanitary works including English type W.C or Asia type W.C. wash hand basins, urinals, sinks, low down and high level cistern, automatic flushing tank, showers, Taps, valves also any special fixtures called for on the plans and mentioned in the Bill of Quantities.

3.1 MATERIAL REQUIREMENTS

3.1.1 Plumbing fixture and Fittings

1. European type water closet shall be of standard clear opening between flushing rim in white earthenware best quality (local made) "P" or "S" trap 3 gallons (13.5 liters) enameled, wall type flushing tank, enameled flush bend, PVC symphonic type fittings complete with corrosion resistant alloy ball level of best quality manufacture in Pakistan. Standard seat cover with PVC rings and nuts and rubber buffers, etc. complete.
2. Asia/Orisa type water closet of standard clear opening as measured between flushing rims with foot rest in white earthenware best quality (local made) with back and front flush, specified dia. C.I trap of same make, 3 gallons (13.5 Liters) Ceramic flushing tank with symphonic type flush fitting corrosion resistant alloy or plastic ball valve of Asia or equivalent 1-1/4" (31 mm) dia telescopic flush pipe made from PVC pipe of the same size fixed to wall with PVC/C.P. saddle.
3. Wash basin of specified size in white color best quality mounted on C.I. brackets fixed to wall, (local made) with 1/2" (15 mm) C.P pillar cock, 1-1/4" (31 mm) C.P waste chain plug, local made heavy counter sunk screws, PVC/C.P down take waste pipe 1/2" (15 mm) PVC/C.P type cock heavy duty with 1/2" (15 mm) PVC/C.P inlet connection 1/2" (15 mm) C.P brass union nuts and washers, including 3 coats of approved enamel paint to C.I brackets.
4. Urinal size 17" (425 mm) in white earthenware best quality (local made) with C.I automatic flush tank 1/2" (15 mm) C.P brass union nuts and washers. The urinals shall be connected with G.I pipe flushing assembly connected to each urinal and 1-1/2" (38 mm) PVC waste pipe.
5. The shower roses shall be chromium finish universal types with adjustable spray of best

quality local made as per approval.

6. The sink shall be stainless steel best quality local made with all accessories.

NOTE:

C.P brass waste and union 1-1/2", 1-1/4" (38mm/31mm) dia with PVC/C.P down pipe to be provided for sinks and wash hand basins.

3.1.2 Showers

The showerhead shall be chromium plated with fountains of size specified in the B.O.Q. OR as approved by the consultants. Each shower shall be connected through a control valve to the hot and cold mixing valve. This shall be best quality manufactured approval shall be given by the consultants.

3.1.3 Taps

All taps shall be of heavy-duty type, chromium plated or brass as applicable and be of approved manufacture.

3.2 **CONSTRUCTION REQUIREMENTS**

3.2.1 Water Closets

The work shall consist of providing and mixing in position Orisa type water closet or European type water closet of an approved manufacture. The type pan shall be of white vitreous China, glazed fire, fire clay, or any other approved non- absorbent material with specified diameter trap of the same material and footrest. The surface shall have a glazed finish with minimum of fouling area and a seal depth greater than 50 mm. The outlet shall be placed well back and the pan shall be sufficiently long to meet the design requirement. The flushing water connection shall be from the rear end.

The European type water closet shall also be vitreous China made of an approved manufacturer with low level flushing cistern and with double seat cover. The W.C shall be of symphonic type with large water area and deep seal, the cleaning being effected by symphonic action. It shall have a low trap at the floor line so that the closet can not be un-trapped by the emptying water.

The flushing cistern shall be of white glazed earthenware 13.6 liters as specified in the B.O.Q.

The flush pipe shall be PVC or chromium plated steel pipe, the holes of inlet, outlet and over flow in the cistern shall be made watertight by inserting rubber washers or other means of providing a watertight joint. The position of water closet shall be so arranged that it shall not face Qibla.

Every water closet shall be provided with a water supply bib tap for filling the small water cans in the site down position. A chromium plated toilet paper holder close to each water closet shall also be installed.

3.2.2 Sink

Sink shall be of stainless steel of size as specified in the BOQ with self-contained drain boards of approved manufacturers. The sink shall be fitted with rubber plug and washers, 38 mm dia. Chromium plated bottle with waste pipe with all necessary accessories for making the sink a complete unit. The internal angles shall be of a design of facilitate cleaning with a fall towards outlet to drain the contents completely.

3.2.3 Service Sink

If required shall be made of stainless steel of 16 gauge as approved by consultants. The sink shall be used for drawing water for scrubbing and cleaning and dispose off the contents of scrub buckets and vessels containing slops. The edge of the sink shall be placed about 600 mm above the floor to minimize, lifting and to leave room for the trap beneath.

The water supply and drainage equipment for such sinks shall be similar to that for kitchen sinks, except that no hot water supply or mixer will be installed.

3.2.4 Water Pump

Pumps for domestic Water, Fire Fighting, Drainage and Sewage Lift Station

The centrifugal pump-motor set shall be heavy-duty industrial type suitable for continuous and quiet operation. The centrifugal pumps shall be single stage, small size of vertically split casting and larger sizes or horizontally split casing as specified in the schedule of equipment.

The pumps to be volute type, cast iron body, fully bronze fitted, bronze impeller of radial type with double curvature vanes, stainless steel shaft or shaft sleeve, properly lubricated bearings, readily accessible stuffing box with packing and seal cage, flanged suction for the pump and the and the motor and the pump shafts covered with approved guard, pump casing to be completed with drain and vent plugs and designed, tested and proven tight for a test pressure at least equal to 1.5 times the maximum pressure.

The pumps to have the gate valves and strainers on the suction side globe valves on the discharge side and pressure gauges on suction and discharge sides. If pumps are operating in parallel than a check valve to be installed on the discharge side of each pump. The pumps shall be direct driven by a constant speed motor and provided with a suitable starter. The pump motor HP has been given for each system for guidance but it is intended that motor of higher HP shall be provided if required to ensure that it is not overloaded under any possible operating conditions of the pumps.

Each pump shall be guaranteed for circulating the specified water quantity against specified net discharge head under the specified conditions of operation when operating continuously without over heating the motor, bearings etc. However the contractor will check and confirm the actual discharge head required before placing orders for the pump.

The pumps shall be selected for quiet operation so that pump noise is not audible outside the plant room. The pump sound shall not be transmitted to the building structure. The pumps

installed for one system should be suitable for parallel operation in all respects. The pump impeller and motor should be so selected that these are not overloaded when only one pump is operating and increased water flow is to be handled due to reduced system head.

The contractor shall supply anti-vibration foundation material (both pads for isolator of main foundation and spring mounting for inertia mass) for isolating the pump foundations from the building structure. The number, size and conditions of operation for pumps required for different systems are specified in the schedule of equipment and pumps location shown in the drawings.

Certified performance data and curves shall be submitted by the CONTRACTOR for approval to confirming the purchase order on the manufacturer/supplier. All pumps to be supplied under this section to be of one manufacturer for the same type.

The pump motor sets to be of local manufacturer, KSB or approved equal, for the sizes manufactured locally.

- a. Pump capacity in US gpm against net discharge head, RPM, HP of motor, and pump maximum HP requirement.
- b. Construction and other technical details.
- c. Overall dimensions and operating weight.
- d. Manufacturer's performing guarantee certificate and performance data and curves and technical bulletin.

The sewage ejector submersible centrifugal pump motor sets shall be vertical heavy duty Industrial type with non-clogging impeller suitable for continuous operation.

The pump capacity rating shall be specified in the schedule of equipment.

The pump shall be vertical single entry single stage non self-priming. The pumps casting shall be radially split open towards the discharge end sealed off by a cover, suction end with a renewable wear plate and nozzle, impeller suitable for mixture of contaminated fluids, solid particles and sludge. The shaft length shall suit the installation depth shown in the drawings and shaft pieces joined together by threaded shaft coupling. The weight of the rotor and axial thrust will be absorbed, by deep groove ball bearing in the vertical hollow shaft motor. A grease pump mounted on the pump mounting plate shall continuously feed grease individually to every bearing during pump operation. The pump shall be fitted with soft packed stuffing box fed with sealing grease the pump base plate shall be sized large enough to enable the pump to be pulled out/lowered into terminated above the base plate. The wear plate shall be of cast iron, shaft-protecting sleeve of stainless steel, Shaft of carbon steel, base plate of steel, motor stool of steel/cast iron and bearing of lead bronze.

The pump motor sets to be of local manufacturer, KSB type KVP or approved equal. The Tenderer to give following information for the pump.

- a. Pump capacity in US gpm against specified head, RPM pump maximum BH requirement and motor HP.
- b. Construction and other technical details.
- c. Overall dimensions and operating weight, clear height required above base plate for pulling out the pump.
- d. Manufacturers Performance Guarantee Certificate and performance data and curves and technical bulletin.

Level Controller

Each group of the above pumps shall have a control system as detailed below:

A three position level controller shall automatically control the pump operation. The level controller shall start the pump at high level and stop the same at low level. A highest level, the level controller shall energize an audio video alarm.

3.2.5 Unions

Provide accessible unions in supply and return connections at all equipment fixtures, fixtures, special automatic valves, screwed end valves and at all other points will the system where required, in order to facilitate removal of specialties or equipment for repairs.

3.2.6 Expansion Joints For C.I Soil or Waste pipe

Expansion joint in C.I soil or waste pipe shall be provided as per plans, where the pipe crosses building expansion joint. These will be of non-pressure type, similar to imported Jossam Series.

3.3 **MEASUREMENT**

Measurement shall be made for the number of fixtures and toilet accessories acceptably provided and fixed in position.

3.4 **PAYMENT**

Payment shall be made for the number measured as provided above at the contract unit rate for the respective items in the Bill of Quantities and shall constitute full compensation for all labor material, use of equipment and tools required for work related to the item including providing and fixing all other work to complete the item in all respects as specified or as directed by the consultants.

SECTION – 4 : SEWERAGE / DRAINAGE WORK

4.1 DESCRIPTION

4.1.1 Sewerage

All sewerage/drainage pipes work inside the houses and buildings and up to the connection of the trunk sewer shall be covered under this section. The pipes shall be M/S DADEX, RCC or C.I as specified including soil, waste, vent and anti syphonic pipes.

4.2 MATERIAL REQUIREMENTS

All RCC/C.I pipes shall confirm to the specifications referred to in section “Material” and as specified in this section.

For cast iron pipes, the joints shall be lead caulked. The packing material shall be pure jute, hemp or hemp yam.

For M/s. DADEX, all activities should be in accordance with the manufacturer’s specifications.

For RCC pipes the cement mortar to be used on joints shall be of 1:1 ratio or as per plans.

Material specifications for sewerage and drainage shall be as follows:

a. Cast Iron Pipe, socket and spigot (6’ length).

Minimum Weights

Dia (in)	2	3	4	6
Weight (Lb.)	24.90	37.00	48.00	72.90
Test Pressure against leakage = 20 Psi.				

b. Cast Iron Fittings

Minimum Weights (lb.)

TABLE-1 (BENDS)

<u>Fittings (inches)</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>6</u>
87-1/2 degree and 45 degree bend without access	6.3	11	15	24.9
87-1/2 degree and 45 degree bend with access	7	11.9	18	29.9

TABLE (WYES & REDUCERS)

<u>Fittings (inches)</u>	<u>2x2</u>	<u>2x3</u>	<u>3x3</u>	<u>2x4</u>	<u>3x4</u>	<u>4x4</u>
87-1/2 degree and 45 degree without access	9	15	16	17	20	24
87-1/2 degree and 45 degree wye with access	11	16	18	20	24	26
Eccentric reducer with Smaller sides socket Ted	-	7.9	-	11	11	-

c. R.C.C Pipe BSS 556: Class-M			< 9"			
6"-dia pipe with collar 9" pipe, spigot and socket ASTM C76- 72-a			>12"			

4.2.1 Cast Iron Floor Trap Manhole Frames and Cover Grating

These shall be from a mixture of cast iron scrap and suitable grade of pig iron, and resultant metal shall be of strong gray structure, free from chips, air bubbles and sand holes and shall be smooth and even both inside and outside.

4.2.2 Grease Trap

Grease trap shall be made of cast iron, for specified capacity and inlet/outlet dia and provided where shown on plans. Grease trap shall be embedded in raised floor and inlet shall be submerged.

4.2.3 Glazed Earthenware

Shall be of best and approved quality and the water seal shall not be less than 63.5 mm (2-1/2") deep.

4.3 CONSTRUCTION REQUIREMENTS

4.3.1 Laying of Pipe

Pipes and accessories shall be carefully examined before being laid and defective damaged pipes shall not be used. The pipes shall be brushed clean inside and outside to remove any oil or foreign matter that may have accumulated, including inside of the sockets and outside of spigots, before being lowered into the trench, and shall be kept clean during laying operation by plugging or other approved method.

The bottom of the trench shall be shaped to give substantially uniform circumferential support to the lower fourth of the each pipe. Pipe laying shall be processed in upgrade with the spigot ends of bell and spigot pipe pointing in the direction of flow. Each pipe shall be laid true to line and grade and in such a manner as to form close concentric joint

with the adjoining pipe. If the width of the trench at pipe is exceeded than necessary, due to any reason other than under direction from consultants, the contractor shall install at no additional cost to the Owner, such concrete cradling pipe encasement or other bedding as may be required to satisfactorily support the added load of the backfill.

Trenches shall be kept free from water until the line jointing material has set, and pipe shall not be laid when the condition of the trench or the weather condition is unsuitable for such work. At times when is not in progress, open ends of pipe and fittings shall be securely and satisfactorily closed so that no trench water, earth, or other substance will enter the pipe and fittings.

As the work progresses, the interior of the sewer shall be cleaned of all dirt and superfluous materials of every description. Where cleaning after laying is difficult because of small size, a suitable swab or drag shall be kept in the pipe and pulled forward past each joint immediately after the jointing has been completed.

Where sewers cross above water line the sewer pipe for a distance of 3 meter (10 feet) each side of the crossing shall be of cast iron steel or other acceptable pressure pipe and with no joint closer than 3 feet (900 mm) to the crossing, or shall be fully encased in concrete of minimum 15cm. (6") thickness.

Any section of the pipe found to be defective before and after laying, shall be replaced with sound pipe without additional expense to the Owner. The jointing of pipes with collars shall be done first with spun yarn rope (dipped in hot mastic composition) fitted in between the ends of pipes and pressed together. The dia of rope shall not exceed 19mm (3/4") or as directed by consultants.

The collar shall then be brought in the middle of the joint. Wooden wedges shall be placed at two or three places around the pipe so that the collar may have uniform gap all round the pipe for pressing pipes together. At a time five or six pipes shall be jointed together. After putting bitumen soaked hemp rope, suitable jacks and wedges or any other approved method shall be used. The inside of the collar and outside portion of the pipe shall be cleaned with brush and cement mortar of 1:1 proportion shall then be inserted from both ends of the collar. The mortar containing as little quantity of water as possible shall be carefully inserted by hand into the joints and tightly pressed with caulking tool. The mortar shall be finished off on the outside at an angle of 45 degree. The wooden wedges shall be carefully removed and mortar filled in the cavity before finishing. The joints shall be protected from weather and

maintained wet for at least ten days and shall not be covered with backfill until the joints have been tested and approval given by the consultants.

For jointing of pipes with spigot and socket joints, the first pipe shall be bedded with the socket end upstream. The interior surface of the socket shall be carefully cleaned with a wet brush and its lower portion filled with mortar to such a depth so to bring together the inner surfaces of the abutting pipes flush and even. All further joints shall be made in this manner. The remainder of the socket joint shall be filled in with mortar and well pressed with the help of caulking tool. The mortar shall be finished smooth on the outside at the angle of 85 degree. The joints shall be protected and cured as for collar joints.

4.4 FLOOR TRAPS

Floor traps with gratings shall be made of high grade, strong, tough, and even grained metals. Casting shall be free from blow holes porosity, hard spots, excessive shrinkage cracks, or other defects, shall be smooth and well cleaned both inside and outside. Casting shall not be repaired, plugged, brazed, or burned. The wall thickness of iron casting shall not be less than 6.4 mm (1/4")

Joints for cast iron soil, waste and vent pipes shall be made with lead, jute, and hemp or hempen spun yarn. The packing material shall be well placed into the annular space so as to prevent the entrance of lead into the pipe. Run lead joints shall be applied to perfectly pipes. Under wet condition lead fiber joints shall be made both with quantities and depth of jointing materials and by method as B.S Code C.P 301 (1950). The remainder of the space shall be filled with molten lead that hot enough to show a rapid change in color when stirred. The lead shall be caulked to form a tight joint without over straining the hell.

4.5 TESTING OF PIPE LINES

No work shall be covered over or surrounded with concrete until it has been inspected, tested and approved by the consultants.

4.6 DRAINAGE PIPES

The test shall be applied before the pipes are launched with concrete or covered in and repeated after backfilling the trench. Water test shall be carried out in drainage lines of RCC and the section of a test pressure of head of water equal to M.H depth by suitably plugging the lower end and filling the system with water.

The test pressure shall be maintained for 30 minutes without showing a drop of more than 7.5 cm (3").

In RCC pipelines water should be added until absorption by pipes and joints have ceased. A slight amount of sweating which is uniform may be over looked but excessive. Sweating in a particular part of joint shall be taken as defect. Any leakage visible shall indicate defective work which shall be cut out and made good by replacement by the contractor at his own cost and retested for acceptance.

Air test may be employed if allowed by the consultants where there are adequate supplies of suitably plugged and air pumped until a pressure of 100 mm (4") of water is indicated in a glass U-tube connected to the system. Without further pumping the pressure should not fall below 75 mm (3") during a period of 5 minutes.

After testing the pipelines as specified the interior of pipelines shall be inspected to ascertain that the pipes are entirely clear of obstruction and that the invert is smooth. For pipes less than 75 mm (3") in diameter, a loose plug shall be passed through each pipeline to ensure that the pipes are entirely clear of obstruction and that the invert is smooth. The loose plug shall be in the form of a cylinder with solid ends made of timber not less than 2.5 cm (1") in thickness, or by any other method as approved by the consultants.

RCC pipes below 300 mm dia shall confirm to B.S Class-A and dia 300 mm or above to ASTM C 76-72-a.

4.7 SAMPLES

Samples of all materials shall be got approved before use from the consultants manufacturer's test certificate shall be submitted to the consultants stating that the pipes confirm to the specified grade/test pressure.

Material may further be got tested, if required by the consultants at contractor's cost. Rejected materials shall be removed from the site of works immediately and same type of material as approved shall be used throughout the works.

4.8 MEASUREMENT

All pipe work be measured in running foot of finished length. No wastage or length consumed in joints shall be measured for payment. Sockets spigot and RCC collar shall not be measured separately. For cast iron pipeline the length consumed in valves, fittings and specials shall be measured along with pipeline.

Cast iron specials and fittings such as tees, tapers, bends, shoes, crosses, offsets, flanged sockets and spigot, and caps etc. shall be measured along with the pipeline.

4.9.1 PAYMENT

The rate of all items under this section shall cover the cost of all materials, labor, tools, equipment and appliance and performing all operations for laying, fixing and jointing and all work as specified in accordance with drawings, bill of quantities and as directed by the consultants.

Rate for pipe work shall also include making and repairing cut holes and chases in walls, floors and slabs etc. painting pipes, supports and accessories cleaning and clearing pipe lines and testing till approved by the consultants.

SECTION – 5 :EXCAVATION FOR WATER SUPPLY LINES & APPURTENANCES

5.1 DESCRIPTION

The work covered by this section of the specifications consists of furnishing all plant, labor, equipment, appliances. And materials and performing all operations in connection with excavation, trenching and backfilling for water lines and appurtenances in strict accordance with this section of the specifications and the applicable drawings, and subject to the terms and conditions of the contract.

5.2 CLEANING AND GRUBBING

The sites of all excavations shall be cleared of all shrubs, plants, bushes, large roots, rubbish and other surface materials. All such materials shall be removed and disposed off in a manner satisfactory to the consultants. All trees and shrubbery that are designated by the consultants to remain shall adequately protected and preserved in an approved manner.

5.3 EXCAVATION

5.3.1 General

All excavations of whatever substance encountered shall be performed to the depths indicated or as otherwise specified. During excavation, material suitable for backfilling shall be stockpiled in an orderly manner at a sufficient distance from the banks, of the excavation to avoid overloading and to prevent sides from caving. All excavated material unsuitable or not required for backfill shall be removed and wasted at a location approved by the consultants. Excavation in the streets shall be done in such a manner that street passage is not blocked by excavated material. Grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations, and any water accumulated therein shall be removed by pumping or by other approved methods. Unless, otherwise indicated or approved by the consultants, excavation shall be open cut.

5.3.2 Trench Excavation

Unless otherwise directed or permitted by the consultants not more than 500 feet of any trench in advance of the end of the pipe line already laid shall be opened at any time, unless otherwise directed or permitted by the consultants not more than 1000 feet of anyone

trench shall be worked on at a time from removal of pavement bottom, not exceeding 5 feet in depth shall be a maximum of 20 inches plus the external diameter of the pipe barrel and the width of the trench exceeding 5 feet in depth shall be maximum 30" plus external diameter of the pipe barrel. The banks of the pipe trench shall be as nearly vertical as practicable. Bell holes and depressions for joints shall be dug after the trench bottom has been prepared. The pipe except for joints shall rest on the prepared bottom for its full length. Bell holes and depressions shall be only of such length, depth, and width as required for properly making the particular type of joints, stones shall be removed to avoid point bearing. Whenever wet or otherwise unstable material that is incapable of properly supporting the pipe as determined by the consultants is encountered in the bottom of the trench, such

material shall be removed to the depth required and the trench backfilled to the proper grade with coarse sand, or other suitable approved granular material. Such replacement of unsuitable material shall be paid for at the contract unit price for that item of work.

Trenches shall be of a depth to provide a maximum cover, over the top of the pipe, of 30" from the existing ground surface or finished grade whichever is closer except that trenches for the pipe laid in lanes and alleys of narrow traveled way (average width of 8 feet or less between structures) shall be of a depth to provide a minimum cover, over the top of the pipe, of 18" from the existing ground surface or finished grade whichever is closer.

5.3.3 Excavation for appurtenances

Excavation for appurtenances shall be sufficient to level at least 12" but not less than 24" between the outer surface and the embankment or timber that may be used to hold and protect the banks. Any over depth excavation below such appurtenances that had not been directed by the consultant shall be considered unauthorized and shall be refilled with compacted sand, gravel or concrete, as directed by the consultants at no additional cost to the owner.

5.3.4 Maintenance of excavation

All excavation shall be properly maintained while they are open or exposed. Sufficient suitable barricades, warning lights, flood lights, signs, and similar items shall be provided by the contractor. The contractor shall be responsible for any damage due to his negligence.

5.3.5 Removal of Water

The contractor shall build all drains and do ditching, pumping, well pointing, hauling, and all other work necessary to keep the excavation clear of ground water, sewage and storm water during the progress of the work and until the finished work is safe from injury. All water pumped or drained from the work shall be disposed of in a manner satisfactory to the consultants and necessary precautions against flooding shall be taken.

5.3.6 Sheeting and Bracing

If ordinary open cut excavation is not possible or advisable, sheeting and bracing shall be provided to the work and provide working conditions, which are safe. The contractor shall

furnish and place the sheeting, shorting, wail braces, necessary for the safety of the work, the general public and adjacent property. Sheeting, shoring and bracing shall be removed as work progress arid in such a manner as to prevent damage to finished work and adjacent structures and property. As soon as withdrawn, all voids left by the sheeting and bracing shall be carefully filled with sand and compacted. The contractor shall be fully responsible for the safety of work in progress, for the finished work, the workmen, the public and adjacent property.

5.3.7 Protection of Facilities

Existing subsurface facilities likely to be encountered during execution of work require special precaution for the protection, such as sewers, drain pipes, water main, conduits and electric cables and the foundation of adjacent structures. The contractor shall be fully responsible for the damage of any such facility and shall repair the same at his expense whether or not this facility has been shown on the drawings.

5.3.8 Surplus materials

All surplus materials shall be disposed of at locations approved the consultants. Disposal of surplus material shall not interfere with other works and shall not damage or spoil other material. When it is necessary to haul earth or the material over street or pavement, the contractor shall prevent such material from filling on the street or pavement.

5.3.9 Cutting pavement

In cutting or breaking street surfacing, the contractor shall not equipment, which will damage the adjacent pavement. Existing paved surfaces shall be cut back beyond the edges of the trenches to form neat square cuts. The road ballast brick pavement and other materials shall be placed on one side and shall be preserved for re-installment when the trench is filled. Where ever necessary or required for the convenience or the public or the individual residents, at street crossings and at private driveways, the contractor shall provide suitable temporary bridges over unfilled excavations. All such bridges shall be maintained in service until backfilling has been completed. The contractor shall keep the road crossings manned 24 hours per day. During night time, enough red lights shall be provided to warn traffic. (Detour is necessary, the contractor shall make proper detour for the traffic and shall install signs 3 feet by 4 feet in size indicating the detour.

5.4 **BACKFILLING**

The trenches shall not be completely backfilled until all required pressure tests are performed and until the water lines as installed confirm to the requirements of specifications. Where in the opinion of the consultants, damage is likely to result from withdrawing sheeting, shoring, the same shall be left in place and cut off at a level 12" below ground surface. Sheeting left in place at the direction of the consultants will be paid for at the contract unit price/approved rate for that item of work. Trenches shall be backfilled to the ground surface with selected excavated material or other material that is suitable for proper compaction. Trenches improperly back filled shall be reopened to the depth required for proper compaction, then

refilled and compacted to the specific density. The surface shall be restored to its original or better condition. Pavement and base course disturbed by the trenching operations shall be required.

5.4.1 Lower Portion of Trench

Backfill material shall be deposited in 5" maximum thickness layers and compacted with suitable and hand tempers to 95% of maximum density until there is a cover of not less than 12" over water lines. The backfill material in this portion of trench shall consist of sandy clay or other approved materials free from stones and humps.

5.4.2 Remaining of Trench

The remainder of the trench shall be backfilled with material that is free from stones larger than 5" in any dimension. Backfill material shall be compacted to 90% of maximum density for cohesive soils and 95% of maximum density for others.

5.4 **BORROW**

Where suitable material for backfill is not available in sufficient quantity from required excavations, suitable material shall be obtained from approved sources at the contractor's responsibility. The necessary clearing and grubbing or borrow areas, disposal and burning of debris there from, the developing of sources including any access roads for hauling and the necessary right-of-way, and the satisfactory drainage of the borrow shall be considered as incidental items to borrow excavation.

5.5 **GRADING**

After completion of all backfilling operations, the contractor shall grade the work areas to be lines, grades and elevation shown on the drawings. Finished grading shall not be done until the installations of all waterlines has been completed and tested. The top surface after completion shall be in level to the adjacent existing surface. Prior to final acceptance, all damages due to settlement shall be repaired by and at the expense of the contractor.

5.6 **TESTING DENSITY OF SOIL IN PLACE**

The consultants may make tests using the calibrated sand cone method/core cutter method to determine the density of the soil in place. If soil in place fails to meet the specified degree of compaction the areas represented by the failing tests shall be removed, replaced and compacted to the specified density in the manner directed by the consultants and at no additional cost to the owner.

5.7 **MEASUREMENT**

The measurement shall be made for the actual quantity of work done in cubic feet. The maximum width of the trenches allowed for payment for various pipe sizes will be as under:

- a. Up to 2" diameter pipe, the trench width will be 15"
- b. Up to 3" diameter pipe, the trench width will be 18"

c.	Up to	4" diameter pipe, the trench width will be	18"
d.	Up to	6" diameter pipe, the trench width will be	21"
e.	Up to	8" diameter pipe, the trench width will be	24"
f.	Up to	10" diameter pipe, the trench width will be	26"
g.	Up to	12" diameter pipe, the trench width will be	28"
h.	Up to	16" diameter pipe, the trench width will be	32"

5.8 **RATE**

The unit rate tendered in the priced bill of quantities for excavation of trenches for water supply lines shall be considered as full compensation for the work specified in this section and shall include constructing and removing of all temporary

arrangements, backfilling pumping, sand filling under pipes an dewatering, removal of soft soil from bottom of trenches, removing the surface material and all incidentals to complete this work.

5.9 *PAYMENT*

Payment shall be made for this item of work at the unit rate quoted in the priced bill of quantities for.

SECTION – 6 : EARTH WORK FOR SEWERS

6.1 DESCRIPTION

Work under this section shall consist of furnishing all materials, equipment and labor for excavation, trenching and backfilling for sewers, drainage facilities, structures and all other appurtenances of sewage collection system, in accordance with drawings to proper line and grade refilling the trenches and dressing them to proper surface.

6.2 CLEARING AND GRUBBING

The sides of all excavations shall be cleared of all shrubs, plants, large roots, rubbish and other surface materials. All such materials shall be removed and disposed of in a manner, satisfactory to the consultants, all trees and shrubbery that are designated by the preserved in an approved manner.

6.3 EXCAVATION

6.3.1 General

The contractor shall do all excavation of whatever substance encountered to the depth shown on the drawings or as otherwise specified. Excavation shall include without classification the removal and disposal of all material whatever nature would interfere with the proper construction and compaction of the work and shall include the furnishing, placing and maintenance of support of the sides of the excavations. The work shall also include all pumping, ditching, dewatering and other measures required for the removal and exclusion of water. During excavation, material suitable for backfilling shall be stockpiled in an orderly manner at a sufficient distance from the bank of the excavation to avoid overloading and to prevent sides from caving. All excavated material unsuitable or not required for backfilling shall be removed and disposed of at a location approved by the consultants.

For contract purposes hereunder, the earth excavation work has been classified into two categories, earth excavation in trenches and earth excavation for structures.

6.3.2 Earth Excavation in Trenches

Except otherwise provided herein, excavation for a sewer line shall be open cut trenches with vertical side and not more than 150 feet of any trench in advance of the end of the built sewer shall be opened at any time and unless written permission to the contractor is given

by the consultants. Trench shall be excavated to its full depth for a distance permitted for the sewer to be laid. Trenches for sewer lines and appurtenances shall be to the lines and grades shown on the drawings or as ordered in writing by the consultants as necessary for the proper completion of the work. Belt holes and depressions for joints shall be dug after the trench bottom has been graded. The pipe except for joints shall rest on the prepared bottom for its full length. Belt holes and depressions, shall be only of such length, depth and width as required for properly making the particular type of joint. Stones shall be removed to avoid point bearing.

Where the bottom of the excavation is in material which in the judgment of the consultants by reason of its hardness cannot be excavated to provide a uniform bearing for the pipe, said material shall be removed to minimum of 6" below the grade of the bottom of the pipe, and the trench backfilled to the required pipe sub grade with the river sand or the other material acceptable to the required depth with concrete grade if so ordered. In no case material removed from such excavation shall be used as backfill material unless approved by the consultants. All instructions shall be in writing by the consultants.

6.3.3 Earth Excavation for structures

All earth excavation under this contract, which is not included under the classification of "Earth Excavation in Trenches" shall be classified and paid for as earth excavation for structures.

The contractor shall provide adequate timbering or shoring for excavations, should the sides and ends of an excavations give way the contractor shall, at no extra cost, removed all disturbed ground. Any excavation carried outside limits shown on drawings and specified herein as the payment limits, shall not be treated as excavation and shall not be paid for.

When foundation level is reached, the consultant's representative will inspect the exposed ground and give directions as to what further excavation, if any, he considers necessary. The excavation should be done in such a manner, as to ensure that the work rests in a solid and perfectly clean foundations. If the contractor allows any portion of such foundations deteriorate due to exposure, he shall make good the foundation to the satisfaction of the consultants without extra cost.

6.3.4 Alignment and Grade

The sewers are to be laid to the alignment and gradient shown on the drawings, but subject to such modifications as shall be ordered by the consultants from time to time to meet the requirements of the works. No deviations from the lines, depths of cutting or gradients of the sewers shown on the drawings and sections shall be permitted except by express directions in writing of the consultants.

6.3.5 Setting of Sight Rails

The sewers shall be constructed and laid to a true grade and in straight lines between curves as shown on the plan. The sewer shall be laid and constructed to their proper levels with the aid of suitable boring rods and sight rails which shall be fixed according to the requirements of the consultants at intervals not exceeding 10 feet and also by leveling along the invert with leveling instruments. The sight rails and boning rods shall be provided, fixed and maintained by the contractor who shall also provide and maintain suitable leveling instruments and equipment and shall set the positions and levels of the sewers and other work according to the drawings and the second deodar timber or ample size and strength. The rails and the boning rods shall be suitably and accurately and no warped or otherwise defective or damaged sight rails or boning rods shall be used. Sight rails shall be secured to the posts by strong steel clamps to the approval of the consultants and in such a manner that they shall be fixed as immovable, in relation to the correct lines and levels. All boning rods and sight rails

shall have the center line accurately marked thereon by a fine saw cut and shall be painted, black and white to the requirements of the consultants. All boning rods shall suitably be showed with iron. At least 4 separate sight rails shaft always be maintained in correct level and alignment along the line of sewer at every place where construction work is proceeding and the alignment and level of the sight rails shall be checked by the level and line at least twice every day to ensure that no disturbance or interference of the alignment and level have taken place. Whenever required the contractor erects and maintains such additional such rails as the consultants shall direct. The contractor shall, at all times, see that these workmen or other unauthorized persons are not allowed, accidentally or otherwise, to temper or interfere with sight rails or other alignment or level marks.

All bends and curves set be set out mathematically in a manner or approved by the consultants and the contractor shall provide and maintain for the purpose such additional sight rail posts and other wrought and rough timber work, steel wire and other articles as the consultants shall require from time to time.

6.3.6 Sheeting and Bracing

If ordinary open-cut excavation is not possible Or advisable, sheeting and bracing shall be furnished and installed in excavations to prevent damage and delay to the work and to provide working conditions, which are safe. The contractor shall furnish and place all shoring, sheeting, wall braces, timbers and similar items necessary for the safety of work, the general public and adjacent property. Sheeting, shoring and wall bracing shall be removed as the work progresses and in such a manner to prevent damage to the finished work and adjacent structure and property.

As soon as it is withdrawn all voids left by the sheeting and bracing shall be carefully filled with selected material and compacted. The contractor shall be fully responsible for the

safety of the work in progress, the workmen, the public expenses, as part of the work under the excavation items and at no extra cost.

6.3.7 Dewatering of Trenches

As part of the work under the excavation items and at no extra cost, the contractor shall built at drains and do ditching, pumping, well pointing, hailing and all other work necessary to keep the excavation clear of ground water, sewage and storm water during the progress of the work and until the finished work is safe from injury, the contractor shall provide all necessary pumping equipment for the dewatering work, as well as operating personal, maintenance, power etc. all at no extra cost. All water pumped or drained from the work shall be disposed of in a manner satisfactory to the consultants. Necessary precautions against flooding shall be taken.

6.3.8 Maintenance of Excavation

All excavation made hereunder shall be properly maintained while these are open and exposed. Sufficient suitable barricades, warning lights, signs and similar items shall be provided by the contractor. The contractor shall be responsible for any personal injury or property damage due to his negligence.

6.3.9 Protection of Existing Facilities

The contractor shall take special care of existing surface facilities likely to be encountered during the excavation for their protection, such as sewers, drain pipes water main conduits, electric cables, communication cables and the foundations of adjacent structures. The contractor shall be responsible for any damage to any such facility and shall repair the same at his expense whether or not the facility has been shown on the drawings.

6.3.10 Disposal of Surplus Excavated Material

All surplus material excavated by the contractor shall be disposed of at locations approved by the consultants. The disposal of surplus material shall not interfere with other works and shall not damage or spoil other materials. When it is necessary to haul earth material over streets or pavements, the contractor shall prevent such material from falling on the streets or pavements.

6.4 **BACKFILLING**

6.4.1 General

After the completion of sewer line, drainage facilities foundations, walls and other structures below the elevation of the final grade all voids shall be backfilled with suitable materials specified below.

6.4.2 Backfilling for Structures

Backfilling operations for structures shall be performed as part of the contractor's work under the payment items of earth excavation and at no extra cost. Backfilling material for foundations, walls and other structures shall consist of excavated soil, which is free from stones and hard clods not larger than 3" in any dimension, and also free from trash, lumber and other debris. Backfill material shall have enough moisture for proper compaction and shall be compacted in an approved manner to 90% of maximum density for cohesive soils and 95% of maximum density for cohesion-less soils. Backfill shall not be placed against foundation walls earlier than 4 days after placing of concrete or brick masonry.

6.4.3 Backfilling for Trenches

After the sewers have been constructed and approved to be water tight as per directions of the consultants the trenches shall be backfilled. Utmost care shall be taken in doing this so that no damage shall be caused to the sewer and other underground utilities. After this has been laid the trench and other excavation shall be backfilled carefully in 6" level with earth as approved by the consultants, each layer being watered to assist in the compaction unless the consultants shall otherwise direct.

6.5 **MAXIMUM DENSITY DETERMINATION FOR COMPACTED SOIL**

The maximum density of the soil shall be determined in accordance with the last revision of American Standard for Testing materials (ASTM) standard D-1556 Density Relations of Soils, using 15 lbs. rammer and 18" drop.

6.5.1 Testing Density of Soil

The consultants may make tests using the calibrated sand cone method/core cutter method to determine the density of soil will place in accordance with ASTM Designation D 2558, latest revision. If soil in place fails to meet the specified degree of compaction the areas represented by the failing tests shall be re-excavated and compacted to the specified density in the manner directed by the consultants at no extra cost.

6.5.2 Top Soil

Topsoil which has been stockpiled during excavation shall be used for the top 6" of backfill, in locations as ordered by the consultants. Topsoil shall be saturated with water and after it has dried, shall be spread to the required final grade and of required density. The work shall be performed at no extra cost.

6.5.3 Proximity to Building

Where buildings in the opinion of the consultants near excavation are likely to be affected, the contractor shall provide proper shoring to protect the buildings in addition to timbering of trenches. The contractor shall be required to leave timbering inside trenches if so required by the consultants for protection of these buildings at no extra cost.

6.6 **LENGTH OF TRENCHES IN ADVANCE OF CONSTRUCTION**

Unless otherwise directed in writing by the consultants of the work not more than 200 feet in advance of constructed or laid sewer shall be left open at any time. The trench shall, however be excavated to full width to minimum length of 16 feet in advance of the constructed laid sewer unless otherwise directed by the consultants.

6.7 **DISPOSAL OF FILTH AND GARBAGE**

No night soil filth and garbage met with during the excavation shall be allowed to be deposited on side of road / street so as to cause nuisance or obstruction to traffic. The same shall be disposed of by the contractor a place to the satisfaction of the consultants.

6.8 **DISPOSAL OF SURPLUS EARTH**

The contractor shall dispose of all surplus excavated materials not required to be used on the work. This shall include surplus earth after refilling and compaction.

6.9 *TUNNELING*

6.9.1 Formation of Soil

Tunneling shall only be permitted if strung hard and homogeneous, clay formation, which are not likely to collapse under normal working conditions. The work shall not be permitted in running sand. In weaker formation such as mixture of clay and sand, which are liable, to collapse when exposed to atmosphere. The roof shall be protected

TABLE OF CONTENTS

General Specifications for Electrical Systems

Section 01	-	General Requirements of External Electrical Works
Section 02	-	Underground Cable Installation
Section 03	-	Wiring Devices
Section 04	-	Standby Diesel Generator & Fuel Tank
Section 05	-	Low Voltage Bus way (BTS)
Section 06	-	Low Voltage Switchboards
Section 07	-	Power Factor Improvement Equipment
Section 08	-	Variable Speed Drives
Section 09	-	Motor Starters
Section 10	-	Motor Control Center (MCC)
Section 11	-	Low Voltage Wire & Cables
Section 12	-	Earthing System
Section 13	-	Automatic Transfer Switch
Section 14	-	Transient Voltage Surge Suppression
Section 15	-	Static Uninterruptable Power Supply
Section 16	-	Fire Alarm System
Section 17	-	CCTV System
Section 18	-	Lightning Protection System
Section 19	-	Telephone System
Section 20	-	Public Address System
Section 21	-	Data Networks
Section 22	-	Luminaires and Accessories

Note: Every Circuit breakers of main LV Panel and DG set should have provisions & communication port for connecting with BMS (by others).

SECTION 01**GENERAL REQUIREMENTS OF
ELECTRICAL WORKS****1.1 Scope of Work**

These specifications are general and the description given in the bill of quantities shall have to be followed. Details and instructions given on the drawings, however, shall have precedence over both and the drawings shall be read together with the Schedule of Technical Particulars.

The Specifications shall be considered as an integral document to cover the furnishing of the specified materials (other than owner supplied), labor, tools and plants, appliances and consumable material necessary for laying of power cables, outdoor HT/LT equipment, street/car parking lighting networks, and all other work required to complete the contract e.g., testing and putting in acceptable operation and maintaining the completed works.

The work under these specifications includes providing of materials and equipment (other than owner supplied) and performing all the works necessary for complete execution of all the electrical work as per electrical and general construction drawings as herein specified or both, until and unless otherwise specifically excluded and which, without excluding the generality of the foregoing, shall include but not be limited to the following principal items of work: -

- a) H.T. Primary supply line, PMT with allied accessories;
- b) H.T. Underground feeder cables;
- c) Pole mounted Transformer;
- d) L.T. Feeder from pole mounted Transformer to the indoor/outdoor LV Room
- e) DBs and MCC
- f) LV cable underground installation
- g) Complete earthing system;
- h) Associated Civil Works;
- i) Testing, commissioning and energization;

All allied and small works and materials, even if not specifically mentioned in the specification and BOQ but required for completeness of the job, shall be deemed to have been included in the contract / BOQ.

1.2 General Requirements

- a) The Contractor shall install, fix, test, and commission Owner supplied material at site conforming to relevant specifications laid down in British Standards, K- Electric or as specified hereinbelow.
- b) The specifications indicated herein are not limited to complete details of construction, and materials and equipment to be furnished under this contract, but only broadly indicate the type and functioning of the same. A Schedule of Technical Particulars of major equipment, however, is included.
- c) The Contractor will make his own survey to ascertain and confirm layout and exact location of equipment as shown on the drawings. He shall, in case of variations revise the layout and submit that drawing for approval of the Engineer, and such checking and confirming the location and layout of the scheme shall be deemed to be included in his bid. Bidders shall submit their quotation on the form and in the order outlined herein, and are required to fill in all the columns of the BOQ.
- d) The Contractor shall coordinate in every way, and work with all other Contractors to whose apparatus he shall connect parts of his work and also provide in this work connections and facilities for the connections of their work. The Contractor shall prepare drawings of details of his electrical equipment, location of sleeves, inserts, and supports as may be required, and coordination of his work with other trades. Upon demand, he shall furnish in adequate numbers these drawings for the information of all parties concerned, and approval of these drawings shall not relieve the Contractor in any way from the responsibility of properly locating and coordination his work with works of others.
- e) The contractor will assist the employer in application of extension of sanction load, if required. Contractor shall be responsible for providing all kind of data related with site to the authority.

1.3 Codes, Regulations, Notices or Fees

The whole of the work shall be carried out in strict accordance with the regulations for the Electrical Equipment for Buildings and infrastructure (latest edition) as issued by the Institution of Electrical Engineers UK, in conformity with the 17th Edition of the UK IEE "Regulations for Electrical Installations", "K-Electric", in accordance with the requirements of the local Electric Inspector, and to the satisfaction of the Employer / Engineer..

Any special conditions and requirements of the local electrical authorities shall be met. The work shall be carried out only by qualified workmen, in possession of necessary competency certificate under instructions of a supervisor having a license granted by the Government of Fujairah whose bio-data shall be submitted before

the commencement of work for approval. The Contractor shall familiarize himself with all

requirements such as the permits, license, fees, and codes and arrange to comply with these. It will be the Contractor's responsibility to give the required notices to the local electrical authorities, and assist the Owner in getting electrical connection as also the acceptance of the installation by the Electrical Inspector.

These specifications and the drawings are based on electrical systems and apparatus terminology defined in the Rules of the Institutions of Electrical Engineer UK and the K-Electric as adopted in Karachi and if some clarification is required in any instance a reference shall be made to the Engineer Incharge whose instructions shall be binding and final.

1.4 Abbreviation for Standards

The standards, codes of practice, and recommendations of the following societies or institutions have either been used in the specification and or cited here as a general level of quality for equipment, material and workmanship.

Abbreviation for international institutions are given below:

International Electromechanical Commission	IEC
European Committee for Standardization	CEN
International Standards Organization	ISO
Association Francaise de Normalization	AFN
British Standard Institution	BSI
Dentsches Institute fur Normung	DIN
Institution of Electrical Engineers, London	IEE
Chartered Institution of Building Services Engineers	CIBSE

1.5 Material and Workmanship

All materials shall be in accordance with K-electric approved or as per types and manufacture described in the specifications, Bill of Quantities, and or shown on relevant drawings. Where the Contractor desires to use materials differing from those described he shall obtain the approval of the Engineer Incharge in writing before tendering.

ANSI & NEMA materials shall accord with the appropriate British Standard Specifications. Rights are reserved to inspect materials on site at reasonable times and to reject any material not complying with the specifications. The cost of any dismantling and re-erection of the installation occasioned by the removal of rejected materials shall be borne by the Contractor.

During the time of the contract and before final approval of the installation two copies of descriptive literature, maintenance and operation data and parts list of each item of

electrical equipment installed under this contract will be submitted to the Engineer Incharge.

- a) All electrical materials shall be new and shall meet the requirements of British Standard Specifications. As soon as practicable and within 30 days after the award of the contract and before any materials and equipment is ordered, the Contractor shall submit for approval complete list of materials, apparatus, and equipment (other than owner supplied) in triplicate, giving the manufacturer's name, address, descriptive data, tradename of items, rated capacities, certified analysis, catalogue, etc. and when called upon to do so complete specifications and cut or drawing of each item or whole or portion of list, as required, which he proposes to use or install.
- b) Samples of conduit, wires, devices, finish plates, and any other item that is not included in owner supplied item as may be required by the Engineer Incharge.
- c) Wherever the words for 'approval' or 'approved' (make, size, arrangement, type etc.) are used, especially with regard to the manufactured specialties etc. or wherever it is desired to substitute a different make or type of apparatus for that specified, all information pertinent to the adequacy and adaptability of proposed apparatus shall be submitted to the Engineer Incharge and his approval secured before the apparatus is ordered or installed.
- d) The work throughout shall be executed in the best and most thorough manner under the direction of the Engineer Incharge. Rights are reserved to reject any work or material which are not in full accordance with the drawings and specifications, and shall have the power to reject any work and material which, in his judgment, are into in full accordance therewith.
- e) The Contractor shall have on file for ready access and reference, a set of drawings indicating all work as actually installed incorporating in same all changes and additions. Upon completion of the contract, he shall prepare a set of tracings indicating thereon electrical work as actually and finally installed. These tracings shall be handed over to the Engineer Incharge.
- f) The electrical plans as draw are based on the architectural plans and details, and show conditions as accurately as possible to show them in scale. The plans are diagrammatical and do not necessarily show all fittings etc. necessary to fit the building conditions. The locations of outlets, apparatus, and appliances shown on the plans are approximate. The Contractor shall be responsible for proper location in order to make them fit with architectural details and instructions given to him at site.

1.6 Equipment, Transportation & Storage:

A packing list of all the equipment and material in a package alongwith its site storage instructions, if any, shall be supplied. All containers, planking, covering, bases etc shall become the property of the Client, after the package has been opened and equipment removed. The Contractor shall arrange for the transportation and storage of material suitably at site to the approval of the Consultant / Engineer.

1.7 Civil Works

The Contractor shall furnish to the proper trades all inserts, anchors, sleeves or other required items which are to be built in by them for securing hangers or other supports of conduits and for an anchorage for electrical apparatus and equipment, and supervise the placing of these inserts, anchors etc.

Trench/Channel sills for leveling and support of all floor mounted and Pad mounted electrical equipment shall be provided as part of the electrical work. Where an item of floor mounted Pad mounted equipment is to be installed, floor/pad and deck loading shall be checked. If it is found that permissible loadings are exceeded by direct application of the equipment to the pad/slab or deck suitable dunnage as approved shall be provided as part of the electrical work.

All necessary concrete foundations, pads, and bases exterior to the building for lighting masts, or other electrical equipment installed as part of the electrical work including such bases or foundations as detailed on architectural / electrical drawings.

Supporting methods for all electrical equipment and circuitry shall conform to the best practice as per BSS and shall utilize only approved materials. All fastenings to attach electrical work to the building structure shall be of an approved type. In general, the fastening methods shall be as follows:

Wood screws on wood

Bolts and expansion shields on concrete or bricks

Toggle bolts on hollow masonry

Machine screws, clamps or welded threaded studs on steel

A licensed electrical contractor should have the following qualifications: -

- a) Must have in his employment a competent graduate Electrical Engineer registered with Local Engineering Council/Body.

- b) Must possess a valid Electrical contractor's License issued by the electric Inspector of the region where the site is situated.
- c) Must have in its employment an Electrical Supervision having certificate of competency who will exclusively supervise this work.
- d) Must have necessary tools, plant and instruments.
- e) Must have adequate experience of similar works.

If a contractor does not possess the above qualifications he shall be allowed to sublet the work to a competent subcontractor provided an application for, his prequalification is made to the Engineer for his approval. Decision of the Engineer in this case shall be binding on the contractor.

1.9 Sub-Contractors

The Contractor shall be held fully responsible for the work of any Sub-contractor or manufacturer performing work for or supplying materials from, as it is intended that the entire Electrical Work. When finally delivered to the Engineer shall be ready in every respect for satisfactory and efficient operation prior written approval for any Sub-contractor shall be obtained from the Consultant / Engineer.

The contractor shall be under obligation to sign a formal contract on judicial paper with the subcontractor and all the clauses of the agreement between the owner and the contractor shall be applicable to the subcontractor. The contractor shall ensure prompt running payments to the subcontractor against his monthly bills and in the event of any extra ordinary delay adversely affecting the progress of work, the owner, on the recommendation of the Engineer, shall make direct payments to the subcontractor from any payments due of which may become due to the contractor.

1.10 Inspection, Acceptance & Rejection

Rights are reserved to arrange inspection of all or any of the items prior to their shipment at the site or factory of the manufacturer and the Contractor shall provide necessary access and facilities with his manufacturer rights are also reserved to reject defective material or require its correction at any time before, during or after fabrication or manufacturer.

Rejected materials and equipment shall be satisfactorily corrected and rejected items shall be satisfactorily replaced with proper material without charge thereof for any replacement costs, shipping charges or handling upto the point of delivery or point of rejection.

The Contractor shall furnish promptly without additional charge all reasonable facilities, labour and assistance for the safe and convenient inspection and / or tests which may be required. All inspection and tests be performed in such a manner as to avoid unnecessary delay of the work. The Contractor shall furnish as soon as possible two un-priced copies of all orders placed outside for articles and materials to be incorporated in the work. The orders in all cases shall carry a notation to the effect that the articles or materials are subject to inspection and acceptance. The inspection may be during manufacture or before or after delivery at the site of work.

Rights are reserved at all times and places to reject articles or materials to be furnished hereunder which, in any respect fail to meet the requirements of these specifications, regardless of whether the defects in such articles or materials are detected at the point of manufacturer or after delivery to the site. If the Consultant / Engineer through an oversight or otherwise has accepted unsuitable materials, no matter in what stage or condition of manufacture, or delivery, said materials may be rejected compliance with the specifications is the responsibility of the Contractor and shall not be voided by any act or omission on the part of the Consultant / Engineers inspection. No inspection or acceptance of or payment for any of the material described herein shall relieve or release the Contractor from any obligation pertaining to the contract.

1.11 Testing and Guarantee

1.11.1 General

All type and routine tests on switchgear and all other equipment 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 as 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 to carry out the required standard/routine tests.

The Contractor shall coordinate and inform the Engineer Incharge about the date and time of test of each equipment in case of owner supplied at least two weeks in advance. All coordination with equipment supplier shall be the contractor responsibility. The witnessing of test by the Engineer Incharge or his representative shall not absolve the Contractor from his responsibility for the proper functioning of the equipment, and for furnishing the guarantees.

1.11.2 Completed Tests

After any equipment has been tested, checked for operation, etc. and is accepted by the Engineer Incharge, the Contractor shall be responsible for the proper protection of that equipment so that subsequent testing of other equipment does not cause any damage to the already testedequipment.

1.11.3 Test Certificates to be furnished by the Contractor

After all tests have been carried at the manufacturer's works the Contractor shall furnish test certificates for the following Electrical systems.

- HT Cables
- LT Cables
- LV Panel
- Distribution boxes / feeder pillars

1.11.4 Expenses to be borne by the Contractor

All expenses i.e. traveling, boarding and loading for carrying out the tests and witnessing by the Engineer / his Representative and the Consultant's Representative shall be borne by the Contractor and are deemed to have been included in the tender bid.

1.11.5 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.

1.11.6 Guarantee

The Contractor shall guarantee that the electrical systems are free from all grounds and all defective workmanship and material, and will remain so far, a period one year from date of acceptance of the work. Any defect appearing within this period shall be remedied by the Contractor at his own expenses.

- a) The Contractor shall indemnify and save harmless the Owner and the Owner's representative from and against all liabilities for damage arising from injuries to persons or property occasioned by any act or omission of the Contractor or any of his sub-Contractor, including any and all expenses, legal or otherwise, which may be incurred by the Owner in the defence of any claim, action or suit.
- b) The Contractor shall be held fully responsible for the work of any supplier or manufacturer (other than owner supplied), as it is intended that the entire electrical and allied works forming part of this Contractor when finally delivered to the Owner shall be ready in every respect for satisfactory operation.

- c) The Contractor shall furnish as soon as possible two unpriced copies of all orders placed outside for equipment to be used in the project. The orders in all cases shall carry a notation to the effect that the equipment is subject to inspection and

acceptance. The inspection may be either during manufacture or before or after deliver at site. The Contractor shall furnish to the Engineer Incharge full information as to the progress of work on said orders, and shall advise in writing at least 21 days prior to the equipment being ready for inspection at the point of origin.

1.12 Climatic Conditions

Equipment and materials supplied shall withstand, under all conditions of continuous operation and without developing any defects, the following environmental conditions:

Maximum outdoor ambient air temperature (Shade)	40 °C
Average daily temperature	30 °C
Minimum ambient air temperature	5 °C
Ground temperature	40 °C
Maximum relative humidity	100%
Altitude	10 m above Sealevel
Location	Karachi, Sindh
Soil thermal resistivity	2.0 C/m/w

1.13 Protection of Work

Unless otherwise noted, all equipment supplied shall conform, as a minimum, to the following protection classes, in accordance with hazardous areas:

Indoor	IP 54
Outdoor	IP 54

With the exception of material specified to be hot-dip galvanized (after fabrication), or otherwise specified, all metal work (steel conduit and accessories, outlet and pull boxes, trunking, straps, brackets, hangers, frames, etc.) shall be given a protective treatment consisting of degreasing, derusting, two coats of zinc-chromate/red-lead primer, and two coats of epoxy during manufacture. After installation on site, any damaged metal work shall be given another coat of paint. Painting of steel conduits shall be to BS 1710 for colour-coding purposes.

Such precaution as are necessary must be taken to properly protect all apparatus, fixtures, appliances, materials, equipment and installation from damage of any kind. Failure to provide such protection to the entire satisfaction of Engineer Incharge shall be sufficient cause for the rejection of any particular piece or pieces of the same. Contractor shall effectually protect the work from damage during and, as may be necessary after installation and he shall likewise protect the work of other trades from damage resulting from installation of electrical work.

1.14 Drawings

The Contractor shall furnish the following drawings:

a) Contract Drawings

The location of various items indicated on the tender construction drawings are presumed to be approximately correct but it is to be understood however, that the small-scale drawings are necessarily diagrammatic and that such locations as shown are subject to slight revision, as the work is installed, which may be necessary to accommodate construction conditions. No major change shall, however, be made without the approval in writing. The Contractor shall examine and study the architectural scale drawings, large scale and full-size details, the approved shop drawings of other trades and he shall frequently consult with Engineer Incharge to ascertain any change that may have been made, and he shall be guided accordingly before establishing the precise location Trench conduit runs, panels, transformers, switches and other systems. All outlets covered or partially covered by ducts, etc. shall be extended laterally or to underside of same so that fixtures, termination kits may be properly installed.

b) Shop Drawings

The locations, routings, and installation heights of electrical equipment, conduits & other raceway, etc., given on the design drawings are indicative and approximate. Based on site conditions, and in coordination with civil, mechanical, and manufacturer's drawings, the Contractor shall prepare shop drawings showing proposed routes of raceway and positions of equipment, including mounting and fixing details and submit the same to Consultant / Engineer for approval. However, if due to any reason the Contractor desiresto later altertheapproved locations, routing, etc, he may do so after obtaining the written approval of the Consultant / Engineer. Afterfinalapproval, asufficient number of copies as desired shall be furnished for distribution. Fixtures and device cuts and/or catalogues shall be clearly marked to indicate the items furnished. Do not submit individual sheets, cuts, catalogues or drawings. For instance, lighting fixturescutsshouldbe, forallfixtures, furnished rather than for a fewtypes.

c) As-Built Drawings

Upon completion of the work, the Contractor shall furnish two complete set of drawings in hard form and one soft copy in CD, showing the work in complete details as installed. Identification marks on the drawings shall correspond to

those marked on the installation. Supplementary drawings in transparencies will also be furnished of the entire installation, system and equipment for safety and operating controls in schematic form. These completion drawings shall then be scrutinized and finalized by the Consultant /Engineer and thereafter Three (3) sets of prints shall also be supplied by the Contractor.

d) Record Drawings

The Contractor shall during the progress of work, keep a careful record of all changes where the actual installation differs from that shown on the Contractor drawings. The Contractor shall in a neat and accurate manner, make a complete record of all changes and revisions to the original design, as installed in the completed work. These drawings shall be submitted for approval. Final payment will be withheld till receipt of the approved record drawings.

e) Further Drawings and Instructions

The Consultant / Engineer will have full power and authority to supply to the Contractor from time to time, during the progress of the works such further drawings and instructions as shall be necessary for the purpose of the proper and adequate executing and maintenance of the works. The Contractor shall out and be bound by the same.

1.15 Foundations, Pads, Bases, Supports & Fasteners

All necessary concrete foundations, pads and bases for lighting poles, communication and electrical equipment installed shall be part of the electrical works including such bases or foundations as detailed in architectural drawings, shall be provided as part of the electrical work. Supporting methods for all electrical equipment and circuitry will conform to the best practice, shall utilize only approved materials and shall be in accordance with the standards as published by the BS Codes of Practice.

1.16 Completeness of the Job

Each item of work has been, as far as possible, fully described and included in these specifications and the bill of quantities. However, supply and installation of any item shall be deemed to include all for completion of the job in accordance with the

tenders shall be deemed to have been included in the supply/installation of the equipment, unless specifically excluded.

This specification covers the complete supply and installation of all communication and electrical works, unless otherwise stated, so as to obtain a complete functioning system for which all sundries such as hooks, hangers, supports, small wiring of components of electrical panel boards, foundations for machinery and/or other such

necessary accessories that are essential are deemed to be included in the Contactor's bid price. Each item of work has been, as far as possible, fully described and included in these specifications and bill of quantities.

SECTION 02

UNDERGROUND CABLE INSTALLATION (DUCTS) UNDERGROUND CABLE INSTALLATION (DUCTS)

PART 1 - GENERAL

1.01 WORK DESCRIPTION

- A. The work to be carried out includes the supply of all the necessary labour, equipment and materials for the laying, joining, termination, testing and commissioning of all the underground cables indicated on the drawings and as specified herein. The single line wiring diagrams indicates the type and sizes of reticulation mains required for the various services.

1.02 *STANDARDS*

- A. If the works is involved for external public road, the requirements shall follow strictly to Local Authority's requirement.

1.03 *SUBMISSION*

- A. All technical submissions shall be approved by the Engineers prior to the respective stages of construction.
- B. As a minimum requirement, the submission shall include the following:
 - 1. Shop drawings of the complete cable routes (including the pipe work, protective cover, trenching, manholes, cable marker etc). Cable routes as shown on the Drawings are subject to co-ordination, no variation will be entertained;
 - 2. Equipment submission and samplesubmission;
 - 3. Cable termination details for cable manufacturer;
 - 4. Cable test reports for routine test, type test and site acceptance test;
 - 5. Testing and commissioning procedure;
 - 6. Builders works Requirement.

1.04 *QUALITY CONTROL*

- A. The Contractor shall use a digital camera (at the Contractor cost) which allows to download the images from the camera to the computer, to take the process from opening the trenches, laying of cables, backfilling and reinstatement. The photo record shall be compiled in report format and submitted for Engineer record.

PART 2 –PRODUCT

2.01 CABLE DUCTS

- A. At road crossings, the cables shall be protected with 150 mm diameter heavy duty uPVC pipes encased in concrete and buried to a depth of 900 mm below road level or as indicated in the drawings. Cable crossings at drains or entry into buildings shall also be protected by similar ducts as necessary. Unless otherwise instructed, all cable entry points shall be protected by means of pipes up to a height of 2500 mm. Such pipes shall be painted as directed.

2.02 BACKFILLING AND REINSTATEMENT

- A. After all protective covers have been laid, the trenches shall be refilled in 150mm layers, each layer being well rammed and consolidated. The finished surface shall be left proud by 50 mm to allow for subsidence. All surplus soil or debris shall be removed from site. The surface of refilled trenches shall be temporarily reinstated and maintained in a thoroughly safe condition until complete consolidation of the soil is achieved.
- B. Necessary backfilling material shall be supplied for the replacement of unsuitable excavation material and the cost of the material together with the backfilling and final reinstatement are to be included.

2.03 CABLE MARKERS

- A. Cable markers shall be provided and installed with the top surface flushed with the ground level to identify cable routes for cables laid direct in the ground. Markers shall be inscribed with indented lettering reading "MV Cable", "LV Cable" as appropriate and shall be installed at every 30 metres along the route and at any changes in direction.

2.04 TEST DURING LAYING

- A. Where required by the Specification, and as required from time to time by the Engineer, completed portions of the cable installation shall be subjected to voltage tests to prove the soundness of the conductor insulation and the soundness of the protective servings, and continuity tests to prove the soundness of the wiring armouring.

2.05 CABLE HANDLING GUIDELINE

- A. The most important point to observe in handling cables are that great CARE must be exercised at all times.
- B. Every precaution should be taken to avoid dropping a drum of cable. Dropping, even from a small height will flatten the layers of cable nearest to the barrel of the drum due to the weight of the outer layers. Similar distortion will also occur if the drum falls on to its side.

- C. When rolling the drum into position, it is essential that the drum rolls smoothly in the direction of the arrow painted on the side of the drum. If this instruction is not observed, slack cable will tend to accumulate towards the inner turns and may possible result in damage to the cable.
- D. When the drum is in position, it should be mounted on jacks and disposed so that the cable is pulled off from the bottom and not over the top. It is preferable to mount the drum at one end of the cable run as close as possible to the edge of trench so that the cable can be pulled off in a continuous manner on rollers in the trench and is in its final position when the last turn leaves the drum. This procedure is not always possible because of excessive length and weight of cable running or because of obstructions or pipes under which the cable has to be thread. In such cases, it may be necessary to position the drum at some other point along the cable run and lay-off the cables on the ground near the drum in a series of loops, one above and the other in the form of a figure eight, crossing the cable back and forth on itself. When the whole length has thus been removed from the drum the inside and of the cable will be on top and can be pulled along towards its final position on rollers in the same manner as if the cable was coming off the drum itself. Whichever procedure is adopted, great care must be taken at all times to ensure that the cable is not twisted and that the turns are well above the minimum bending radii of the cable. As a general rule, the absolute minimum bending radii of cables is as follows:

Type of Cable	Overall Diameter D	MINIMUM BENDING RADIUS	
		During Installation	Adjacent to and terminations
BS5467, BS6724 & BS6346			
Circular Copper Conductor Non- Armoured	10mm – 25mm above 25mm	4D 6D	4D 6D
Circular Copper Conductor Armoured	Any	6D	6D
Solid Aluminium or Shaped Copper Conducts Armoured or Non-Armoured	Any	8D	8D
IEC 502			
Single Core - Unarmored - Armoured	Any Any	20D 15D	15D 12D
Three Core - Unarmored - Armoured	Any Any	15D 12D	12D 10D
BS 6480			

Type of Cable	Overall Diameter D	MINIMUM BENDING RADIUS	
		During Installation	Adjacent to and terminations
Up to 6350/11000V			
- Single Core	Any	18D	18D
- Multicore	Any	15D	15D

2.06 ***CABLE INSTALLATION***

- A. All cables laid shall be in full length unless otherwise are buried minimum 750 mm below the finished ground level. All cable terminating materials and tools required to complete the above shall be of the type recommended or manufactured by the cable manufacturer.
- B. Cables shall not cross in straight runs in trenches or in any other positions, except where a cross is impracticable to avoid, by advance planning of the laying of cables.
- C. Space factor for installation of cables in cable ducts or covered trenches shall follow the requirements of the relevant BS and IEE Regulations.

2.07 ***TESTING AND COMMISSIONING***

- A. All cables shall be tested and certified that they safe before supply is switched on.
- B. Tests shall include continuity test, phasing out test and insulation resistance test.
- C. Copies of all results shall be submitted before the cables are energised.

2.08 ***INDEMNIFY AGAINST DAMAGES***

- A. The Employer shall be indemnified of any claims arising from damage to property (e.g. Local Telecom cables, water mains, sewage pipes, etc.) or injury caused during the underground cable installation work.
- B. An experienced and competent supervisor shall be on site at all times on site while this work is in progress.

2.9 ***EARTHING AND BONDING***

- A. All the non-current carrying metal parts in the system shall be adequately bonded to each other for earthing.

- B. For PVC armoured cable, the wire armour shall not be used as the sole means for earth continuity. A separate copper conductor or copper tape of sectional area in accordance with the IEE Wiring Regulation shall be provided.

PART 3 –EXECUTION

3.01 INTRODUCTION

The intent of this specification is to define the technical and installation requirements for LV cable installation.

3.02 *SCOPE OF WORK*

- A. The works shall comprise the supply of necessary labour, supervision staff, plants, materials, transport and tools for the installation of underground low tension electric cables and all ancillary works.

3.03 *DEPTHS OF CABLES*

- A. Cables shall be laid direct in the ground to a depth between 0.6 - 1.3 metre below the level of the road at the kerb edge except at those places indicated by the Engineer, where cable pipes, conduits or ducts shall be installed by the Contractor.

3.04 *CABLE TRENCH DIMENSIONS AND CABLE SPACING*

- A. Standard cable trench dimensions for excavations and cable spacing's shall follow the recommendations in BS 7671. The particular standard to be adopted for each section of the route as directed by the Engineer and specified cable spacing's shall be strictly observed.

3.05 *FENCING, LIGHTING AND GUARDING*

- A. The Contractor shall take every reasonable precaution to safeguard the public from being involved in any accident attributable either directly or indirectly to the works involve.
- B. The Contractor shall rope off and clearly define with red flags by day and flashing lights by night the full length and width of all excavations, piles of earth, cable drums, pumps, etc.

3.06 *TEMPORARY TIMBERING*

- A. The Contractor shall provide all necessary temporary timbering for trenches where necessary during the progress of the work for upholding and maintaining excavations in a good and safe condition

3.07 *SUMP HOLES*

- A. Sump-holes shall wherever possible be cut to one side of a trench to avoid creating irregularities and possible subsidence spots beneath cables.

3.08 MAINS, SEWERS, DRAINS, CONDUITS AND THE LIKE

- A. Cable shall normally go under all obstructions such as mains, sewers, drains, conduits and the like which cross the trench. The trench bottom shall be carefully ramped.

The removal, alteration, or diversion of mains, sewers, drains, conduits and the like shall be avoided.

3.9 INSTALLATION

- A. Cable pipes, conduits or ducts shall be installed at locations where cable trench intersects private access road, entrances, etc. and at other locations as indicated by the Engineer.
- B. Only one cable shall be permitted in each cable pipe, unless otherwise instructed by the Engineer.

3.10 INSTALLATION OF CABLE – PVC/SWA/PVC

- A. XLPE/SWA/PVC cable shall terminate in cable glands, incorporation a rubber compression ring, and armour clamp. The cable gland shall be covered with PVC shroud.
- B. If the space for wiring inside the switch is restricted, a galvanised metal extension box shall be fitted to the switch and the gland shall be screwed to the box.
- C. A separate earth tape for the earth continuity of the armour, shall be incorporated to improve the equivalent resistance of cast iron box to within the limit as recommended by the manufacturer.
- D. The cable shall be supported in such a way that it is not exposed to undue mechanical strain and such that there is no appreciable mechanical strain on the terminations of the conductor. Cable shall be supported at spacing not exceeding the appropriate value stated in IEE Wiring Regulation, latest Edition.

3.11 SEALING OFF OF CABLE ENTRY INTO SWITCHROOM

- A. All cable entries into the switch room shall be completed with water tight multi-cable transit (MCT) by the Contractor immediately upon completion of laying of the cable / cables through the cable entries to prevent ingress of water into the substation.

- B. In the case where the cable laying could not be completed on the same day or had to be stopped due to rain, the cable entries should be temporarily but effectively sealed to prevent entry of water.
- C. Cable glands must be 60079 compliance and suitable for hazardous area classification zone-1 and 2.

3.12 ***ROAD CROSSING MARKERS***

- A. Position Markers for cable pipes, ducts or conduits shall be fixed at each end of a Road Crossing position in a manner directed by the Engineer.

3.13 ***CABLE PULLING***

- A. Bottom of cable trench shall be level and smooth without stones or hard lumps. In rough ground a smooth 75mm thick layer of riddled solid or sand shall be laid along the trench bottom, or as directed by the Engineer.
- B. Cables shall normally be pulled into place along rollers placed at intervals of 4m along the bottom of the trench.
- C. The minimum bending radii of the cables as specified by the cable manufacturers shall be strictly observed. The cable shall be bent as little as possible preferable always in the same plane to avoid twisting the cable.
- D. Unless with the consent of the Engineer, there should be no “figure eighting” of cables.
- E. Pulling ropes shall be attached to the free end of low-tension cables by means of a cable stocking. The stocking shall grip directly upon the armour.
- F. Mechanical pulling of cable is permissible provided that pull is applied gradually and provided that the pulling mechanism has an automatic slipping clutch set to limit the pull to a maximum of 1500 kg.

3.14 ***FIRST EARTH FILLING***

- A. First earth filling shall be selected from earth free from stones or sharp objects and riddle if necessary. The filling shall be compacted around the cables and finished off level 150mm above the largest cable.
- B. The removal of surplus earth and the cost of transporting such material shall be at the Contractor's own expense.

3.15 SECOND EARTH FILLING

- A. The second earth filling shall extent to 300mm above PVC plates and shall not contain stones having a dimension exceeding 75mm. The filling shall be compacted in layers of 300mm in depth by means of hand rammers.

3.16 *PVC PLATES*

- A. PVC plates shall be laid end to end on top of the first earth filling and directly over the cables as required.

3.17 *BACKFILLING*

- A. Backfilling shall be in layers of 300mm in thickness. Each layer shall be well consolidated by means of mechanical rammers before the next layer is added.

3.18 *CABLE ROUTE RECORD DRAWINGS*

- A. The Contractor shall at their own expense prepare cable route record drawings.
- B. The Contractor shall record the Manufacturer's Order number and drum number of each length of cable in the order of laying.
- C. The records of cable lengths and cable drums details shall be submitted to the Main-Contractor weekly during the progress of the Contract and the full records in the as-built maintenance manuals.

3.19 *CUTTING AND SEALING OF CABLE*

- A. Work entails cutting the cable, capping the two cable ends by heat-shrinkable materials using blow-lamp, followed by PVC taping. The Contractor shall provide all materials and equipment necessary for the cut-and-seal. All low-tension cable ends shall be shorted core-to-core by means of earthing wires prior to sealing.

3.20 *INSULATION TEST TO BE CARRIED OUT BY CONTRACTOR PRIOR TO AND AFTER PULLING*

- A. The Contractor shall test the insulation of the cables prior to and after pulling and record the readings for submission to the Engineer. The Contractor shall possess his insulation testers (up to 2.5 kV).

PART 4 - PROTECTIVE COVERS**4.01 MATERIAL AND CONSTRUCTION**

- A. The make of the cable cover plates shall be high impact resistant polyvinyl/chloride without plasticizer (uPVC). Use of regenerated PVC or PE or PP is strictly forbidden.

Each cable cover plate shall be linked to the adjacent cover plates at both ends to form a continuous chain.

4.02 ***PROPERTIES***

The PVC cover plates must have the following properties:-

- A. Three fully processed specimens tested for their impact strength should not have more than 3 cracks respectively (5 drop hammer tests per specimen). And the drop hammer should not penetrate the specimens more than 100mm for more than 3 times in a series of 15-drop hammer tests. If these requirements are not met, the same test series are repeated on the specimens from the same lot. Should the specimens tested in the second series of tests also fail to meet the requirements, the whole test is considered to fail.
- B. The longitudinal connections (linking mechanism) of the fully processed specimens shall withstand a tensile strength of minimum 100N. The sample shall show no. of distortion, crack, fracture or warpage before and after the test.
- C. The Vicat softening temperature of the fully processed samples must not be less than 72°C (Rate A at 50°C, 5°C per hour).
- D. The fully processed specimens shall be aged at 70°C for 168 hours. Aged specimen shall also be tested for their tensile strength in the longitudinal connections. The change in properties must be less than 20% of the original value. There shall be no change in colour before and after the test.

4.03 ***TESTING***

- A. The Contractor shall submit the test report in English from the recognised laboratory. The material and the colour of the cable cover plates shall be resistance to chemical influences when buried in the ground. The recognised laboratory shall be the authorised one recognised by the Local Authority.

4.04 ***COLOUR, DIMENSION AND LETTERING***

- A. Colour

- 1. The colour of the plates shall remain permanent and non-fading. The colour code is to be in accordance to BS 381C or its equivalent.

B. Dimensions

1. The LV cable cover plates shall have the following dimensions:-
 - a. Length 1000mm

- b. Breadth 172.4mm
- c. Thickness 2mm (minimum)
- d. Tolerance allowed for 15mm
Length and Breadth

C. Lettering

1. The English words or with another national language if it is required by the Local Authority of the followings shall be printed on the centre of the cable cover.
“DANGER, Voltage of Cables” continuous on the plate.

SECTION 03

WIRING DEVICES

PART 1 - GENERAL

1.01 WORK DESCRIPTION

- A. The drawings for the lighting and power points indicate approximate positions of all lighting fittings, switches, power outlet points, isolating switch points and the like. The actual positions of all fittings, switches, the wiring details and cable routes shall be co-ordinated with M&E Services on site and submitted for the approval of the Engineer. All time and cost required to adjust the layout or adjust the completed installation to Engineer satisfaction and to suit site co-ordination is included in the Contract.
- B. During the exact positioning of lighting and power points, due consideration shall be given to the operational requirements of the installation, the selection of the most accessible routes for wiring and the convenience of switching.
- C. No additional cost will be entertained should the final positions be relocated within the same room or not more than five (5) metres away from the original locations due to any requirement.
- D. For the purpose of this Specification and related Drawings, each lighting and small power point circuits shall in general be coded with a prefix to indicate the corresponding distribution board number; details on the circuit way and phase shall be submitted for the approval of Engineer.
- E. Certain types of electrical equipment or systems involving sudden changes, or low frequency or of direct electric current such as fluorescent lamps, contactors, etc. shall be fitted with radio and television interference suppression components suitable to meet the levels specified in BS 800 "Limits of Radio Interference".
- F. This section included the specification of the following :
 - 1. 13A Switched Socket Outlet
 - 2. Fused Connection Unit
 - 3. Lighting Switches
 - 4. 15A & 30A Switched Socket Outlets
 - 5. Lighting Point Installation
 - 6. Weatherproof Isolator
 - 7. Shaver Outlets
 - 8. Isolating Switches
 - 9. Telephone Outlets
 - 10. Contactors
 - 11. Lighting Dimmers Switch

12. Time Switch
13. Cooker Control Units
14. Water Heater Switches
15. Bell Push Switches
16. Power Supply for Lighting at wet condition

1.02 ***STANDARDS***

- A. The complete wiring installation shall be engineered according to manufacturer data and constructed in accordance with the latest revision of the following standards and the appropriate BS/IEC:

1. BS7671 : Electrical Installation
2. BS 1363 : 13A Switched Socket Outlet
3. BS 3676 : Lighting Switches
4. BS 546 : 15A & 30A Switched Socket Outlets
5. BS 800 : TV & Radio Frequency Interference
6. BS 1362 : 13A Cartridge Fuse-Link for Fused Connection Units
7. BS 3052 : Shaver Outlets
8. BS 3676 : Isolating Switches
9. BS 4662 : Conduit Boxes
10. BS 5424 : Contactors

- B. In the adoption of standards and requirements, the Contractor shall take the following precedence:

1. Engineer's decision;
2. Local codes of practice;
3. Drawings;
4. Specification;
5. International standards and requirements.

1.03 ***SUBMISSION***

- A. All technical submissions shall be approved by the Engineer prior to the respective stages of construction.

- B. As a minimum requirement, the submission shall include the following:

1. Equipment catalogues submission with manufacturer's data;
2. Sample submission include all wiring accessories;
3. Shop Drawings of the lighting and power positions, circuit numbers, cable routings, switching arrangement, mounting height, etc. The positions and mounting heights shall be coordinated with other services. Fixing details of all wiring accessories shall also be included.
4. Drawings showing the installation details.
5. Labeling system

6. Builder's works requirement.

PART 2 –PRODUCT

2.01 LIGHTING POINT INSTALLATION

- A. The various types of light fittings to be supplied and installed are described in the drawings and the Schedule of Lighting Fittings on Drawing
- B. Surface mounted light fitting shall terminate at a BS 4662 junction box having entries appropriate to the run of conduit and shall be complete with porcelain connector suitable for the size and number of connections to be made at the point and the wiring required to connect the specified fitting. Wiring to the light fittings within the false ceiling spaces shall be by means of heat resistant (butyl or silicon rubber insulated to BS 6500) cables i.e. between the junction box and the lamp holder/terminal blocks, in flexible conduits.
- C. At every light fitting an approved type earthing terminal shall be provided for connection of the circuit protective conductor of the final circuit.
- D. Ferrous metalwork shall be of minimum thickness of 1mm. treated against corrosion by galvanising after welding or be lead primer or other approved process. Metalwork shall be painted with one priming coat, one under-coat and two top coats finished stove-enamelled matt white, unless otherwise specified.
- E. Cables used for internal wiring of the lighting fittings shall be of appropriate type and size and number. Conductor shall be of size not less than $1.5 \text{ mm}^2/1\text{C}$ or the equivalent. The insulation of the cables shall be able to withstand throughout the life of the fitting the maximum temperature to which it will be subject in normal use without deterioration which could affect the safety of the fitting.
- F. Cables within the lighting fittings shall be neatly bundled by nylon self locking cable ties; wiring shall be properly routed and secured away from control gear etc. wherever possible.
- G. All cable terminations within the light fittings shall be suitably shrouded to the approval of the Engineer.
- H. All lighting fittings shall be self-supporting complete with the appropriate fixing accessories such as clips, supporting brackets, suspension sets, nuts, washers, screws etc. for the proper installation of the fittings on different types of ceiling panels. Suspension sets shall be of adjustable type suitable to carry the weight of the lighting fittings and unless otherwise stated or indicated on Drawings, the suspension sets shall be generally 900 mm in length; exact lengths required shall suit site situations.

- I. All lamps complete with control gear necessary in operational condition shall be provided together with the lighting fittings as specified.

2.02 ***SWITCHES***

- A. Lighting switches, unless otherwise specified, shall be single pole, quick make and slow-break, silent switch action type with solid silver alloy contacts and totally enclosed switch action for flush or surface mounting as required.
- B. Lighting switches shall be suitable for indoor or outdoor service according to location, housed in standardized purpose manufactured galvanized steel boxes completed with conduit knockouts made up into single or multi-gang units employing a grid switch system of fully interchangeable components at standardized fixing centers of matching switches of different types and ratings but of identical dimensions, push buttons, neon indicator lamps, blanking units, grids, steel boxes and plates all capable of integration into standard composite assemblies in any combination as required.
- C. Grids shall be adjustable for variation in depth of plaster and for squaring errors and of the same type for surface or flush mounting.
- D. Switches for public areas shall be of special designs/finishes, in accordance with the specific "Designer Range Series" of the products, selected and approved by the Engineer. Switches of other areas shall be of high-impact resistant polycarbonate. Color finishes shall generally be in white, as selected and approved by the Engineer. Switches in mechanical plant rooms and electrical sub-stations and switch rooms shall be of the metal clad type approved by the Engineer, mounted in flush or surface conduit boxes as specified elsewhere.
- E. Switches located on brick or concrete walls shall be mounted in horizontal arrangement in plaster depth steel boxes or in galvanized steel boxes using box suspension straps and cover plates. Countersunk screws shall be provided for fixing to the conduit boxes.
- F. Switches for external use shall be of weatherproof construction with IP65 rating, unless otherwise specified.
- G. Samples of all switches, conduit boxes and plaster depth boxes shall be submitted to the Engineer for approval prior to installation.
- H. Samples shall be rated for 10 Amps (minimum light switch rating 10A), 15 Amps or 20 Amps as determined by circuit load which for inductive lighting circuit shall be assessed at twice the steady state connected load current, one way or two ways as indicated on the drawings and fixed generally at a height of 1400 mm from floor level and where located in rooms the switch shall, where possible be located on the inside of the room on the handle side of the door as close to the door as is practicable.

- I. An earthing terminal, connected to the earth continuity terminal shall be provided and connected to the circuit protective conductor at every lighting switch positions.
- J. Single pole switches shall be connected to break the phase wire of the supply; the neutral wire shall not be routed through switch boxes.
- K. Switches which are mounted in the same location shall be of multi-gang type, of the maximum number of gangs available.
- L. All switches used shall be of an approved or prescribed items as required by local Authorities.
- M. Circuit from different phase and circuit from emergency power should have separate switch plate.

2.03 SWITCHED SOCKET OUTLETS

- A. Switched socket outlets shall be to BS1363 single pole 13 Amp 3 rectangular pin switch shuttered outlets, one or two gang for indoor service except otherwise specified and either surface or flush mounting according to location.
- B. Switches shall be of the quick-make slow break type with silent, totally enclosed switch action and solid silver alloy contacts. Switched socket outlets for indoor use shall be housed in suitable galvanized steel boxes to BS 4662 with conduit knockouts. Types and finishes of socket plates shall match those for the lighting switches.
- C. Generally switched socket outlets shall be positioned 300 mm above floor level except in plant rooms, kitchen, etc. where they shall be positioned 1400 mm above floor level or 150 mm above counters or benches whichever is suitable.
- D. Switch socket outlet in all mechanical plant rooms, electrical switch rooms shall be of the metal clad type, with recessed or protected switch dolly, mounted in flush or surface conduit boxes as specified elsewhere.
- E. All switched socket outlets used shall be of an approved or prescribed items as required by the local Authorities.

2.04 FUSED CONNECTION UNIT

- A. All fused connection units shall be double pole switched, rated at 13 Amp unless otherwise specified, with fuse-links to BS 1362.
- B. Units shall be of moulded ivory plastic, flush mounted, suitable for housing into galvanised

steel boxes to BS 4662 with conduitknockouts.

- C. Fused connection units shall be of the same manufacture as 13 Amp socket outlets and of matching appearance.
- D. Fused connection units provide supply to gas ignition of home appliance shall not be located in gas pipe compartment.

2.05 ***ISOLATION SWITCH***

- A. Isolating switches shall be of the current ratings and number of poles (generally double pole for single phase and 4-pole three phases) as indicated on the Drawings.
- B. Isolating switches shall be of the totally enclosed pattern, metal-clad or polycarbonate with positive quick-make and quick-break action.
- C. Switches shall be capable of passing and also interrupting their full rated current safely and without damage.
- D. Ferrous materials shall be galvanised, switch handles shall be interlocked to prevent opening the cover with the switch "ON".

2.06 ***15 AMP SWITCHED SOCKET OUTLETS***

- A. 15 Amp switched socket outlets shall be 3 pin round type to BS 546 shuttered, of a finished similar to 13 Amp switched socket outlets and flush mounted in galvanised steel conduit boxes to BS 4662 requirements.

2.07 ***WEATHERPROOF ISOLATOR***

- A. Weatherproof enclosure shall be of the high impact, water resistant to IP65. The isolator provided shall complete with lockable device. Isolators shall be double-pole, 4-pole as specified.

2.08 ***LIGHTING DIMMER SWITCH***

- A. Lighting dimmer switch shall be the solid state, variable load, thyristor controlled type suitable for controlling fluorescent and or incandescent lighting circuits operating at 230V \pm 10% 50Hz single phase AC supply.
- B. Dimmer Rack for local or remote control shall refer to Section 27.
- C. Dimmer switch shall be manufactured to eliminate TV and radio frequency interference in

compliance with BS 800.

- D. The ratings of the dimmer units shall be suitable for lighting circuit specified on Drawing.

2.09 ***TIME SWITCHES***

- A. Time switches shall be self-contained units suitable for mains operation. All units shall have a self-starting synchronous motor with a single-pole fuse in the motor circuit, a 3-way terminal block and a thirty-six (36) hours spring reserve complete with an automatic solar dial.
- B. When fitted, the solar dial shall be capable of switching ON at sunset and OFF at sunrise throughout the year by control of a secondary calendar dial with month and day settings, and the automatic switching time shall be adjustable.
- C. Time switches shall be encased in a dust-tight metal casing have a hinged front cover with a clear perspex window. The casing shall be effectively earthed.
- D. A manual bypass switch shall be incorporated with the time switch to facilitate maintenance of the latter.

2.10 ***CONTACTORS***

- A. Contactors for lighting control, whether locally, remotely or through timer, shall comply with BS 5424: Part 1, utilization category AC-2, Class 3 intermittent duty, and shall have a current rating of not less than that of the outgoing switchgear to which they are connected, and in any case not less than 20A.

2.11 ***TELEPHONE OUTLETS***

- A. Telephone outlets where called for shall be single or twin of the flush mounted type suitable to receive the plug-in telephone cable lead to the approval of the Local Authority. The finishes of the telephone outlet plates at various areas shall be as specified for lighting switches.

2.12 ***BELL PUSHSWITCHES***

- A. Bell push switches shall be flush-mounted conforming to BS 3676 having a single-pole AC switch rated at 5 amps and marked with bell symbol.

2.13 ***SHAVER OUTLETS***

- A. Shaver outlets shall comply with BS 3052 and shall comprise a 20VA continuously rated double wound isolating transformer to provide an earth-free AC supply at mains frequency, complete with self resetting thermal overload device fitted in the primary circuit an insulated voltage selector switch to provide either 115 or 230 volt output, one ON-OFF switch and one

universal socket outlet suitable for British, American, Continental and Australian razor plugs, all contained in a recessed sheet steel box with insulated moulded front plate suitable for flush, mounting and suitably inscribed to

give a clear indication of the voltages available at the outlet and the service of the outlet.

2.14 ***COOKER CONTROL UNITS***

- A. Cooker Control Units shall be flush mounted conforming to BS 3676 having a double pole AC switch rated at 30 amps complete with pilot indicating lamps and a self adhesive plastic identification label mounted on a removable chassis contained within a steel box finished aluminium stoved enamel provided with conduit knockouts and earthing terminals. The cover plates shall be of the same finish as those specified for the lighting switches.
- B. Associated connector units shall be provided adjacent to the cooker units.
- C. Wirings between the cooker control units and associated connector units shall be provided in concealed conduits.

2.15 ***WATER HEATERSWITCHES***

- A. Water heater switches shall be flush mounted conforming to BS 3676 having double pole AC switch rated at 20 amps fitted with pilot lamp and marked "water heater". The cover plates shall be of the same finish as those specified for the other switches. Associated connector units shall be provided next to the water heater units.

2.16 ***POWER SUPPLY FOR LIGHTING AT WET CONDITION***

- A. Residual Current Circuit Breakers shall be provided individually for each circuits serving lighting subject to wet condition.

SECTION 04

STANDBY DIESEL GENERATOR & FUEL TANK

PART 1 - GENERAL

1.01 WORK DESCRIPTION

- A. This section describes the engineering, supply, delivery to site, hoisting into position, install, test and commission the standby generating system together with the necessary controls and switchboards as specified and indicated in the Drawings. Protection circuits, control wiring system and interlock circuits not specified or indicated in the Drawings, but deemed necessary for the safe operation of the generating system shall be provided to complete the system. The standby generator set shall provide secondary supplies to all premises electric requirement in the event of mains failure
- B. All the equipment quoted shall be manufactured to accommodate in the room or open space provided as per the tender drawing. The standby generating system shall comply with the requirements of Local Authority.

1.02 *SUBMISSION*

- A. All technical submissions shall be approved by the Engineer prior to the respective stages of construction.
- B. As a minimum requirement, the submission shall include the following:
 - 1. Equipment submission with manufacturer's data.
 - 2. Shop drawing showing the coordinated installation detail and control block diagram.
 - 3. Builder's works requirement.
 - 4. Detail water cooling circulation drawing complete with cooling tower, pump sizing calculation or skid mounted radiator endorsed by the Contractor and Manufacturer.

1.03 *STANDARDS*

- A. The complete system and installation shall be engineered and constructed in accordance with the latest revision of the standards and the appropriate BS/IEC as specified in this specification.

- B. The complete system and installation shall also conform to the requirements of all relevant local codes, as applicable, together with the additional requirements referred

to in this Specification and Drawings, whichever is the more stringent and acceptable to the Engineer.

- C. In the adoption of standards and requirements, the Contractor shall take the following precedence:
1. Engineer's decision;
 2. Local codes of practice;
 3. Drawings;
 4. Specification;
 5. International standards and requirements

PART 2 –PRODUCT

2.01 DIESEL ENGINE

- A. The diesel engine shall be of the 4 stroke, multi-cylinder direct injection, compression ignition type operating at a speed of 1500 rpm with vertical in-line or V form cylinders, and as far as possible be silent, vibration free while in operation and comply with BS 3046.
- B. The engine shall be complete with water cooled body jacket, water cooled engine, fan, lubricating oil pump, lubrication oil pressure gauge, tachometer, digital or electronic type governor, integrated hours-run recorder, over speed trip and all other necessary auxiliaries.
- C. The brake horse power of the engine with all attached accessories as specified shall not be less than that which is required by the full load rating of the alternator taking into consideration losses, plus a reserve factor of at least 10%.
- D. Starting
 - 1. Starting system of the standby generator shall be of a heavy-duty electric motor complete with a 24 V_{DC}. Heavy-duty battery of at least 300 AH. The electric motor shall be capable of cranking the engine to achieve the rated speed in less than 10 seconds from the initiation of the starting process. The electric start battery shall be of adequate capacity for 10 successive starts. Time delay relays shall be incorporated to provide a rest period of 1-5 seconds (adjustable) before each successive start and a time lag period of 19-100 seconds (adjustable) before the system lock out due to failure of the 5th start to crank up the engine.
 - 2. The generator set shall be provided with a micro-processor based control system which is manufactured to provide automatic starting, monitoring, and control functions for the generator set. Interface to BMS system according to point schedule on drawings shall be provided.
 - 3. The control system shall include an engine governor control, which functions to provide steady state frequency regulation. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.
- E. Speed Regulation
 - 1. The governor shall be capable of regulating the speed of the engine within the limits approximately 10% of the rated speed within 4 seconds due to a sudden application or removal of a full load. The steady load speed shall vary within the limits of approximately 1% of the rated speed.

F. Cooling

1. The engine cooling system shall be of a closed circuit water recirculating system to cool the engine as well as the body to minimize heat radiated into the generator room. The cooling circuit will exchange heat through a heat exchanger capable to remove the heat generated under continuous full load operation. Condenser water from cooling tower will be provided by Contractor's mechanical work to exchange the heat to external of the building. The cooling system shall include the heat exchanger, fan, pump and all ducting, acoustic attenuation and support brackets for mounting of the heat exchanger.

G. Lubricator

1. The lubricating system shall be by a positive displacement oil pump providing a positive force feed to all lubricating points.
2. Good quality lubricating oil filters with replacement elements shall be provided.

H. Exhaust System

1. Adequate sized piping and fittings shall be installed to carry the engine exhaust discharge into the atmosphere as indicated in the drawings.
2. Mufflers shall be installed to reduce the engine exhaust noise to a maximum of 5 dBA above ambient noise level at nearest area accessible to the public within 3m from Generator Room and at least 2m above floor level. Flexible connection shall be provided between the engine and the fixed piping. All fittings shall be wrapped in an approved calcium silicate heat insulation material of 40mm thick and shall be rigidly bonded and supported.

2.02 FUEL PIPING AND FUEL TANK INSTALLATION

- A. The complete system shall include engineering, supply, installation, testing and commissioning the tanks, pumps, piping, valves and control system.

2.03 INSTRUMENTS

- A. An instrument panel mounted on the engine shall be provided and shall comprise the following flush-mounted instruments and gauges:
 1. Cooling water inlet temperature
 2. Cooling water outlet temperature

3. Cooling water inlet temperature to lubricating oil cooler
4. Lubricating oil inlet temperature

5. Lubricating oil outlet temperature
6. Lubricating oil pressure gauge
7. Tachometer, positive driven
8. Elapsed hour counter.

2.04 PROTECTION DEVICES

A. Warning indication and automatic shut-down shall be provided for the following:

1. Low oil pressure (alarm)
2. Low oil pressure (shutdown)
3. Oil pressure sender failure (alarm)
4. Low coolant temperature (alarm)
5. High coolant temperature (alarm)
6. High coolant temperature (shutdown)
7. Engine temperature sender failure (alarm)
8. Low coolant level (alarm or shutdown –selectable)
9. Fail to crank (shutdown)
10. Overcrank (shutdown)
11. Overspeed (shutdown)
12. Low DC voltage (alarm)
13. High DC voltage (alarm)
14. Weak battery (alarm)
15. Low fuel-day tank (alarm)
16. High AC voltage(shutdown)
17. Low AC voltage (shutdown)
18. Under frequency (shutdown)
19. Over current (warning)
20. Over current (shutdown)
21. Short circuit (shutdown)
22. Ground fault (alarm)
23. Overload (alarm)
24. Emergency stop (shutdown)

B. Failure warning lights and an alarm buzzer shall be installed at the control panel and shall have indication of the type of fault. Manual reset facilities shall be incorporated to restore the operation to normal.

C. The starting circuit shall be disconnected in the event of any of the above shutdowns.

2.05 ALTERNATOR

A. The alternator shall be foot-mounted drip proof, self-ventilated and screen-protected and directly coupled on to the diesel engine by flexible driving discs.

- B. The full load output voltage shall be 400 volts, 3 phase, 4 wire, 50 Hz at 0.8 power factor with neutral solidly earth with the frequency maintained at 0.5 Hertz at all time under any load condition including transient overload due to motor starting etc. The alternator shall be manufactured and tested in accordance with IEC60034, to suit local conditions.
- C. The rotor shall consist of the main alternator field poles, the brushless exciter and its rectifier module, all bolted on a common alternator shaft. The rotor shall be mechanically and electrically balance up to 135% of the rated speed. The insulation of the alternator shall be non-hygroscopic, Class "H" on the exciter, Class "H" on the stator and Class H on the rotating pole pieces.
- D. The rectifier module of the exciter shall be impregnated with epoxy resin and shall be capable of withstanding without damage or deterioration of the thermal, centrifugal and other stresses that is experienced during normal or short circuit conditions. Rectifiers shall be of silicon type.
- E. The voltage build up shall be of self-excitation using the residual voltage of the alternator through a solid-state voltage regulator. The voltage regulator shall be capable of maintaining the voltage regulation to $\pm 1\%$ independent of power factor, heating and 5% of speed variation. The voltage output of the alternator shall also be capable of manual adjustable to $\pm 5\%$ of the rated voltage.
- F. The response of the voltage regulator shall be less than 10 millisecond. The voltage dip shall not exceed 15% when a rated continuous load is supplied to the unloaded alternator and the correction time shall not exceed 200 millisecond. When the rated load is withdrawn, the voltage overshoot shall not exceed 20%.
- G. The automatic voltage regulator and the exciter shall be manufactured to withstand 50% overload at a constant terminal voltage.
- H. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of motor current for not more than 10 seconds.

2.06 GENERATOR CONTROL PANEL

- A. The generator control panel shall be floor-mounted, and shall have all necessary instruments and accessories for operation and control of the generating set. On sensing the utility mains voltage dip of 40% of the rated voltage, the control panel shall send a signal to start the generator. After 5 successive start and if the diesel generator is not started up, the alarm signal shall be activated.

- B. The generator control panel shall consist of all Auto-transfer switch, circuit breakers, protective relays if applicable and accessories required to control the generator operation and shall include but not limited to the following:
1. Voltmeters
 2. Frequency meter
 3. Power factor meter
 4. Ammeters
 5. Kilowatt meter with maximum demand indicator
 6. Kilowatt hour meter
 7. Hour run meter
 8. Start-stop and automatic mains monitoring system
 9. Emergency off push button
 10. Manual speed adjusting switch, reset switches for overload, alarm muting, etc.
 11. Fully automatic trickle battery charger with batteryvoltage meter
 12. Indicating lamps for 'Mains Available', 'Mains on Load', 'Standby Available', 'Standby on Load', 'Alarm', 'Mains Fail', etc.
 13. Audio and visual (flasher) alarmsystem.
- C. The start-stop and automatic mains monitoring system shall be equipped with the following:
1. Duty selector switch for 'off-automatic-test-manual' operation
 2. Manual start-stop push button switch
 3. Manual alternator circuit breaker 'On-Off' switch
 4. Cancel alarm switch
 5. Reset switch
 6. Indicating lamps

2.07 BUILDING MANAGEMENT SYSTEM CONNECTION

- A. Voltage free auxiliary contacts and high level interface shall be provided including transducers, current transformer, software, etc. required by Contractor's BMS work. The detail shall be subject to co-ordination. All cost for interfacing requirement shall be included in the Contract.

2.08 ACOUSTIC CANOPY

- A. Drop-over close-fit weather-proof type, 16SWG galvanized sheet-steel clad, powder- coat finish, lined with sound-absorbent mineral wool (48kg/m³) retained with 22 SWG galvanized perforated (40% minimum) galvanized steel sheet. Attenuators on air intake/exhaust ports, shield plate on exhaust pipe. Sealed access doors. No derating of genset 15dB (A) sound reduction.

PART 3 - EXECUTIVE

3.01 TESTING AND COMMISSIONING

- A. All the necessary comprehensive tests shall be performed to the approval and satisfaction of the Engineer at the completion of installation. Before the commencement of acceptance testing, the installation shall be in a state of practical completion and shall have completed all of the preliminary testing and adjusted the equipment to its proper running order.
- B. A full seven (7) days' notice of his readiness for carrying out acceptance tests shall be given to the Engineer.
- C. Prior to the date of giving such notice a complete details schedule of the tests to be carried out shall be submitted to the Engineer for his approval and alternations and additions to the schedule are made may require.
- D. Notwithstanding his approval of the testing schedule the Engineer may at any time before or during the testing period direct further tests to be carried out that he considers necessary.
- E. On receiving notice of the readiness for acceptance testing the Engineer shall set aside and designated a period for the carrying out of acceptance tests. During this period no modification, adjustments or other work on the installation shall be done without the express permission of the Engineer in each case.
- F. Should there be any contravention of this requirement the Engineer may reject the results of all tests completed and order a commencement of testing program.
- G. A detailed day-to-day program of testing shall be prepared and all measures necessary to ensure that testing proceeds as much as possible in accordance with this program shall also be taken.
- H. Any variation to the program during the testing period shall be at the discretion of the Engineer.
- I. Upon completion of all above tests, four (4) sets of the test results shall be submitted for the Engineer's approval. All test reports submitted shall be endorsed by all parties witnessing the test including the contractor's and manufacturer's Qualified Personnel.
- J. No acceptance tests shall be carried out except in the presence of the Engineer or their authorized representatives appointed for the purpose.
- K. The Contractor shall provide at his own cost all materials, including electric power, instrument test set, fuel, lubricants and other consumable, Load Bank required for the tests and adjustments of the equipment and for carrying out the acceptance tests and

any re-tests that may be necessitated by failure of the installation or by any other causes within his control.

- L. The Contractor shall ensure that the fuel supplied for use in acceptance tests is part of a batch for which certified test data is available. Two copies of the test certificate shall be supplied to the Engineer prior to the commencement of tests.
- M. During the testing period the Contractor shall appoint a qualified personal to carry out the checking and testing the testing instrument (equipment which are to be used for the test) including accurately calibrated test equipment for checking the accuracy of gauges and instruments forming part of or supplied with the installation.
- N. Prior to commencement of testing a detailed list of the equipment shall be submitted to the Engineer for his approval and no item on the list shall be removed from the site without his consent until the completion of testing.

3.02 ***FACTORY TEST***

- A. Tests proving the satisfactory performance of all safety controls shall be carried out. These shall include the over speed and oil pressure failure cutouts, and such other safety devices and automatic alarms as are required to satisfy this Specification.
- B. Governor trials shall be carried out as laid down in BS 3046. IF the Governor performance does not come within the prescribed limits, the Contractor shall make the necessary adjustments and repeat the Governor trial until a satisfactory results is obtained.
- C. The preliminary electrical tests required to be carried out by the Contractor shall include the following:
 - 1. Insulation resistance:
Stator, rotor and exciter windings to
earth Stator – between windings
 - 2. Check of efficiency of radio interference suppression equipment control panels shall be carried out concurrently with the preliminary engine and alternator tests.
 - 3. The Contractor shall include the cost for the requirement for witness at manufacturer for Factory Acceptance Test (FAT), the Engineer and Employer representative – 2 persons 3 days (excluding transport time) for tests at USA embassy rate.

3.02 ***PERFORMANCE TESTS***

The schedule of tests to be performed in the Factory Acceptance Test shall include the following:

- A. On each of three separate days and before any other operation of the diesel-alternator on that day three successful manual start-up operations to be accomplished.
- B. Three separate manual start-up operations each within one minute of the diesel-alternator being shut down after running continuously for not less than one hour and attaining normal engine running temperatures.
- C. Three separate automatic start-up operations with simulation of "mains failure". In all or any of these tests the diesel-alternator may be out on load by the automatic closing of the emergency power supply circuit breaker.
- D. Three separate automatic shutdown operations, each initiated by mechanical simulation of a "low pressure" condition.
- E. Three separate automatic shutdown operations, each initiated by manual instigation of an "over-speed" condition.
- F. Three separate abortive start-up operations, each inducing "failure to start" shut- down.
- G. The load tests shall be carried out as follows:
 - 1. 25% of full load at 1.0 pf For half hour
 - 2. 50% of full load at 1.0 pf For one hour
 - 3. 100% of full load at 1.0 pf For two hours
 - 4. 110% of full load at 1.0 pf For one hour

At the completion of the test, readings shall be taken of Voltage, Frequency, Current, Temperature, Vibration and the following:

- 1. Insulation resistance – rotor, stator, exciter – to earth;
- 2. Insulation resistance – between stator windings;
- 3. Alternator rotor and exciter armature temperature

After the load run, all inspection doors shall be removed from the engine, the running gear examined and all nuts checked for tightness. The crankshaft alignment shall be checked when the engine is cold.

The exhaust temperature at normal full load shall be taken. These temperatures shall be within plus or minus 15°C of the manufacturer's standard exhaust temperature for full load when the correction of compression and firing temperatures has been made.

- H. Such further tests as are reasonable to determine the compliance with specified requirements of controls, warning signals and other equipment not otherwise tested.

- I. After completion of above test, perform sudden 60% applied load tests and check the response time and voltage dip.
- J. Temperature measurements for the alternator during the above test shall be carried out in accordance with requirements of IEC 60034.
- K. A record shall be kept of the readings of all fixed and temporary instruments and gauges immediately before and after each "running" test at reasonable intervals (in proportion to its duration) during each test. The record of readings taken at intervals for a period after certain test. The ambient temperature and other relevant data shall also be recorded in each case. On top of all the data taken on the above interval record, all the data including Voltage, Frequency, Current, Vibration and any data as required by the Engineer shall be continuously electronically recorded.
- L. Should one or more of any series of tests resulted in the failure of the installation or any part of it to perform in accordance with the requirements of the Specification or Guarantee, the installation shall be deemed to have failed on initial test in that respect. The Contractor may then request the Engineer to amend the testing program to allow time then to alter for modifications or adjustments to the installation to overcome the defect.
- M. The Engineer will make such alternations to the testing programs as is reasonable for this purpose and the unsuccessful test series shall be re-performed after the modifications and adjustments have been made. The Engineer at his discretion, require the re-performance of all or any of the other tests that were carried out prior to the making of modifications and adjustments.
- N. Should the installation again fail to perform in accordance with the requirements of the Specification and Guarantee during the first or any further re-performance of any series of tests, the granting of permission to make further modifications and adjustments and to make further re-tests shall be entirely at the discretion of the Engineer.
- O. The Contractor shall bear the full cost of conducting all such further re-tests including the reimbursement to the Engineer and other essential participants of their incurred in being present at, and/or providing for, such re-tests.
- P. Should only any of series of three or more tests result in the failure of the installation or part of it to perform in accordance with the requirements of the Specification or guarantees and should this failure be of a minor nature only and no other faults be made evident the Engineer may, at his discretion and taking into consideration the results of the other tests of the series and of other series, accepted the overall result of the series of test as being successful.
- Q. Should the installation fail to perform in accordance with the requirements of the Specification and Guarantee during the first or any further re-performance of any

series of tests the Engineer may at any stage deem the installation to have failed on test and be may reject the whole or any part of it.

- R. If during the course of testing any evidence of structural or mechanical failure of any parts of the installation should become apparent the Engineer, may at his discretion permit the Contractor to carry out rectification or modification and re-testing but with the full cost of all re-test, including the first, being borne by the Contractor.
- S. Should the Engineer consider any structural or mechanical fault or failure to be such that on site rectification nor modification would not be desirable or that such fault or failure reveals and undesirable inherent defect of manufacturer detail, or should a fault or failure occur after rectification or modification, he may reject the whole or any part of the installation.
- T. No extension of the Contract Period shall be granted by reason of any extension of testing period to permit rectification, modification, adjustment or retesting of the installation.

3.03 ***SITE TEST***

- A. Upon the delivery to the site and if the generator set is required to re-assemble on site, similar tests shall be carried out by the Contractor to ensure that the performance is not degraded. The tests, but not limited to are:
 - 1. Diesel engine-Generator coupling and shafts alignment.
 - 2. On load 'mains failure' simulation test
 - 3. Safety devices test
 - 4. Remote monitoring
 - 5. Auxiliary contacts etc.
 - 6. Load tests.
 - 7. BMS interface test
- B. Load tests may be carried out through building load and/or Contractor load bank. Cost to arrange for the load for purpose of testing shall be included in the Contract.

3.04 ***PAINTING OF PIPE WORK***

- A. All pipe work, other than buried pipes, shall be painted immediately after installation with at least one coat of red primer and two (2) finishing coats of best quality aluminum paint approved by the Contractor. The color will be determined by the Engineer on site.

3.05 VIBRATION CONTROL

- A. The complete generator assembly shall be isolated on static deflection unhoused spring-neoprene in series isolator with non-skid neoprene pads. Start-up and shut down rocking restraint snuffers shall be provided at four corners of base frame.
- B. All fuel line pipes shall be cushioned with a layer of harness and neoprene pad at attached points.
- C. All pipe work and engine silencers shall be suspended on static deflection spring-neoprene in-series hangers.
- D. Detail calculation and proposal for justifying the size and provision shall be provided for Engineer's review prior to the installation.

SECTION 05**LOW VOLTAGE BUS DUCT*****PART 1 –GENERAL*****1.01 DESCRIPTION**

- A. This section specifies the supply, installation, testing, commissioning and setting to work of a totally enclosed, non-ventilated type of housing, low impedance insulated copper bus duct system.
- B. Bus duct shall be of totally enclosed with independent copper earth bar, low impedance having minimum rating as indicated in the Drawings and Specification with all necessary fittings, tap-off units, supporting devices and manufacturer recommended accessories to complete the installation as a whole.
- C. Ratings and the indicative routings of bus duct shall be as indicated on the Drawings. It is solely the responsibility of the Contractor to carry out site survey, co-ordinated and check the location of these facilities and make any necessary adjustment modifications to the Engineer's approval.

1.02 STANDARDS

- A. The bus duct shall be low impedance solid rectangular busbars trunking made of totally enclosed extruded aluminium housing with electro-tin plated hard drawn high-conductivity copper to BS EN 13601.
- B. The bus duct shall be type-tested assemblies (TTA) as defined in IEC 61439, manufactured and tested by a specialist bus duct manufacturer to BS EN 61439.
- C. Material and installation shall comply with BS7671, Local Authority's regulations and any other recommended practices, Standards of ANSI, IEEE, NEMA and UL.
- D. The bus duct and associated equipment shall be certified for the category of duty specified hereafter, in particular, with regards to fault conditions and temperature rise limits.
- E. The manufacture of various components and accessories, including the plug-in units, shall be as recommended by the bus duct manufacturer to ensure compatibility of the components.

- F. The bus duct shall be of Local Authority's approved type and the Contractor are required to submit project reference list for the Engineer's review.

1.03 SUBMISSION

- A. All technical submission shall be approved by the Engineer prior to the respective stages of construction.
- B. As a minimum requirement, the submission shall include the following:
 - 1. Equipment submission with manufacturer's data such as resistance per metre, reactance per metre, mV/A/m, contact resistance per joint, etc.;
 - 2. Test certificate for short circuit capacity and IPrating;
 - 3. Shop drawings for construction details of bus duct arrangements, spring hangers, wall flanges, floor flanges, plug-in boxes, etc.;
 - 4. Bus duct routing drawings showing the co-ordinated routing of the bus duct, setting out lines of the bus ducts relative to building grids, locations of bus duct joints, suspension and fixing units, etc.;
 - 5. Weight of equipment
 - 6. Builder's works requirement.

PART 2 –PRODUCTS

2.01 GENERAL

- A. Bus duct shall be factory fabricated epoxy insulated totally enclosed, vermin and insect proof, non-ventilated type suitable for three phase four wire system with full sized busbar for phases and neutral.
- B. Bus duct complete with plug-in units shall be type-tested to National Electrical Manufacturer's Association (NEMA) Standard (No. BU-1972) and U/L 857 and shall be able to withstand a short circuit condition equivalent to 50 kA 3 sec or not less than the type-tested short circuit capacity of the corresponding switchboards.
- C. Bus duct shall be insulated to Class B i.e. 85°C temperature rise above ambient temperature of 50°C but maximum operation temperature should not exceed 95°C.
- D. A complete bus duct assembly shall comprise the following:
 - 1. Cable and box
 - 2. Hangers
 - 3. Plug-in/feeder busbar
 - 4. Plug-in/tap-off box
 - 5. Elbow
 - 6. Off set
 - 7. Transposing unit
 - 8. End cap
 - 9. Fire barrier
 - 10. Expansion joints
 - 11. Integral earth
- E. Fire resistance bus duct shall be insulated with double layers of mica and silicone rubber on the busbars. All jointing parts shall be protected with fire protective enclosure. Test certificate for fire resistant bus duct shall be submitted to the Engineer for approval. Fire resistance bus duct shall be provided for all circuit incoming and outgoing from the Emergency Main Switch Board.
- F. All bus duct and the associated fittings shall be minimum IP44 rating within Electrical room and Electrical riser. At car park, outdoor or plant room areas shall be weatherproof type to IP 65 in accordance to IEC 529. Weatherproof bus duct shall incorporate gaskets; drain holes, etc. suitable for outdoor use. All the plug-in, joint and accessories shall be special box-up to manufacturer detail to the same IP rating as the busway.
- G. Minimum 2 nos. of hanger/support shall be provided for every 2m run of bus duct. Extra number of hangers will be required for joints. The bus duct shall be so supported

that no visible stress shall be apparent from either unbalanced plug-in units. Vertical floor support shall be complete with spring hanger.

- H. All joints shall be the one-bolt removable/isolating type with through-bolts that can be checked for tightness without de-energizing the system. It shall be possible to make up a joint from one side in the event the bus duct is installed against the wall or ceiling. The joint shall be so manufactured so as to allow removal of any length without disturbing adjacent lengths. Belleville spring shall be provided to give positive pressure over complete contact area. Plug-in feeder shall use identical parts.
- I. The bus duct system shall be capable of being mounted in any position without de-rating. Plug in and feeder sections shall be interchangeable without the use of special adapter joint covers.
- J. The complete bus duct system shall be capable of withstanding the short circuit capacity of the electrical installation without damaging by the electrical, mechanical and thermal stress under fault condition of a service voltage of 415V 50Hz.
- K. Bus duct shall have rated insulation voltage and rated operating voltage of 600V respectively.

2.02 ***BUSBAR***

- A. Busbar shall be of hard drawn high conductivity copper of adequate area complying IEC Publication 61439. The maximum hotspot temperature rise at any point in the bus duct at continuous rated load shall not exceed 45°C above a maximum ambient temperature of 50°C in any position.
- B. Busbar shall be suitably plated at all joints and contact surfaces
- C. Busbar shall be tinned plated for low contact resistance.
- D. Bus duct system shall be terminated by end closure.
- E. Unless otherwise highlighted, full size neutral of the same cross-sectional area as the phase conductor shall be provided for all rating of the busbar system.

2.03 ***HOUSING***

- A. The housing shall be of extruded aluminium with epoxy painted to provide maximum protection against corrosion from water and other contaminants. All hardware shall be plated to prevent corrosion.

2.04 ***PLUG-IN***

- A. For vertical bus duct risers, provisions shall be made in the bus duct for tap-off units at intervals of 600mm; tap-off points where not used shall be provided with proper outlet covers. Tap-off openings shall be of the safety type and in conjunction with the tap-off units shall have interlocks provided which prevent addition or removal of the tap-off unit when the switching mechanism is in the 'on' position. Metal parts of the tap-off units shall be manufactured to contact the metallic casing before the plug fingers contact the busbars. 'Danger' warning signs of an approved type shall be provided at all tap-off points. Feeder bus ducts utilised for the inter connection between transformers and the main switchboards shall not be provided with tap-off points.
- B. When the busbar cover is opened, no live part can be accessed and the degree of protection provided shall have the same IP rating as specified for the bus duct.

2.05 ***PLUG-IN UNIT (TAP-OFF UNITS)***

- A. Housing shall completely enclose the moulded case circuit breaker with rating as indicated in the Drawings. Enclosure shall be of galvanised sheet steel furnished in epoxy baked enamel paint over a rust inhibitor.
- B. Stable shields shall be provided to protect stabs and ground plug body to bus duct housing before stabs make power contact. Earth terminal shall be provided inside plug body, adequate shielding shall be provided to prevent access to live parts when cover is open. An earth stab shall be manufactured to engage grounding tab on bus duct and internal earthing bus shall be provided.
- C. Handle lock attachments complete with padlock and four keys shall be provided for padlocking cover and operating handle in either "ON" or "OFF" position. The operating handle shall be easily moved from end to side or vice versa so that it will be in the correct position to operate from the floor. All current carrying parts shall be suitably plated.
- D. A releasable cover interlock shall be manufactured to prevent opening cover except when breaker is in "OFF" position. This interlock shall be convertible to non-releasable interlock preventing closing switch with cover open shall also be included, as well as an interlock to prevent insertion or removal from bus duct when in "ON" position.
- E. Circuit breaker type plugs shall have an interrupting rating of not less than 36kA rms symmetrical and not less than the type tested short-circuit capacity of the designated bus duct.
- F. Plug assists shall be furnished on all plugs over 100A that will mechanically engage or disengage the plug from the bus duct, but only when the plug is in the "OFF" position.

2.06 FIRE BARRIER

- A. All sections that passed through the floor slabs or walls shall have a minimum 2 hour rated (or rated not less than that of the slab/wall) fire barrier in accordance to the requirements of the Local Authorities and Civil Defence requirement.

2.07 EXPANSION JOINTS AND TRANSPOSITION JOINT

- A. All bus ducts shall be equipped with expansion joints and also a transposition joint when it crosses a building expansion joint or to reduce the stress on the system by differential expansion. The bus duct expansion units shall be capable of taking up all thermal expansion due to the temperature differential of the bus ducts, and building vertical settlement of not less than 100mm. Additional expansion units shall be provided along horizontal and vertical runs at intervals of about 30m, and where considered necessary by the bus duct manufacturer. This requirement is exempted if the manufacturer shall submit comprehensive calculation to warrant the expansion joints and transposition joints are not necessary.

PART 3 –EXECUTION**3.01 GENERAL**

- A. Store bus duct in clean dry area. Bus duct shall not be delivered or installed until building is enclosed and dry.
- B. Clean conducting surfaces and install bus in accordance with manufacturer's installation instructions. Torque all connections. Adjust spring hangers to equally distribute load.
- C. Provide 10 cm high concrete curb around bus duct floor penetrations.
- D. Provide a spring suspension hanger at each floor and not more than every 4 vertical meters.
- E. Provide expansion fittings in accordance with manufacturer's recommendations.
- F. Provide listed fire stop fittings at floor and wall penetrations.

SECTION 06

LOW VOLTAGE SWITCHBOARDS

PART 1 - GENERAL

1.01 WORK DESCRIPTION

- A. The switchboards, distribution boards and control panels shall be built in accordance with IEC 61439 "Factory Built Assemblies for Low Voltage" or BS 5486 "Factory-built Assemblies of Switchgear and Control Gear for Voltage up to and including 1000 AC and 1200VDC.
- B. All factory built assemblies shall be capable of withstanding the electrical, mechanical and thermal stresses of the prospective fault level experience. The prospective fault levels of the various factory built assemblies shall be as indicated in the Drawings.
- C. All equipment used in the factory built assemblies shall have been type tested/partial type tested. Type test certificates shall be submitted for all major equipment at the time of technical submission.

Besides, a full type test report as specified under IEC 61439, the Low voltage switchboard shall also be tested for electromagnetic compatibility (EMC), internal arcing-fault test and seismic withstand test under the relevant standards.

- D. All factory built assemblies, as a complete unit shall have a rating equal to or greater than the integrated equipment rating as indicated in the Drawing.
- E. All factory built assemblies subject to rain or wet conditions or located outside electrical switch room shall be weatherproof constructed to IP 66, able to withstand high impact strength of 60 KN/m² (min), temperature resistant with consideration of Ambient temperature 48 degrees C and average switch room temperature 38 degrees C. Flame retardant and corrosion resistant.

1.02 *STANDARDS*

- A. The LV switchboards and distribution boards shall be constructed in accordance with the latest revision of the following standards:

- 1. BS 88-2 : Cartridge fuses for voltages up to and including 1000V

AC and 1500V DC.

- 2. BS 89-2 : Direct acting electrical indicating analogue electrical measuring instruments and their accessories.
- 3. BS 142 : Electrical protection relays
- 4. BS 159 : Busbars and busbar connections

-
- | | | | |
|-----|---------------|---|--|
| 5. | BS 13601 | : | Copper for electrical purposes. Rods and bars. |
| 6. | BS EN 60898 | : | Circuit-breakers for over current protection for household and similar installations. |
| 7. | BS 61869 | : | Current transformers |
| 8. | BS EN 60947-2 | : | Low-voltage switchgear and controlgear. Circuit- breakers. |
| 9. | BS EN 60947-2 | : | Control switches (switching devices, including contactor relays, for control and auxiliary circuits, for voltages up to and including 1000V AC and 1200V DC). |
| 10. | BS EN 60947 | : | Air-break switches, air-break disconnectors, air break switch disconnectors and fuse combination units for voltages up to and including 1000V AC and 1200V DC. |
| 11. | BS EN 60947 | : | Degrees of protection of enclosures of switchgear and control gear for voltages up to and including 1000V AC and 1200V DC. |
| 12. | BS 5424 | : | Control gear for voltages up to and including 1000V AC and 1200V DC Contactors. |
| 13. | BS 61439 | : | Low-voltage switchgear and control gear assemblies. Specification for type tested and partially type tested assemblies.(General requirements) |
| 14. | BS EN 62053-1 | : | Electricity meters – Specification for Class 0.5, 1 and 2 single phase and polyphase, single-rate and multi-rate watt-hour meters. |
| | | : | Electrical relays. |
| 15. | BS EN 61810-2 | | |
| 16. | BS 6004 | : | PVC insulated cables, non-armoured, for electric power, lighting and internal wiring. |
| 17. | BS 6231 | : | PVC insulated cables for switchgear and controlgear wiring. |
| 18. | BS 7430 | | Code of practice for Earthing |
| 19. | IEC 61439 | : | Low-voltage switchgear and control gear assemblies Type-tested and partially type-tested assemblies |
| 20. | AS 3439-1 | : | Low-voltage switchgear and control gear assemblies. Type-tested and partially type-tested assemblies |
| 21. | IEC 60068-3-3 | : | Environment testing: Guidance Seismic test methods for equipment. |
-

- B. BS/IEC or other National standards not mentioned above but are applicable to this installation shall also apply.

1.03 ***SUBMISSION***

- A. A component list and catalogues.

- B. Detailed shop drawings of all factory built assemblies shall be submitted for approval before construction commences.
- C. Such drawings shall show the proposed method of construction of the cubicles, method of supporting equipment and busbars, full details of busbar layout, method of support, electrical control wiring diagrams, equipment weight, colors, and surface treatment and mounting type etc.
- D. The drawings shall also incorporate a full list of proposed materials. The construction shall not commence until the drawings are approved for construction.
- E. Factory and site testing procedures and report formats shall also be included.

PART 2 –PRODUCTS

2.01 GENERAL

- A. The factory built assemblies shall be of the totally enclosed, modular cubicle type, which are extensible and suitable for floor mounting as indicated in the drawings. The assemblies shall be manufactured in a facility that is ISO 9000 certified.
- B. The factory built assemblies shall be compartmented and utilize sheet steel plates of thickness as detailed below. The panels shall be vermin proof and constructed to a minimum degree of protection of IP ratings to BS 60529. The IP ratings indicated below shall be applicable unless otherwise indicated in the drawing.
- C. Main and Sub-Switchboards
 - 1. 2mm thick sheet steel
 - 2. Form 4a, Type 3 for Main Board and for Emergency Board and Form 2b, Type 2 for Distribution Board unless otherwise specified to BS 61439 with separation of busbars from the functional units and separation of all functional units from one another
 - 3. Minimum IP 54 and IP 2X after opening of doors & panels (of external covers) unless otherwise specified.
 - 4. IP66 for location subject to rain wet conditions or located outside electrical switch room.
 - 5. Switchboard frame shall be of modular detail and extensible.
 - 6. The interior of each cubicle shall be dust inert and vermin resistant.
- D. Switchboard frames shall be fabrication of 2.0mm thick electro-galvanized steel. All joints shall be neatly formed and finished flush with the adjacent surfaces by grinding and/or machining. No joints shall be located on a corner and all bare edges shall be lipped.
- E. Structural members and bracing, where necessary, shall be welded or bolted to the frame.

2.02 *DOORS ANDPANELS*

- A. Full access shall be provided to service and maintain all equipment inside each cubicle by means of a suitable hinged door that shall open a minimum of 120 degrees. All hinged doors shall have an earth braid connected to the cubicle and drawing holding pocket.
- B. Doors and panels shall be constructed of 2 mm electro-galvanized sheet steel, pressed or rolled so that edges are given a neat round finish and shall reinforced with a suitable frame welded to the inside folded edge of the door. An approved stiffener shall be welded to the inside of each door and/or panel.

- C. Doors shall hang on substantially concealed non-corrosive hinges and shall be fitted with good quality door handles to Engineer's approval which shall be lockable and operable by the same key. The door handles shall be fitted with toggles to operate rods to latch with suitable slots in both the top and bottom of the switchboards. Latching rods shall be guided by brackets. The latching rods and associated brackets shall be cadmium plated.
- D. All front, side and top panels shall be constructed in a manner similar to that specified for doors above. They shall be fitted to the frame from the outside with captive, hand tightened screw. Panels longer than 1.2 meters shall be provided with 3 point locking system

2.03 *BASEPLATE AND INSULATING PANELS*

- A. The switchboards shall be mounted on 50mm X 50mm C-channel. Wherever insulating panels are required to mount special equipment, they shall be of high quality black bakelite, polished on the front.
- B. All edges must be cut straight and square and shall be chamfered on the front edge with a 3mm chamfer.

2.04 *FINISHING OF METAL WORK*

- A. Panel work of the switchboards shall be finished with electrostatic epoxy powder coating of minimum 50 microns all treat with 180 °C, 12 minute oven backing. All metal work shall be rust inhibited and sprayed with two coats of primer. The painting shall be of best quality oven-bake epoxy powder coated, of Grey color.
- B. After erection on site and after all inspection and tests have been carried out, the Contractor shall thoroughly clean all painted parts, touch-up with application of an additional coat of anti-corrosive structural priming paint to any part of the originally painted surfaces that have been scratched or otherwise marked and at least one additional touch-up finishing coat of Grey color.

2.05 *BUSBARS AND CURRENT CARRYING PARTS*

- A. The manufacturing of the busbar system shall comply to the latest edition of BS 159. All busbars and current carrying parts shall be manufactured to carry a current density of not more than 1.55 A/mm² and shall be capable of carrying normal current continuously without the temperature rise of any part exceeding 30°C. Their location shall be such as to ensure adequate spacing between conductors and they shall be securely fastened and braced to withstand all stress set up during transportation, erection and normal operation, and under short

circuit conditions. The busbars shall not be damaged in any way under a fault of short circuit experience with minimum 46 MVA for 3 seconds. Where two or more

conductors are used to form a phase, it shall be separated with an air gap sufficient to allow for the ventilation of the individual conductors all round. Busbar supports shall be made of slotted first grade "Bakelite" or glass fiber reinforced polymer able to withstand minimum operating temperature of 110°C.

- B. All connections in current carrying part shall be made by means of bolts with lock nuts. The use of tapped holes and studs or any other alternative method of connection in current carrying parts shall not be employed without the express approval of the Engineer prior to manufacture.
- C. Busbars shall be provided with approved shrinkable tube of adhesive stickers of appropriate phase color to indicate phases. Busbar shall be copper tin-plated.
- D. All connections, tapping and clamping shall be made in an approved manner to ensure minimum contact resistance. All connections in the busbars shall be firmly bolted and clamped with even tension. Before assembly, all busbar joint surfaces shall be filed or finished to remove burrs, dents and oxides and silvered to maintain good continuity at all joints.
- E. All intermediate conducting material shall be used when there is a possibility of electrolytic action when contacts of the copper busbars with dissimilar metals are made.
- F. An earth bar minimum size comply with BS 7671 and BS 7430 with minimum 50mm x 10mm to each vertical section of the cubicle units and shall run the full length at the bottom of each switchboard. All metal parts of the switchboards and associated equipment shall be bonded and connected to this earth bar. Minimum 2 connections to main earthing system shall be provided. The protective circuit shall have a rated conditional short circuit current of 39kA at 240V and a rated peak and short-circuit withstand current of 81.9kA and 39kA for 1 sec respectively.
- G. The neutral busbar shall be the same size of that of the phase bars and shall be provided with an adequate number of terminals including cable lugs, bolts, etc. to suit the installation.
- H. For circuits not less than 200A, busbar drops to moulded case circuit breakers or other apparatus shall be made of circular or rectangular busbar covered with Nylex tubing of appropriate color and terminated in adequately sized concentric lug, of lug type, cone grip cable sockets or approved equal. Cables may be used for circuits less than 200A to type test configuration.
- I. All visible rectangular busbars shall be bare tinned type size 1.55A/mm² based on current density. Rated current of assembly shall be based on tinned busbar and must be certified by type testing.

- J. All screws, bolts, washers used for the busbars shall be Stainless steel. All contact parts of the busbars and connections shall be sanded and coated with a thin coat of chemical inert petroleum jelly. All bolts shall be tightened with an even tension. Approved spring washers shall be used at all joints complete with high tensile stainless steel bolts.
- K. All busbars and switchgear terminals to which outgoing or incoming cables are terminated shall be manufactured for a maximum temperature of 30°C above ambient. Where there are two incomers to the Low voltage switchboard, the bus-coupler and the busbar work shall type tested to certify the integrity of the system.

2.06 *INSULATION*

- A. The clearances and insulation shall be such as to withstand the standard 3 kV dielectric tests on the switchboard.
- B. All insulation used shall be of the best quality and sufficiently strong to withstand all stresses which may be imposed on it in the ordinary erection and operation of the switchboards.
- C. Where insulators are cemented or jointed to metal parts, such jointing shall be of such a nature that no dangerous stresses are set up in the insulators by the unequal expansion or contraction of the insulation and the metal through the range of temperatures stated.

2.07 *CABLE OR BUSDUCT ENTRIES*

- A. Provision shall be made within the factory built assemblies for the proper support and bracing of outgoing and incoming cables or bus ducts.
- B. Weatherproof cable glands and all necessary non-ferrous gland plates, etc. shall be provided for all cables entering or leaving the switchboards. Cable terminating end boxes shall be mounted from top of the switchgear in the cubicles. Cable supports shall be provided for the termination boxes.
- C. Bus duct entries to the switchboard shall be liaised with bus duct vendor for the exact position and phasing.
- D. Detail of cable or bus duct in and out of the switchboard shall take into the IP rating requirement as specified for the switchboard.

2.08 *PHASING*

- A. Phase rotation shall be strictly maintained throughout the project. Phase distinguishing colors shall be RED, YELLOW and BLUE.

2.09 LABELS

- A. All factory built assemblies and equipment shall be clearly labeled in accordance with Local Authority's regulations and to indicate its functions by means of engraved 'Traffolite' labels. Plastic labels are not acceptable. Emergency Main Switch Board shall be "red-on-white" others shall be "black-on-white". Engraved lettering not less than 20mm high or as otherwise required and approved.
- B. Labels shall be attached by means of chrome finished countersunk screws and nuts.
- C. Prior to engraving the labels, a label schedule shall be submitted for approval. Allow for two spare sets of label blanks and the cost of engraving as directed by the Engineer. If not so directed, the spare sets of labels are to become the property of the Employer.

2.10 SPECIFICATION FOR SPARES

- A. The switchboards shall incorporate a rack for mounting spares, moulded case circuit breakers and a minimum of 20 percent standby/space capacities shall be provided for future installation of circuit breakers.
- B. End covers and pre-drilled holes at main busbars shall be manufactured for future extension of the switchboards at both ends.
- C. Spare shall be provided according to those as specified in the DB schedule/Single line diagram.

2.11 BASE SUPPORTS

- A. The base support shall be fabricated from 50mm x 50mm C-channel base sufficiently stiffened to adequately support the switchboard. The base shall be hot dip galvanized after fabrication. The base may be made as part of the switchboard.

2.12 VENTILATION

- A. All switchboards shall be properly natural ventilated. Force ventilation to achieve the required rating of the assembly is prohibited.
- B. Vents shall be provided with the consideration of IP rating as specified.

- C. Detailed calculation shall be submitted to verify the total heat from the switchgear and switchboard and the amount of vents and ventilation fans size.

2.13 ***INDICATING INSTRUMENTS***

- A. Indicating instruments shall comply with BS 89. Meters for external panel mounting shall be of the flush pattern type with square escutcheon plate's finished matt black and polycarbonate cases.
- B. The main low voltage switchboards shall be provided with High performance and high accuracy power meter/Energy Analyzer with LCD display that capable of indicating real-time readings, demand reading, energy readings, set up and resets menus shall be installed for the main switchboards. Power meter shall be provided for the circuits above 100A or as specified on the drawings.
- C. The reading shall include but not limit to current (per phase, neutral and earth), voltage (L-L, L-N), real power, reactive power, apparent power, power factor, frequency, energy, power quality readings such as voltage and current THD, demand, date/time stamping, on-board memory for alarms/relay functions such as under/over conditions, phase unbalance conditions, data log, event log, etc.
- D. The meter power shall accept inputs from standard 5A current transformers and has full-scale input of 10A. The voltage inputs shall be directly connected to 3 phase circuits of 600V and below without the need for Potential or current transformer. All reading shall be scaled to their actual values without the need for a multiplier.
- E. The power meter set up and resets shall be password protected and easily done via the meter display or via network software.
- F. In addition, unless otherwise specified, following analogue indicating instrument shall be installed for sub-board and distribution boards above 100A incoming or as specified on the drawings.
- G. Ammeter and voltmeters shall be of digital type, accuracy Class 1.5.
- H. Ammeters shall be selected such that full load current indications are not less than the two thirds of linear scale of the meter and have a suppressed upper scale.
- I. Ammeters shall be capable of taking overloads of 2 times continuously and voltmeter 1.2 times continuously.
- J. Ammeters at the main incoming feeders shall in addition to the moving iron mechanism be provided with thermal bimetal indicators with draw pointers to record maximum demands. The mechanism shall not respond to short current peaks and shall be manuallyresettable.

- K. Frequency indicators shall be of the vibrating reed type. The meter shall be capable of proper operation for voltage variation of $\pm 10\%$ rated voltage.
- L. Power factor meters shall be of the electrodynamics crossed coil mechanism suitable for balance load, three phase four-wire system. The accuracy class shall be 1.5 and range 0.5 lag to 0.5 lead.
- M. Monitoring Kilowatt-Hour Meters and current transformers where specified shall be provided. The kilowatt-hour meter shall have a digital display reading up to 100 million Kilowatt-Hours and to the nearest 100 KW-Hr. The overall accuracy shall be better than $\pm 2.0\%$.
- N. The KWh meters shall be of flush mounting, rear connection type, current transformer operated and suitable for three phase balanced and unbalanced loads. The meter shall be complete with the three metering elements and shall have a cyclometer register with six rollers.
- O. Instrument dials shall be white with black markings, and scales shall be of such material that ageing, peeling or discoloration will not take place under tropical conditions.
- P. All instruments, when mounted on the switchboard, wired and ready for service, shall be in good order and condition in every way. The measuring elements shall be completely free from any discernible stickiness either at zero or upscale, and they shall be capable of attaining the performance guaranteed by the manufacturers of the respective instruments.
- Q. All terminals shall be completely insulated and potential circuits shall be suitable fused.

2.14 *SELECTOR SWITCHES*

- A. The switches shall be of the panel mounting type with totally enclosed contacts and stud connection. Ammeter selector switches shall have make before break contacts to ensure that the current transformers are never open circuited.
- B. The ammeter selector switch shall be suitable for measuring the current in each phase independently.
- C. The voltmeter selector switcher shall be 7-way type. Voltmeter selector switches shall have break before make contacts.

2.15 *CURRENT TRANSFORMERS*

- A. Current transformers necessary for the operation of instruments and meters shall comply with BS 61869 and be of the 'straight through' epoxy-resin type.

Measuring current transformer shall be of accuracy class 1 and for metering of accuracy Class 0.2 (for energy metering).

- B. They shall be adequately rated in V.A. to carry the summation of all V.A. burdens of connected loads, and shall be capable of carrying current of the corresponding circuit breakers and fuses. The output secondary current shall be 5 amperes.
- C. They shall be capable of operation, without damage, with open circuited secondary and full load current flowing in the primary.
- D. Current transformers shall be adequately supported and installed as to permit easy access and to be readily replaceable, if necessary, without dismantling of adjacent equipment.
- E. All current transformers shall be provided with an identifying label giving type, ratio, class, output and serial number.
- F. Current transformers provided for protective gear purposes shall have overcurrent and accuracy limit factors not less than those corresponding to the short circuit level of the system. The output of each current transformer shall be not less than that specified and the capacity of the current transformers provided shall be adequate for operation of the associated protective devices and instruments. Where double ratio secondary windings are specified, a label shall be provided at the secondary terminals of the current transformer indicating clearly the connection required for either ratio. These connections and the ratio in use shall be shown on the appropriate schematic and connection diagrams. Protection current transformer shall be of accuracy Class 5P 10 and the burden in no case shall be less than 15VA.
- G. Magnetization curves shall be submitted at the time of shop drawing submission.

2.16 CONTACTORS

- A. Contactors shall be fully tropicalized and robust construction and shall comply with relevant parts of BS 5424 and be rated for the following duties.
- B. Contactors for voltages up to and including 1000 volts A.C. and 1200 volts D.C. (BS 5424 Part 1).
 - 1. Rated duty - Uninterrupted
 - 2. Mechanical duty - Class I
 - 3. Making and Breaking - AC4 Category
- C. Contactors shall be selected to suit the load such that a minimum electrical life of one million operations is ensured. The mechanical life shall be at least 5 million operations.

- D. Contactors shall have at least 15 times making capacity and 10 times breaking capacity for contactors less than 100 amps and 10 times and 8 times respectively for contactors above 100 amps. The selection of contactors shall be coordinated with the prospective fault levels suitable at that point of installation.
- E. Contactors shall generally be suitable for rail mounting and be of modular detail. The coil shall be suitable for +10% and –15% of nominal main voltage. Provision shall be made on the contactors for affixing of termination and contactor identification labels.
- F. Contactors shall be provided in sheet steel enclosure of a tropical finish and vermin proof. Adequate ventilation shall be accordance with BS 5424, category IP 42 for indoor service and IP 65 for outdoor service.
- G. The contactor shall be located within the enclosure so that upon making or opening of the contactor under normal or fault conditions, damage will not be caused to other equipment and wiring within the enclosure.
- H. An isolating switch shall be provided for each contactor circuit except that if there is more than one contactor and they are grouped together, one incoming supply isolating switch shall be provided to isolate all contactor circuits. A mechanical interlocking device between the isolating switch and panel cover shall be provided to prevent access to live parts within the panel when the isolating switch is in the “ON” position.
- I. Contactors equipped with both local and remote control shall have local/remote changeover switches capable of being locked by padlock in the either position.
- J. Contactor shall be provided with spare auxiliary (2 No. + 2 NC) in addition to other required auxiliary contacts specified in the Contract.

PART 3 –RELAYS

3.01 CONTROL RELAYS

- A. All control and indication relays shall be of the heavy-duty pattern fully tropicalized type.
- B. Relays shall be grouped conveniently in dust proof cases with removable covers given access for adjustment, cleaning, etc., without dismantling the relay.

3.02 PROTECTION RELAYS

- A. Protection relays shall be approved types complying with BS 142 or equal and shall have approved characteristics and be flush mounted in dust proof cases. Relay cases shall generally be finished in black enamel.
- B. Relays shall be of construction detail arranged so that adjustments, testing and replacements can be effected with the minimum of time and labor. Relays of the hand reset type shall be capable of being reset without opening the case.
- C. Relay contacts shall make firmly without bounce and the whole of the relay mechanisms shall be as far as possible unaffected by vibration or external magnetic fields.
- D. Relays, where appropriate shall be provided with flag indicators of approved type, phase colored where applicable. Flag indicators shall be of the hand-reset pattern and shall be capable of being reset without opening the case. Where two or more phase elements are included in one case separate indicator shall be provided for each element.
- E. Relays with provision for manual operation from outside the case, other than resetting will not be accepted, and time delay relays shall not be of the dashpot type.
- F. Relays shall be provided with clearly inscribed labels describing their application and rating in addition to the general-purpose labels.
- G. Approved means shall be provided on the relay panels for the testing of protective relays and associated circuits. Withdraw able type cases and plug-in type test facilities being preferred.
- H. Full discrimination relay curves indicate relay setting shall be co-ordinate by the Contractor and submit for approval. The submission shall cover both O/C & E/F protection up to final circuit and shall be endorsed by the Contractor's Installation Engineer.

3.03 *OVERCURRENT PROTECTION*

- A. Overcurrent protection shall be of the current transformers operated direct acting type. Where instantaneous trip is specified, the relay shall incorporate an electronic timer with adjustable time delay setting.
- B. Where IDMT characteristic is required the time/current characteristic shall comply with BS 142. IDMT type relay shall consist of an electromagnet with shading rings on the pole pieces driving an induction disc. Current setting shall be of a plug and bridging socket arrangement and time lag setting shall be by setting screw located above the time scale.
- C. Overload phase indicator shall be provided to show the phase overload condition.
- D. The range of current setting adjustment for phase faults shall be 50% to 200% of rated full load with tapping at 25% intervals and the time setting adjustment shall be 0 to 3 seconds at 10 times the normal operating current. The current/time characteristics of the relays shall be in accordance with the British Standard Curve and shall be provided during the technical submission.
- E. Both electromechanical and electronic type protective relays may be considered. Submission of full technical detail and approval shall be obtained prior to installation.

3.04 *EARTH LEAKAGE PROTECTION*

- A. The earth leakage relays shall be of the instantaneous type with adjustable current settings from 5% to 40% in 5% steps.
- B. The operating coils and contacts shall be adequately rated to carry the necessary load. Operating indicator and reset facilities shall be provided.
- C. The relays shall house in dust proof sheet metal casings, provided with viewing glass.
- D. Both electromechanical and electronic type protective relays may be considered. Submission of full technical detail and approval shall be obtained prior to installation.

PART 4 – CONTROL CIRCUIT WIRING AND AUXILLARY

4.01 CONTROL CIRCUIT WIRING

- A. All wiring shall be arranged in a regular manner with bends set at 90 degree and securely held in position with suitable clips and where convenient shall be installed in the uprights and/or back-stays insulating bushes being used where necessary.
- B. Control wiring of the switchboard shall be carried out in PVC insulated switchboard cable of size not less than 1.5mm² and those for current measurement shall be minimum 2.5mm². All meter wiring shall be of similar colors to those of the respective bus bars, etc., to which connections are made. The cable termination shall be made with cable lugs.
- C. No wires/cables shall be tee-off or jointed between terminal points.
- D. Wiring shall be carried out in such a manner as to make circuits and connections easily traceable. Cable marking ferrules or similar shall be used at each termination. Terminals shall be designated in an approved manner.
- E. All terminals shall be fitted with brass washers and securely fixed with lock nuts.
- F. Displacement Insulation push-in type termination for cable up to 2.5mm², tunnel type terminals shall be provided for cables up to and below 6mm². Cables larger than 6mm² shall be terminated with compression cable lugs or proprietary makes of termination approved by the Engineer.

4.02 *ANTI-CONDENSATION HEATERS*

- A. Anti-condensation heaters shall be fitted in each cubicle together with an ON/OFF isolating switch and adjustable thermostat suitable for electrical operation at 230 volts A.C. 50 Hz single phase of sufficient capacity to raise the internal ambient temperature by 5°C. The electrical apparatus so protected shall be detailed so that the maximum permitted rise in temperature is not exceeded if the heaters are energized while the switchboard is in operation.
- B. As a general rule, the heaters shall be placed at the bottom of the cubicle.

4.03 *TERMINAL BOARDS*

- A. All terminal boards shall be mounted in accessible positions and, when in enclosed cubicles shall be inclined downwards towards the door. Spacing of adjacent terminal boards shall not be less than 100 mm and the bottom of each board shall not be less

than 200 mm above the incoming cable gland plate. Separate studs shall

be provided on each terminal strip for the cores of incoming and outgoing cables including all spare cores.

- B. Brass bolts and studs shall be of not less than 6 mm diameter size but stainless steel and bronze down to 4.5 mm diameter may be used provided that the current carrying capacity is adequate. All studs shall be provided with nuts, washers and lock nuts or lock washers. Where pinch type terminations shall be provided. They shall have adequate current carrying capacity and shall be provided with locking devices. Insulated barriers shall be fitted between adjacent terminals.
- C. 400/230 volt and higher voltage circuit terminals shall be segregated from other terminals and shall be fitted with non-flammable transparent plastic covers to prevent contact with any live parts. They shall have warning labels with red lettering, mounted thereof in a conspicuous position.
- D. All connections shall be made at the front of the terminal boards and no livemetal shall be exposed at the back.

4.04 *FUSES AND DISCONNECTING LINKS*

- A. All fuse link and disconnecting link assemblies associated with electrical installation, instrument, protection and control circuits shall be of approved type and grouped as far as possible according to their functions. They shall be clearly labeled, both on the panels and the associated wiring diagrams.
- B. Fuse link and disconnecting link assemblies associated with tripping circuits shall preferably be mounted on the outside of controlling compartment. All others shall be mounted internally.
- C. Carriers and base for flush links shall be black. Disconnecting link carriers and bases shall be white.
- D. All fuselinks shall be High Rupturing Capacity (HRC) cartridge type and all fuse switches and distribution boards and the like shall be suitable for the accommodation of these fuses.
- E. Each cartridge shall incorporate a fuse element of appropriate current rating and fusing factor in order that adequate protection and discrimination is provided to the circuit.
- F. The high rupturing capacity (HRC) cartridge fuses of rating shown shall conform to BS 88 Part 2 Class Q1 with minimum breaking capacity of 80 KA. When fuses are used for motor protection they shall have Class R rating. Fuse bases and carriers shall be made of high-grade phenolic moulding.

4.05 *PUSH BUTTON*

- A. All the push buttons shall be made of non-hygroscopic material, non-swelling and fitted to avoid any possibility of sticking. Unless otherwise specified, they shall be of the non-retaining type. All push buttons shall have minimum IP54 ingress protection rating.
- B. The contacts of all push buttons shall be of adequate strength and have a positive wiping action when in operation.

4.06 *INDICATING LAMPS AND FITTINGS*

- A. Indicating lamps fitted to the fascia of switch and instrument cubicles or panels shall be adequately ventilated.
- B. Lamps shall be easily removed and replaced from the front of the panel by manual means not requiring the use of extractors.
- C. The bezel of metal holding the lamp glass shall be easily removable from the body of the fitting so as to permit access to the lamp and lamp glass.
- D. The lamps shall be LED type. The rated lamp voltage shall be 4% in excess of the auxiliary supply voltage AC 230V and DC48V.
- E. The lamp glasses/lens shall be in the standard colors, red, yellow, blue and amber. The color shall be in the glass/lens and not an applied coating and the different colored glasses/lens shall be interchangeable.
- F. Neon indicating lamps shall not be used with colored lens.
- G. Unless otherwise indicated or agreed with the Engineer, all lamp colors shall conform to the following practice:
 - 1. Red - red phase;
 - 2. Yellow - yellow phase;
 - 3. Blue - blue phase;
 - 4. White - supply available.

4.07 *RADIO INTERFERENCE SUPPRESSION*

- A. All Plant and apparatus, including such items as contactors, starters, relays and the like

where the normal operation is such that interruption of low frequency or direct current occur, shall be fitted with means of suppressing all interference frequencies caused.

- B. The standard of interference suppression shall be in accordance with the current edition of BS 800 incorporating all amendments but extended to include the frequency ranges 300 to 360 MHz and 1.000 to 3,400 MHz.
- C. Details of the equipment and methods to be used in quantitative assessment of the level of radio interference shall be as specified in BS 55016-1-4.
- D. For guidance in the installation of electrical equipment to meet the foregoing standards, reference shall be made to BS Code of Practice CP:1006 "General Aspects of Radio Interference Suppression: which deals with interference caused by electrical apparatus and installations.

4.08 *SURGE PROTECTION DEVICES*

- A. Surge Protection devices shall be provided whichever cable route from external or to external of the building.

PART 5 - EXECUTION

5.01 TESTING AND COMMISSIONING

- A. All switchboards shall be tested and certified by the installation Engineer that it is safe before supply is energized, and that all the equipment comply with the requirements of the Specification.
- B. Generally such tests in the factory and repeated at site are as follows:
 - 1. Insulation resistance tests;
 - 2. Earth continuity tests;
 - 3. Dielectric test – 3 kV DC for 1 minute;
 - 4. Check of clearance and creep age distances;
 - 5. Tests to prove correct operation of controls, interlocks, tripping and closing circuits, indications, etc.;
 - 6. Phasing tests;
 - 7. Operation of all protective gear circuits by primary injection and system fault tests to check sensitivity and stability;
 - 8. Test of accuracy of all measuring instruments;
 - 9. Test operation of alarm devices;
 - 10. Interfacing test with BMS
 - 11. Checking of all internal cabling and function operation;
 - 12. Above tests are minimum requirement and shall include all other tests required by the Engineer to verify compliance with the Specification.
- C. Triplicate sets of all principal test records and test certificates are to be supplied for all the tests carried out in accordance with the Specification to the Engineer for approval before dispatch from the switchboard factory.
- D. All costs, materials, equipment, labor, etc. necessary for the execution of the testing shall be included in this portion of work.
- E. The Contractor shall include the cost for allowing the Engineer or his representative to witness the factory tests.

5.02 TRANSPORTATION

- A. Switchboards are not allow to be delivered to site until the electrical room or switch room is in a clean and acceptable condition with lockable doors.
- B. Switchboards transported to site shall be fully covered with weatherproof covers and transportation eye bolts shall be provided for handling at site.

- C. Switchboards which are poorly packed and result in signs of corrosion will be rejected.

- D. All necessary measures to cover and protect the switchboards at site shall be provided. Such measures shall include a complete PVC blanket over the whole switchboard or distribution board.

5.03 REJECTION OF SWITCHBOARD

- A. If any of the above tests fail to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site, the Engineer may reject the item or defective component thereof, whichever is considered necessary, and after adjustment or modification as directed by the Engineer, the Contractor shall submit that item for further inspection and/or test. In the event of the defective item being of such nature that the requirements of this Specification cannot be fulfilled by adjustment or modification, such item is to be replaced by the Contractor at his own expense, to the entire satisfaction of the Engineer. Delivery of switchboard on site without significant cable connection (Say 80%) shall not entitle progress payment certified for material delivery on site.

5.04 EARTHING

- A. Suitable earthing terminals or studs shall be provided on the frame for the connection of 25 mm x 3 mm copper strip to the main earthing bar in the switchroom.
- B. A main earthing bar of HDHC copper with cross-sectional area in compliance with BS 7671 and BS 7430 50 mm x 6 mm shall be provided in the switchroom and to which all earthing connections shall be made. This earthing bar shall run along the wall adjacent to the full length of the main switchboard. Two connections to main earthing system shall be provided.

5.05 PROVISION OF ELECTRICAL SERVICES AND EQUIPMENT TO MEET LOCAL AUTHORITIES' REQUIREMENT

- A. All other requirements by Local Authority that are imposed in the course of execution of the work, particularly those listed below shall be provided.
 - 1. Danger signs;
 - 2. Rubber floor mat of 6m thickness and 1 meter width provided for the full length of the switchboard;
 - 3. A dry chemical type fire extinguisher of 9 kg capacity with approved label;
 - 4. Framed single line diagram with minimum A1 size endorsed by Contractor's Qualified personnel;
 - 5. 'First-Aid' Demonstration sign;
 - 6. Sand for cable trenches after completion of all cable installation work, if applicable.

SECTION 07

POWER FACTOR CORRECTION EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide power factor correction equipment in accordance with the Contract Documents and drawings.

1.02 *STANDARDS*

- A. The installation shall comply with BS 60831 and Local Authority's regulation.

1.03 *SUBMITTALS*

- A. Manufacturer's product data sheets for Capacitor Banks, overcurrent protection devices, automatic power factor regulators, harmonic filters, etc.
- B. Dimensioned layout and elevation drawings showing the capacitor banks, housekeeping pads, and support locations and types.
- C. One line diagram showing capacitor ratings, overcurrent protection device ratings, cable lugs, metering displays, identification nameplate, and fuse clip sizes.
- D. Wiring diagrams.
- E. Installation instructions.
- F. Certified test reports.

1.04 *FIELD TESTING*

- A. Field inspection and testing shall occur after installation is complete, feeders are terminated, and the room is secure. Testing shall be conducted not more than 4 weeks before equipment is energized.
- B. Testing Scope:

1. Visual and physical inspection of equipment.
2. Check control wiring and metering.
3. Meter calibration.
4. System Grounding

C. Certified Test Reports:

1. Field testing shall be performed by an independent third party testing agency.
2. Verify that the installation is in accordance with the manufacturer's instructions.
3. Verify that the equipment has been fully type tested and is operational.
4. Perform testing and compile detailed test reports for each capacitor banks and overcurrent protection device.

PART 2 –PRODUCTS

2.01 POWER FACTOR CORRECTION / HARMONIC FILTERING EQUIPMENT

- A. Voltage: 400volts \pm 10% three phase, 50Hz
- B. Operating Temperature Limits: manufacture detail to operate at 100 percent rated voltage in ambient air temperature up to 50°C.
- C. Indicators: Include LED indicating light for each step of capacity.
- D. Basic Impulse Level: 30kV
- E. Integrated Equipment Short-Circuit Rating: 65,000 rms amperes symmetrical.
- F. Power Factor Sensing and Control: Utilize reactive current sensing and solid state electronic controller to automatically connect appropriate correction capacitors and detuned reactors to line through contactors. Include time delay to accommodate capacitor resistor discharge and prevent hunting.
- G. Contactors: electrically held, three-pole, 600-volt, general-purpose magnetic contactors sized in accordance with IEC Standard. Contacts shall be silver plated.
- H. Power Bus: tin-plated copper sized to handle rated current without abnormal temperature rise.
- I. Under voltage Relay: Controller shall incorporate an under voltage relay to interrupt control relays for power failures longer than 15 milliseconds.
- J. Fuses each individual capacitor branch circuit on the line side of the contactor. Fuses shall be current-limiting type with 100,000-ampere symmetrical interrupting capacity.
- K. Blown Fuse Indicator: Each capacitor and harmonic filter fuse circuit shall provide with a blown fuse indicator consisting of a fused neon lamp which illuminates without requiring removal of covers.

- L. Transient Suppressors: Each capacitor and harmonic filter branch circuit shall include a current-limiting air core inductor. The inductor shall be sized to limit the capacitor

in-rush current to a value equal to or less than the capacitor switching rating of the contactor.

- M. Blocking Reactor; a harmonic current suppression (Blocking Reactor – 7%) shall be provided for each step.
- N. Power Factor Meter: switchboard-type power factor meter with display range of 0.5 lagging accuracy, plus or minus 1 percent to 0.5 leading. Meter shall be located in the door of the controller enclosure.
- O. Current Transformer: Provide a current transformer with turn's ratio as required. Extend control conductors to controller.
- P. Dielectric Impregnant: non-PCB, non combustible liquid.
- Q. Enclosure: Complete with enclosure and located in switch room outside switchboard
- R. Construction: internally fused, replaceable capacitor cells factory assembled and bussed and together in protective enclosure; include internal discharge resistor.
- S. Cooling: naturally ventilated.
- T. Access: enclosure access through a removable capacitor door located on top of enclosure; access door shall be interlocked to de-energised contactor(s) when the door is opened.
- U. Finish: manufacturer's standard grey enamel

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Install in accordance with manufacturer's instructions.
- B. Locate capacitors and harmonic filters to allow adequate ventilation around enclosure.
- C. Provide disconnecting switch to remove capacitors and detuned reactors.

3.02 DEMONSTRATION

- A. Provide a factory trained field representative to instruct the Employer's personnel for a period of no less than 2 days in maintenance and operation of the equipment.

3.02 ***FIELD QUALITY CONTROL***

- A. Test the Capacitor Banks in accordance with the requirements of Start-up Testing and Commissions of Electrical Equipment.

SECTION 08

VARIABLE SPEED

DRIVES

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Comply with Division 1, General Requirements and all documents referred to therein.
- B. Provide all labour, materials, products, equipment and services to supply and install variable speed drives and motors, as indicated on the Drawings and specified in this Section of the Specifications.

1.02 *REFERENCESTANDARDS*

- A. Use only products which have been successfully used on other projects in similar mechanical applications and for which there is local parts and service.
- B. Provide variable speed drives from suppliers who have been established locally for at least five years.
- C. The manufacturer of variable speed drives should demonstrate a continuous period of manufacture and development for at least 10 years. VSD manufacturer shall have local representatives in UAE to provide technical supports, stocking of spare parts, etc.

1.03 *RELATED WORK*

- A. For motors connected to variable speed drives, refer to requirements of Section 23.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Provide variable torque variable speed drives capable of driving a standard AC induction motor.

- B. Provide variable speed drives as shown in the equipment schedules on the Drawings.
- C. The variable speed drive shall not be a general purpose product. It must be a dedicated mechanical drive with pump and fan characteristics in program.

2.02 VARIABLE SPEEDDRIVES(VSD)

- A. Provide VSDs to convey utility power to an adjustable voltage and frequency, 3 phase

power for stepless motor speed. The VSD must be equipped with rectifiers in the input circuit which converts the incoming AC voltage to DC voltage. The DC voltage will be converted to AC voltage with insulated bipolar transistors (IGBTs) in the output circuit.

- B. Provide VSDs with Voltage Vector Control (VVC) output, all solid state. Nomotor derating is allowed. For pulse width modulated output, provide output LRC filters with 100 meters of output cable length.
- C. Provide IP54 (NEMA 4) enclosures for each variable speed drive for protection against dust, splashing water and moisture.
- D. Provide VSDs with built-in DC link filters to reduce harmonic distortion on the main supply. The 5th harmonic must be reduced to 35% or below in accordance with IEEE Standard 519-1992. No external reactors are allowed.
- E. Provide VSDs capable of accepting full 3 phase line voltage at the input terminals and capable of operating within rated input voltage of 400V/230V +/- 10% and 50Hz.
- F. Provide current limiting feature that will protect the electronics upon sensing excessive currents by shutting the drive down. Maximum motor current must be limited to 110% of rated motor current to prevent motor damage.
- G. Provide local or remote mode selection to enable remote speed control or local speed control, programmable in the VSD through manual pre-setting.
- H. Provide manual speed control through the full speed range located on the outside front display of the VSD.
- I. Provide VSDs with speed control input for 0 to 5 VDC, 0 to 20 VDC, 2 to 10 mA or 4 to 20 mA.
- J. Provide adjustments for maximum and minimum speeds, acceleration and deceleration times. Automatic adjustment of the ramp time, to prevent motor from tripping, must be incorporated in the VSD. In case of power loss, the VSD must go into an orderly, pre-programmed deceleration. Upon resumption of power, the VSD must go into an orderly, pre-programmed automatic restart sequence and provide for motor soft start.
- K. Provide VSDs rated to operate at maximum loads in ambient temperatures of 10 deg. C to 48 deg. C and ambient humidity range of 20 to 100% RH.
- L. VSDs shall suppress all electrical and radio interference. Ensure that interference, caused by switching, commutation, or pulse generation, does not affect sound, communication, video, radio or telephone systems, or any other control equipment in or adjacent to building. Keep external electrical and magnetic fields of VSD to

minimum level that will not cause interaction with microphones, magnetic device replay heads, audio or radio frequency loops, computers or any other apparatus likely to be used in vicinity. Ensure that VSD is protected from unexpected service failure or normal levels of service-borne interference caused by others. The VSD shall comply with FCC Part 15, Class A.

- M. Provide short circuit protection for the VSD. The VSD must not be damaged if a short circuit at the output phase to phase or phase to ground occurs. The VSD must be protected against transients on the mains.
- N. Provide VSDs with a minimum line side power factor of 0.95 over the entire speed range.
- O. Provide VSDs with built-in as standard, galvanic isolation to protect connected PLCs or BAS/BMS against damage.
- P. Provide VSDs that model the motor in its software to predict motor overheating without the use of thermistors in the motor. If overheat is predicted, an alarm or automatic shutdown shall be initiated.
- Q. Provide VSDs that incorporate a run permissive function, which will export a "run permissive standby" signal to a digital output, when a start signal is applied to the VSD.
- R. Provide VSDs which can catch a rotating motor operating forward or reverse up to full speed without requiring fan or pump motor to stop and prevent nuisance tripping.
- S. In case of AC mains failure and voltage drops, the VSD must be able to reset automatically when the voltage normalizes.
- T. Provide VSDs with built-in PID controller to maintain constant pressure or flow for closed loop control or remote position. Two setpoint PID process controller should be able to accept at least two sensor feedback with minimum, maximum, sum, difference, or average calculations. Response to the setpoint/feedback differences must be programmable in process units.
- U. Provide VSDs with Automatic Motor Adaptation (AMA) to optimise motor performance, improve start capabilities and compensate for motor cable variances. AMA should be carried out at motor standstill with no need for detaching the load from the motor.
- V. Provide VSDs with automatic energy optimisation feature to reduce voltages when the motor is lightly loaded and minimise the motor's energy consumption. The remote position, a sleep mode should be carried out when the motor's load is minimal and the motor should automatically restart when the theoretical output frequency exceeds the pre-set minimum value.

- W. If one of the input phases is missing or if there is critically high mains imbalance, the VSD must be able to reduce the output power to maintain operation at reduced speed.
- X. Provide VSDs with display on the front to indicate status for power, running or fault including operating speed indication, in percentage of full speed. Provision for logging and display of the total energy consumption in KWH must be available.
- Y. In case of alarm or warning, a clear message must be indicated with clear alphanumeric text on the display of the VSD.
- Z. Provide VSDs with open protocol serial communication capability with the BMS through the use of RS-485 or RS-232 port. Provide the necessary hardware and software for this communication. Liaise with BMS installation to ensure full communication including run/stop control, speed set adjustment, drive status, warning/fault status and diagnostics and drive by pass status at a minimum.

2.03 ***SEQUENCE OF OPERATION***

- A. With the Local/Remote mode selection in the Local position, power shall be applied to the VSD to provide a soft motor start and acceleration to the speed set on the manual control.
- B. With the Local/Remote mode selection in the Remote position, stop and start of the VSD will be controlled by the BMS or sensors sending a corresponding feedback signal wired to the appropriate VSD terminal. Drive speed will be controlled by the speed control input signal.

PART 3 – EXECUTION

3.01 **INSTALLATION**

- A. Meet manufacturer's installation instructions.
- B. Provide a disconnect switch at the motor where required by the authorities having jurisdiction. Where such a switch is installed, provide an auxiliary contact or switch at the disconnect, mounted to open when the disconnect switch is opened and wired to the VSD terminal such that opening the disconnect switch initiates a drive shut down and prevents the drive from starting in either Line or Drives positions.
- C. Locate and mount VSD panels in Mechanical Rooms or where shown on the Drawings.
- D. Arrange for the manufacturer's technical representative or local representative, if qualified, to inspect the installation of each drive and to commission operation with

startup and testing procedures. Arrange for the controls Contractors to provide coordination of control sequences for start up and testing.

SECTION 09

MOTORS, STARTERS AND WIRING

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Comply with Division 1, General Requirements and all documents referred to therein.
- B. Provide all labour, materials, products, equipment and services to supply and install the motors, starters, control centres and wiring indicated on the Drawings and specified in this Section of the Contract.

PART 2 - PRODUCTS

2.01 MOTORS

- A. Provide motors, except where noted, with the following characteristics:
 - 1. Under 1.0 kW - single phase, 230V \pm 10% , 50Hz \pm 0.5% 2.
 - 1.0 kW and over - 3 phase, 400V \pm 10%, 50Hz \pm 0.5%
- B. All motors shall be squirrel cage induction type conforming to either IEC 34-1 and IEC 85 or BS 5000 and BS 2757 or NEMA Design B with minimum Class F insulation.
- C. All varnishes and impregnate used shall be inorganic and suitable for tropical service.
- D. Bearing shall be so selected for its duty and shall be housed in dust tight enclosure with efficient shaft seals to prevent dust ingress and escape of grease, and be equipped with grease nipple and relief plugs. Motor bearing shall have an L10 design life fat least 200,000 hour.
- E. Terminal boxes shall be of hot-dip galvanised cast iron and be provided with glands to accept conduit. Terminal blocks shall be of high quality insulating materials and be capable to support incoming cables.
- F. All motors shall be so selected to have at least 115% of the power rating above the design duty point. It shall also operate with power factor of not less than 0.85 at full load, otherwise, power factor correction capacitors shall be provided.
- G. High efficiency motors shall be compatible with standard motor frames.

- H. All motors unless specified differently, shall be T-frame, A.C. Three Phase and equal to Motor Efficiency Level as tested to the most recent issue of IEEE standard.

- I. The minimum requirement for 3 phase motors shall be Class F insulated, and suitable to operate at maximum 55 deg C ambient.
- J. Select motors for quiet continuous operation to suit loads imposed by equipment. Recognize that motor horsepower specified and scheduled are minimum sizes. Include extra costs for larger motors, starters, power wiring and additional control wiring if larger motors are required for alternative equipment accepted as part of the Contract Price.
- K. Provide motor enclosures as follows:
 - 1. Open drip proof to minimum IP54, 1.15 service factor for motors protected from the weather and moisture environment to operate satisfactorily at maximum temperature and moisture levels of surrounding air for motors located in air streams.
 - 2. Totally enclosed to minimum IP65 fan cooled 1.15 service factor for motors in all other locations, including cooling towers.
 - 3. Provide explosion proof motors where scheduled.
 - 4. All motors installed outdoor shall be provided with sunshade to avoid temperature rise.
- L. Equipment motors 18 kW and larger, as well as those smaller but with longer than 10 second starting time, with inherent overheat protection, consisting of thermistors, one for each phase, embedded in the stator windings. Extend wires out to motor terminal box, ready for field wiring into the starter holding coil circuit. Provide manual reset tripping device compatible with starter.
- M. Provide motors to operate with variable speed drives supplied according to Section 24 and to meet the following:
 - 1. Rated for VSD duty
 - 2. Be operable from a pulse width modulated (PWM) waveform and shall not saturate while operating at up to 110% of the nameplate voltage.
 - 3. Cast frame construction
 - 4. Must be capable of running at 10% full rated speed with the VSD output provided by the drives supplied under Section 24.
 - 5. Provided with thermal sensors imbedded in the windings with connections extended to the motor terminal box. For motor sizes up to and including 18.6 kW, the thermal sensors may be thermistors. For larger sizes, provide RTDs (Resistive

Temperature Device). Embed sensors in that part of the windings which is in the iron for response to both copper and iron temperature.

- N. Two speed motors shall be, single winding, variable torque high and low speed. Provide starter to suit motor requirements.
- O. All motor used in smoke control, staircase/protected lobby pressurisation, kitchen exhaust, basement carpark, and basement loading/unloading ventilation systems shall have class H insulation and shall be able to operate at a temperature of 300°C continuously for at least 1 hour.
- P. All motors shall be provided with name plates showing all the technical data, such as: model Number, electrical characteristic, weight, etc.

2.02 *STARTERS, CONTACTORS AND MOTOR CONTROL*

- A. Starters and contactors factory built into the control panel of packaged equipment will be considered as an integral part of the package and may be from a different manufacturer.
- B. Magnetic Motor Starters
 - 1. Magnetic Motor Starters shall be for general purpose, Class A and for induction motors rated in horsepower.
 - 2. Self contained unit in a NEMA 1 gasketed enclosure (NEMA 3R where installed outdoors), externally operable from the front.
 - 3. Provide full voltage non-reversing (FVNR) type combination magnetic starters for motors of up to 7 kW.
 - 4. Unless shown on the Drawings, provide reduced voltage, non reversing, Wye- delta type combination magnetic starters for motors 7.5 kW up to 70 kW.
 - a. Adjustable timing relay for start to run transfer timing.
 - b. Closed transition from reduced to full voltage.
 - 5. Unless shown on the Drawings, provide reduced voltage, non reversing, auto-transformer type, combination starters for motors above 70 kW.
 - a. Two winding, open delta connected.
 - b. Adjustable timing relay for start to run transfer timing.
 - c. Closed transition from reduced to full voltage.
 - d. Field adjustable auto transformers taps, 50%, 65%, and 80%, factory set at 80%.
 - 6. Provide an individual control power transformer with two primary and one secondary control fuses for each motor controller. The other secondary lead shall be

7. Provide each motor controller with three phase, ambient temperature compensating, thermal overload relays with heaters. Overload relays shall be adjustable from 90% to 110% of heater rating, factory set at 100%. Provide an insulated pushbutton on the outside of door to reset overload relays.
8. Provide each motor controller with a Hand-Off-Automatic (HOA) selector switch. Provide a Hand-Automatic (HA) selector switch for life safety equipment. Mount switch on outside of door.
9. Provide each motor controller with 2 normally open and 2 normally closed auxiliary contacts long life (50,000 hours) pilot indicators on outside of door, auxiliary relays, and other devices required for operation of the equipment to be controlled.
10. Provide transformer type indicating lights in from cover (Lens colour(s) red-stop, green run) and push to test type indicating lights.

2.03 *MOTOR CONTROL CENTRES*

- A. Refer to Section 10 for motor control centres.

PART 3 - EXECUTION

3.01 *INSTALLATION AND WIRING*

- A. Provide all power wiring from load side of starters and contactors.
- B. Sizing for starters and wiring shall meet requirements of the Electrical Code.
- C. Provide control wiring for all equipment provided or supplied.
- D. Provide control wiring between kitchen exhaust hood control box and exhaust fan starter.
- E. Connections to motors shall be made in flexible seal tight conduit, and with sufficient material to reduce vibration transmission and to allow full travel of motor for belt adjustment.
- F. Install wiring materials parallel to or perpendicular to building planes.
- G. Power wiring and control wiring connected to life safety equipment shall utilize fire rated

cable.

3.02 ***WARNING NOTICES***

- A. Place warning notices at each starter and on or close to each motor under BMS control.
- B. Provide conspicuous notices with bold lettering and advising that the motor is under BMS control and may start at any time without warning. Submit notices at the shop drawing stage for Engineer's review.

SECTION 10

MOTOR CONTROL

CENTRE

PART 1 - GENERAL

1.01 WORK DESCRIPTION

- A. The Motor Control Centre and control panels shall be built in accordance with IEC 439 "Factory Built Assemblies for Low Voltage" or BS 5486 "Factory-built Assemblies of Switchgear and Control Gear for Voltage up to and including 1000 AC and 1200V DC.
- B. Motor Control Centre shall be of type manufacture conforming to tests conducted by ASTA or other recognized testing authority. Type test certificates obtained from the testing authority together with the construction details of the Motor Control Centre on which the approval was obtained shall be submitted at the time of technical submission.
- C. All factory built assemblies shall be capable of withstanding the electrical, mechanical and thermal stresses of the prospective fault level experience.
- D. All equipment used in the factory built assemblies shall have been type tested. Type test certificates shall be submitted for all major equipment at the time of technical submission.
- E. All factory built assemblies, as a complete unit shall have a rating equal to or greater than the integrated equipment rating as indicated in the Drawing.
- F. All factory built assemblies subject to rain or wet conditions or located outside electrical room shall be weatherproof constructed to IP 65, able to withstand high impact strength of 60 KN/m² (min), temperature resistant with consideration of Ambient temp 50°C and average switch room temperature 35°C, flame retardant and corrosion resistant.

1.02 STANDARDS

- A. The Motor Control Centre and Control Panels shall be manufactured and constructed in accordance with the latest revision of the following standards:

- 1. BS 88 : Cartridge fuses for voltages up to and including 1000V AC and 1500V DC.
- 2. BS 89 : Direct acting electrical indicating analogue electrical

measuring instruments and their accessories.

- 3. BS 142 : Electrical protective relays
- 4. BS 159 : Busbars and busbar connection
- 5. BS 1433 : Copper for electrical purposes. Rods and bars.

- | | | | |
|-----|---------------|---|--|
| 6. | BS EN 60898 | : | Circuit-breakers for over current protection for household and similar installations. |
| 7. | BS 3938 | : | Current transformers |
| 8. | BS EN 60947-2 | : | Low-voltage switchgear and controlgear, Part 2 circuit-breakers. |
| 9. | BS 4794 | : | Control switches (switching devices, Part 1 including contactor relays, for control and auxiliary circuits, for voltages up to and including 1000V AC and 1200V DC). General requirements. |
| 10. | BS 5419 | : | Air-break switches, air-break disconnectors, and fuse combination units for voltages up to and including 1000V AC and 1200V DC. |
| 11. | BS 5420 | : | Degrees of protection of enclosures of switch Part I great Part I and controlgear for voltages up to and including 1000V AC and 1200V DC. |
| 12. | BS 5424 | : | Controlgear for voltages up to and including 1000V AC and 1200V DC – Part 1 Contactors. |
| 13. | BS 5486 | : | Low-voltage switchgear and control gear Part 1 assemblies. Part I : Requirement for type tested and partially type tested assemblies. |
| 14. | BS 5685 | : | Electricity meters – Part I : Class 0.5, 1 and 2 single phase and polyphase, single-rate and multi-rate watt- hour meters. |
| 15. | BS 5992 | : | Electrical relays |
| 16. | BS 6004 | : | PVC insulated cables, (non-armoured), for electric power and lighting. |
| 17. | BS 6231 | : | PVC insulated cables for switchgear and controlgear wiring. |
| 18. | BS 7430 | : | Earthing |

- B. BS/IEC or other National standards not mentioned above but are applicable to this installation shall also apply.

1.03 ***SUBMISSION***

- A. Please refer to submittal requirement in Division 1 of the Contract.
- B. A component list and catalogues.
- C. Detailed construction drawings of all factory built assemblies shall be submitted for approval before construction commences.

- D. Such drawings shall show the proposed method of construction of the cubicles, method of supporting equipment and busbars, full details of busbar layout, method of support, electrical control wiring diagrams, equipment weight, colours, surface treatment.

- E. The drawings shall also incorporate a full list of proposed materials. The construction shall not commence until the drawings are approved for construction.
- F. Factory and site testing procedures and report formats shall also be included.

PART 2 –PRODUCTS

2.01 GENERAL

- A. The factory built assemblies shall be of the totally enclosed, modular cubicle type, which are extensible and suitable for floor mounting as indicated in the drawings.
- B. The factory built assemblies shall be compartmented and utilise sheet steel plates of thickness as detailed below. The panels shall be vermin proof and constructed to a minimum degree of protection of IP ratings to BS 5420. The IP ratings indicated below shall be applicable unless otherwise indicated in the drawing.
- C. Motor Control Centre
 - 1. 2mm thick sheet steel
 - 2. Form 3b for Motor Control Centre unless otherwise specified to BS 5486 with separation of busbars from the functional units and separation of all functional units from one another
 - 3. Minimum IP 54 unless otherwise specified.
 - 4. IP65 for location subject to rain wet conditions or located outside electrical room.
 - 5. Motor Control Centre frame shall be of modular detail and extensible.
 - 6. The interior of each cubicle shall be dust inert and vermin resistant.
- D. Motor Control Centre frames shall be fabrication of 2.0mm thick electro-galvanised steel. All joints shall be neatly formed and finished flush with the adjacent surfaces by grinding and/or machining. No joints shall be located on a corner and all bare edges shall be lipped.
- E. Structural members and bracing, where necessary, shall be welded or bolted to the frame.

2.02 *DOORS ANDPANELS*

- A. Full access shall be provided to service and maintain all equipment inside each cubicle by means of a suitable hinged door that shall open a minimum of 120 degrees. All hinged doors shall have an earth braid connected to the cubicle.
- B. Doors and panels shall be constructed of 2 mm electro-galvanised sheet steel, pressed or rolled so that edges are given a neat round finish and shall reinforced with a suitable frame welded to the inside folded edge of the door. An approved stiffener shall be welded to

the inside of each door and/or panel.

- C. Doors shall hang on substantially concealed non-corrosive hinges and shall be fitted with good quality door handles to Engineer's approval which shall be lockable and operable by the same key. The door handles shall be fitted with toggles to operate rods to latch with suitable slots in both the top and bottom of the Motor Control Centre. Latching rods shall be guided by brackets. The latching rods and associated brackets shall be cadmium plated.
- D. All front, side and top panels shall be constructed in a manner similar to that specified for doors above. They shall be fitted to the frame from the outside with captive, hand tightened screw. Panels longer than 1.2 metres shall be provided with 3 point locking system

2.03 BASEPLATE AND INSULATING PANELS

- A. The Motor Control Centre shall be mounted on 50mm X 50mm C-channel. Wherever insulating panels are required to mount special equipment, they shall be of high quality black bakelite, polished on the front.
- B. All edges must be cut straight and square and shall be chamfered on the front edge with a 3mm chamfer.

2.04 FINISHING OF METAL WORK

- A. Panel work of the Motor Control Centre shall be finished with electrostatic epoxy power coating of minimum 50 microns all treat with 180°C 12 minute oven baking. All metal work shall be rust inhibited and sprayed with two coats of primer. The painting shall be of best quality oven-bake epoxy power coated of Grey colour.
- B. After erection on site and after all inspection and tests have been carried out, the Contractor shall thoroughly clean all painted parts, touch-up with application of an additional coat of anti-corrosive structural priming paint to any part of the originally painted surfaces that have been scratched or otherwise marked and at least one additional touch-up finishing coat of Grey colour.

2.05 BUSBARS AND CURRENT CARRYING PARTS

- A. The manufacture of the busbar system shall comply to the latest edition of BS 158 and BS 159. All busbars and current carrying parts shall be manufactured to carry a current density of not more than 1.55 A/mm² and shall be capable of carrying normal current continuously without the temperature rise of any part exceeding 30°C. Their location shall be such as to ensure adequate spacing between conductors and they shall be securely fastened and braced to withstand all stress set up during transportation, erection and normal operation, and under short circuit conditions. The busbars shall not be damaged in any way under a fault of short circuit experience with minimum 35 MVA for 3 seconds. Where two or more conductors are used to form a phase, it shall be separated with an air gap sufficient to allow for the ventilation of the individual conductors all round. Busbar supports shall be made of slotted first grade "Bakelite"

or glass fibre reinforced polymer able to withstand minimum operating temperature of 110°C.

- B. All connections in current carrying parts shall be made by means of bolts with lock nuts. The use of tapped holes and studs or any other alternative method of connection in current carrying parts shall not be employed without the express approval of the Engineer prior to manufacture.
- C. Busbars shall be provided with approved shrinkable tube of appropriate phase colour to indicate phases.
- D. All connections, tapping and clamping shall be made in an approved manner to ensure minimum contact resistance. All connections in the busbars shall be firmly bolted and clamped with even tension. Before assembly, all busbar joint surfaces shall be filed or finished to remove burrs, dents and oxides and silvered to maintain good continuity at all joints.
- E. All intermediate conducting material shall be used when there is a possibility of electrolytic action when contact of the copper busbars with dissimilar metals are made.
- F. An earth bar minimum size comply with BS7671 and BS7430 with minimum 50mm x 6mm to each vertical section of the cubicle units and shall run the full length at the bottom of each Motor Control Centre. All metal parts of the Motor Control Centre and associated equipment shall be bonded and connected to this earth bar. Minimum 2 connections to main earthing system shall be provided.
- G. The neutral busbar shall be the same size of that of the phase bars and shall be provided with an adequate number of terminals including cable lugs, bolts, etc. to suit the installation.
- H. For circuits not less than 200A, busbar drops to moulded case circuit breakers or other apparatus shall be made of circular or rectangular busbar covered with Nylex tubing of appropriate colour and terminated in adequately sized concentric lug, of lug type, cone grip cable sockets or approved equal. Cables may be used for circuits less than 200A to type test configuration.
- I. All visible rectangular busbars shall be bare tinned type size 1.55A/mm² based on current density.
- J. All screws, bolts, washers used for the busbars shall be cadmium plated. All contact parts of the busbars and connections shall be sanded and coated with a thin coat of chemical inert petroleum jelly. All bolts shall be tightened with an even tension. Approved spring washers shall be used at all joints complete with cadmium plated high tensile steel bolts.
- K. All busbars and switchgear terminals to which outgoing or incoming cables are terminated shall be manufactured for a maximum temperature of 30°C above ambient.

2.06 INSULATION

- A. The clearances and insulation shall be such as to withstand the standard 3 kV dielectric tests on the Motor Control Centre.
- B. All insulation used shall be of the best quality and sufficiently strong to withstand all stresses which may be imposed on it in the ordinary erection and operation of the Motor Control Centre.
- C. Where insulators are cemented or jointed to metal parts, such jointing shall be of such a nature that no dangerous stresses are set up in the insulators by the unequal expansion or contraction of the insulation and the metal through the range of temperatures stated in Clauses above.

2.07 CABLE OR BUSDUCT ENTRIES

- A. Provision shall be made within the factory built assemblies for the proper support and bracing of outgoing and incoming cables or busducts.
- B. Weatherproof cable glands and all necessary non-ferrous gland plates, etc. shall be provided for all cables entering or leaving the Motor Control Centre. Cable terminating end boxes shall be mounted from top of the switchgear in the cubicles. Cable supports shall be provided below the termination boxes.
- C. Busduct entries to the Motor Control Centre shall be liaised with busduct vendor for the exact position and phasing.
- D. Detail of cable or busduct in and out of the Motor Control Centre shall take into the IP rating requirement as specified for the Motor Control Centre.

2.08 PHASING

- A. Phase rotation shall be strictly maintained throughout the project, and shall comply with the requirements of BS 258. Phase distinguishing colours shall be RED, YELLOW and BLUE.

2.09 LABELS

- A. All factory built assemblies and equipment shall be clearly labelled in accordance with regulations and to indicate its functions by means of engraved 'Traffolite' labels. Plastic labels are not acceptable. Engraved lettering not less than 20mm high or as otherwise required and approved.
- B. Labels shall be attached by means of chrome finished countersunk screws and nuts.

- C. Prior to engraving the labels, a label schedule shall be submitted for approval. Cost for two sets of labels shall be included in the Contract to cater for any amendment to the label as directed by the Engineer.

2.10 ***SPECIFICATION FOR SPARES***

- A. The Motor Control Centre shall incorporate a rack for mounting spares, moulded case circuit breakers and a minimum of 25 percent space capacities shall be provided for future installation of circuit breakers.
- B. End covers and pre-drilled holes at main busbars shall be manufactured for future extension of the Motor Control Centre at both ends.
- C. Spare shall be provided according to Section 1.

2.11 ***BASE SUPPORTS***

- A. The base support shall be fabricated from 50mm x 50mm C-channel base sufficiently stiffened to adequately support the Motor Control Centre. The base shall be hot dip galvanised after fabrication. The base may be made as part of the Motor Control Centre.

2.12 ***VENTILATION***

- A. All Motor Control Centre shall be properly natural ventilated.
- B. Vents shall be provided with the consideration of IP rating as specified.
- C. Detailed calculation shall be submitted to verify the total heat from the switchgear and Motor Control Centre and the amount of vents and ventilation fans size.

2.13 ***INDICATING INSTRUMENTS***

- A. Indicating instruments shall comply with BS 89. Meters for external panel mounting shall be of the flush pattern type with square escutcheon plate's finished matt black and polycarbonate cases.
- B. The Motor Control Centres shall be provided with High performance and high accuracy power meter with LCD display that capable of indicating real-time readings, demand reading, energy readings, set up and resets menus, monitoring functions as well as high level communication via RS-485/Modbus shall be installed for the Motor Control Centre. Power meter shall be provided for the circuits above 100A or as specified on the drawings.

- C. The reading shall include but not limit to current (per phase, neutral and earth), voltage (L-L, L-N), real power, reactive power, apparent power, power factor, frequency, energy, power quality readings such as voltage and current THD, demand,

date/time stamping, on-board memory for alarms/relay functions such as under/over conditions, phase unbalance conditions, data log, event log, etc.

- D. The meter power shall accept inputs from standard 5A current transformers and has full-scale input of 10A. The voltage inputs shall be directly connected to 3 phase circuits of 600V and below without the need for Potential or current transformer. All reading shall be scaled to their actual values without the need for a multiplier.
- E. The power meter set up and resets shall be password protected and easily done via the meter display or via network software.
- F. The power meter shall be able to support RS 485 communication for interfacing with the building management system.
- G. In addition, unless otherwise specified, following analogue indicating instrument shall be installed for sub-bard and distribution boards above 100A incoming or as specified on the drawings.
- H. Ammeter and voltmeters shall be of moving iron coil spring controlled type with 96mm square dials, accuracy Class 1.5 with external zero adjustment screw that is accessible from the front.
- I. Ammeters shall be selected such that full load current indications are not less than the two thirds of linear scale of the meter and have a suppressed upper scale.
- J. Ammeters shall be capable of taking overloads of 2 times continuously and voltmeter 1.2 times continuously.
- K. Ammeters at the main incoming feeders shall in addition to the moving iron mechanism be provided with thermal bimetal indicators with draw pointers to record maximum demands. The mechanism shall not respond to short current peaks and shall be manually resettable.
- L. Frequency indicators shall be of the vibrating reed type. The meter shall be capable of proper operation for voltage variation of $\pm 20\%$ rated voltage.
- M. Power factor meters shall be of the electro-dynamics crossed coil mechanism suitable for balance load, three phase four-wire system. The accuracy class shall be 1.5 and range 0.5 lag to 0.5 lead.
- N. Monitoring Kilowatt-Hour Meters and current transformers where specified shall be provided. The kilowatt-hour meter shall have a digital display reading up to 100 million Kilowatt-Hours and to the nearest 100 KW-Hr. The overall accuracy shall be better than $\pm 2.0\%$.

- O. The KWh meters shall be of flush mounting, rear connection type, current transformer operated and suitable for three phase balanced and unbalanced loads. The meter shall

be complete with the three metering elements and shall have a cyclometer register with six rollers.

- P. Instrument dials shall be white with black markings, and scales shall be of such material that ageing, peeling or discoloration will not take place under tropical conditions.
- Q. All instruments, when mounted on the Motor Control Centre, wired and ready for service, shall be in good order and condition in every way. The measuring elements shall be completely free from any discernible stickiness either at zero or upscale, and they shall be capable of attaining the performance guaranteed by the manufacturers of the respective instruments.
- R. All terminals shall be completely insulated and potential circuits shall be suitable fused.

2.14 ***SELECTOR SWITCHES***

- A. The switches shall be of the panel mounting type with totally enclosed contacts and stud connection. Ammeter selector switches shall have make before break contacts to ensure that the current transformers are never open circuited.
- B. The ammeter selector switch shall be suitable for measuring the current in each phase independently.
- C. The voltmeter selector switcher shall be 7-way type. Voltmeter selector switches shall have break before make contacts.

2.15 ***CURRENT TRANSFORMERS***

- A. Current transformers necessary for the operation of instruments and meters shall comply with BS 3938 and be of the 'straight through' epoxy-resin type. Measuring current transformer shall be of accuracy class 1 and for metering of accuracy Class 0.2 for energy metering.
- B. They shall be adequately rated in V.A. to carry the summation of all V.A. burdens of connected loads, and shall be capable of carrying current of the corresponding circuit breakers and fuses. The output secondary current shall be 5 amperes.
- C. They shall be capable of operation, without damage, with open circuited secondary and full load current flowing in the primary.
- D. Current transformers shall be adequately supported and installed as to permit easy access and to be readily replaceable, if necessary, without dismantling of adjacent equipment.
- E. All current transformers shall be provided with an identifying label giving type, ratio, class,

- F. Current transformers provided for protective gear purposes shall have overcurrent and accuracy limit factors not less than those corresponding to the short circuit level of the system. The output of each current transformer shall be not less than that specified and the capacity of the current transformers provided shall be adequate for operation of the associated protective devices and instruments. Where double ratio secondary windings are specified, a label shall be provided at the secondary terminals of the current transformer indicating clearly the connection required for either ratio. These connections and the ratio in use shall be shown on the appropriate schematic and connection diagrams. Protection current transformer shall be of a accuracy Class 5P 10 and the burden in no case shall be less than 15VA.
- G. Magnetisation curves shall be submitted at the time of shop drawing submission.

2.16 ***CONTACTORS***

- A. Contactors shall be fully tropicalised and robust detail and shall comply with relevant parts of BS 5424 and be rated for the following duties.
- B. Contactors for voltages up to and including 1000 volts A.C. and 1200 volts D.C. (BS 5424 Part 1).
 - 1. Rated duty - Uninterrupted
 - 2. Mechanical duty - Class I
 - 3. Making and Breaking Category - AC4
- C. Contactors shall be selected to suit the load such that a minimum electrical life of one million operations is ensured. The mechanical life shall be at least 5 million operations.
- D. Contactors shall have at least 15 times making capacity and 10 times breaking capacity for contactors less than 100 amps and 10 times and 8 times respectively for contactors above 100 amps. The selection of contactors shall be coordinated with the prospective fault levels suitable at that point of installation.
- E. Contactors shall generally be suitable for rail mounting and be of modular detail. The coil shall be suitable for +10% and –15% of nominal main voltage. Provision shall be made on the contactors for affixing of termination and contactor identification labels.
- F. Contactors shall be provided in sheet steel enclosure of a tropical finish and vermin proof. Adequate ventilation shall be accordance with BS 5424, category IP 42 for indoor service and IP 65 for outdoor service.
- G. The contactor shall be located within the enclosure so that upon making or opening of the contactor under normal or fault conditions, damage will not be caused to other equipment

and wiring within the enclosure.

- H. An isolating switch shall be provided for each contactor circuit except that if there is more than one contactor and they are grouped together, one incoming supply isolating switch shall be provided to isolate all contactor circuits. A mechanical interlocking device between the isolating switch and panel cover shall be provided to prevent access to live parts within the panel when the isolating switch is in the "ON" position.
- I. Contactors equipped with both local and remote control shall have local/remote changeover switches capable of being locked by padlock in the either position.
- J. Contractor shall be provided with spares auxiliary (2NO. + 2NC) in addition to other required auxiliary contacts specified in the Contract.

PART 3 –RELAYS

3.01 CONTROL RELAYS

- A. All control and indication relays shall be of the heavy-duty pattern fully tropicalised type.
- B. Relays shall be grouped conveniently in dust proof cases with removable covers given access for adjustment, cleaning, etc., without dismantling the relay.

3.02 PROTECTION RELAYS

- A. Protection relays shall be approved types complying with BS 142 or equal and shall have approved characteristics and be flush mounted in dust proof cases. Relay cases shall generally be finished in black enamel.
- B. Relays shall be of construction detail arranged so that adjustments, testing and replacements can be effected with the minimum of time and labour. Relays of the hand reset type shall be capable of being reset without opening the case.
- C. Relay contacts shall make firmly without bounce and the whole of the relay mechanisms shall be as far as possible unaffected by vibration or external magnetic fields.
- D. Relays, where appropriate shall be provided with flag indicators of approved type, phase coloured where applicable. Flag indicators shall be of the hand-reset pattern and shall be capable of being reset without opening the case. Where two or more phase elements are included in one case separate indicator shall be provided for each element.
- E. Relays with provision for manual operation from outside the case, other than resetting will not be accepted, and time delay relays shall not be of the dashpot type.
- F. Relays shall be provided with clearly inscribed labels describing their application and rating

in addition to the general-purpose labels.

- G. Approved means shall be provided on the relay panels for the testing of protective relays and associated circuits. Withdrawable type cases and plug-in type test facilities being preferred.
- H. Full discrimination relay curves indicate relay setting shall be co-ordinate by the Contractor and submit for approval. The submission shall cover both O/C & E/F protection up to final circuit.

3.03 ***OVERCURRENT PROTECTION***

- A. Overcurrent protection shall be of the current transformers operated direct acting type. Where instantaneous trip is specified, the relay shall incorporate an electronic timer with adjustable time delay setting.
- B. Where IDMT characteristic is required the time/current characteristic shall comply with BS 142. IDMT type relay shall consist of an electromagnet with shading rings on the pole pieces driving an induction disc. Current setting shall be of a plug and bridging socket arrangement and time lag setting shall be by setting screw located above the time scale.
- C. Overload phase indicator shall be provided to show the phase overload condition.
- D. The range of current setting adjustment for phase faults shall be 50% to 200% of rated full load with tapping at 25% intervals and the time setting adjustment shall be 0 to 3 seconds at 10 times the normal operating current. The current/time characteristics of the relays shall be in accordance with the British Standard Curve and shall be provided during the technical submission.
- E. Both electromechanical and electronic type protective relays may be considered. Submission of full technical detail and approval shall be obtained prior to installation.

3.04 ***EARTH LEAKAGE PROTECTION***

- A. The earth leakage relays shall be of the instantaneous type with adjustable current settings from 5% to 40% in 5% steps.
- B. The operating coils and contacts shall be adequately rated to carry the necessary load. Operating indicator and reset facilities shall be provided.
- C. The relays shall house in dust proof sheet metal casings, provided with viewing glass.
- D. Both electromechanical and electronic type protective relays may be considered. Submission of full technical detail and approval shall be obtained prior to installation.

PART 4 – CONTROL CIRCUIT WIRING AND AUXILLARY

4.01 CONTROL CIRCUIT WIRING

- A. All wiring shall be arranged in a regular manner with bends set at 90 degree and securely held in position with suitable clips and where convenient shall be installed in the uprights and/or back-stays insulating bushes being used where necessary.
- B. Control wiring of the Motor Control Centre shall be carried out in PVC insulated of size not less than 1.5mm² and those for current measurement shall be minimum 2.5mm². All meter wiring shall be of similar colours to those of the respective busbars, etc., to which connections are made. The cable termination shall be made with cable lugs.
- C. No wires/cables shall be tee-off or jointed between terminal points.
- D. Wiring shall be carried out in such a manner as to make circuits and connections easily traceable. Cable marking ferrules or similar shall be used at each termination. Terminals shall be designated in an approved manner.
- E. All terminals shall be fitted with brass washers and securely fixed with lock nuts.
- F. Displacement Insulation push-in type termination for cable up to 2.5mm², tunnel type terminals shall be provided for cables up to and below 6mm². Cables larger than 6mm² shall be terminated with compression cable lugs or proprietary makes of termination approved by the Engineer.

4.02 *ANTI-CONDENSATION HEATERS*

- A. Anti-condensation heaters shall be fitted in each cubicle together with an ON/OFF isolating switch and adjustable thermostat suitable for electrical operation at 230 volts $\pm 10\%$ A.C. 50 Hz single phase of sufficient capacity to raise the internal ambient temperature by 5°C. The electrical apparatus so protected shall be manufactured so that the maximum permitted rise in temperature is not exceeded if the heaters are energised while the Motor Control Centre is in operation.
- B. As a general rule, the heaters shall be placed at the bottom of the cubicle.

4.03 *TERMINAL BOARDS*

- A. All terminal boards shall be mounted in accessible positions and, when in enclosed cubicles shall be inclined downwards towards the door. Spacing of adjacent terminal boards shall not be less than 100 mm and the bottom of each board shall not be less than 200 mm above the incoming cable gland plate. Separate studs shall be provided on

each terminalstrip forthecores of incoming and outgoing cables including allspare cores.

- B. Brass bolts and studs shall be of not less than 6 mm diameter size but stainless steel and bronze down to 4.5 mm diameter may be used provided that the current carrying capacity is adequate. All studs shall be provided with nuts, washers and lock nuts or lock washers. Pinch type terminations shall be provided. They shall have adequate current carrying capacity and shall be provided with locking devices. Insulated barriers shall be fitted between adjacent terminals.
- C. 400/230 volt and higher voltage circuit terminals shall be segregated from other terminals and shall be fitted with non-flammable transparent plastic covers to prevent contact with any live parts. They shall have warning labels with red lettering, mounted thereof in a conspicuous position.
- D. All connections shall be made at the front of the terminal boards and no live metal shall be exposed at the back.

4.04 ***FUSES AND DISCONNECTING LINKS***

- A. All fuse link and disconnecting link assemblies associated with electrical installation, instrument, protection and control circuits shall be of approved type and grouped as far as possible according to their functions. They shall be clearly labelled, both on the panels and the associated wiring diagrams.
- B. Fuse link and disconnecting link assemblies associated with tripping circuits shall preferably be mounted on the outside of control panels. All others shall be mounted internally.
- C. Carriers and base for flush links shall be black. Disconnecting link carriers and bases shall be white.
- D. All fuse links shall be High Rupturing Capacity (HRC) cartridge type and all fuse switches and the like shall be suitable for the accommodation of these fuses.
- E. Each cartridge shall incorporate a fuse element of appropriate current rating and fusing factor in order that adequate protection and discrimination is provided to the circuit.
- F. The high rupturing capacity (HRC) cartridge fuses of rating shown shall conform to BS 88 Part 2 Class Q1 with minimum breaking capacity of 80 KA. When fuses are used for motor protection they shall have Class R rating. Fuse bases and carriers shall be made of high-grade phenolic moulding.

4.05 ***PUSH BUTTON***

- A. All the push buttons shall be made of non-hygroscopic material, non-swelling and fitted to avoid any possibility of sticking. Unless otherwise specified, they shall be of the non-retaining type. All push buttons shall have minimum IP54 ingress protection rating.

- B. The contacts of all push buttons shall be of adequate strength and have a positive wiping action when in operation.

4.06 *INDICATING LAMPS AND FITTINGS*

- A. Indicating lamps fitted to the fascias of switch and instrument cubicles or panels shall be adequately ventilated.
- B. Lamps shall be easily removed and replaced from the front of the panel by manual means not requiring the use of extractors.
- C. The bezel of metal holding the lamp glass shall be easily removable from the body of the fitting so as to permit access to the lamp and lamp glass.
- D. The lamps shall be clear and shall fit into an accepted standard form of lamp holder. The rated lamp voltage shall be 10% in excess of the auxiliary supply voltage, AC230V and DC48V.
- E. The lamp glasses/lens shall be in the standard colours, red, yellow, blue and amber. The colour shall be in the glass/lens and not an applied coating and the different colored glasses/lens shall be interchangeable.
- F. Neon indicating lamps shall not be used with coloured lens.
- G. Unless otherwise indicated or agreed with the Engineer, all lamp colours shall conform to the following practice:
 - 1. Red - red phase;
 - 2. Yellow - yellow phase;
 - 3. Blue - blue phase;
 - 4. White - supply available.
 - 5. Green - start
 - 6. Red - stop
 - 7. Green - running
 - 8. Red - fault

4.07 *RADIO INTERFERENCE SUPPRESSION*

- A. All Plant and apparatus, including such items as contactors, starters, relays and the like where the normal operation is such that interruption of low frequency or direct current occur, shall be fitted with means of suppressing all interference frequencies caused.
- B. The standard of interference suppression shall be in accordance with the current edition of BS 800 incorporating all amendments but extended to include the frequency ranges 300 to

360 MHz and 1.000 to 3,400 MHz.

- C. Details of the equipment and methods to be used in quantitative assessment of the level of radio interference shall be as specified in BS727.
- D. For guidance in the installation of electrical equipment to meet the foregoing standards, reference shall be made to BS Code of Practice CP:1006 "General Aspects of Radio Interference Suppression: which deals with interference caused by electrical apparatus and installations.

4.08 *SURGE PROTECTION DEVICES*

- A. Surge Protection devices shall be provided according to specification section 18 whichever cable route from external or to external of the building.

PART 5 - EXECUTION

5.01 TESTING AND COMMISSIONING

- A. All Motor Control Centre shall be tested and certified by the Contractor that it is safe before supply is energised, and that all the equipment comply with the requirements of the Specification.
- B. Generally such tests in the factory and repeated at site are as follows:
 - 1. Insulation resistance tests;
 - 2. Earth continuity tests;
 - 3. Dielectric test – 3 kV DC for 1 minute;
 - 4. Check of clearance and creepage distances;
 - 5. Tests to prove correct operation of controls, interlocks, tripping and closing circuits, indications, etc.;
 - 6. Phasing tests;
 - 7. Operation of all protective gear circuits by primary injection and system fault tests to check sensitivity and stability;
 - 8. Test of accuracy of all measuring instruments;
 - 9. Test operation of alarm devices;
 - 10. Interfacing test with BMS;
 - 11. Checking if all internal cabling and function operation
 - 12. Above tests are minimum requirement and shall include all other tests required by the Engineer to verify compliance with the Specification.
- C. Triplicate sets of all principal test records and test certificates are to be supplied for all the tests carried out in accordance with the Specification to the Engineer for approval before dispatch from the Motor Control Centre factory.
- D. All costs, materials, equipment, labour, etc. necessary for the execution of the testing shall be included in this portion of work.

- E. The Contractor shall refer to Section 40 for other testing requirement.

5.2 TRANSPORTATION

- A. Motor Control Centre are not allow to be delivered to site until the electrical room or Motor Control Centre room is in a clean and acceptable condition with lockable doors.
- B. Motor Control Centre transported to site shall be fully covered with weatherproof covers and transportation eye bolts shall be provided for handling at site.
- C. Motor Control Centre which are poorly packed and result in signs of corrosion will be rejected.
- D. All necessary measures to cover and protect the Motor Control Centre at site shall be provided. Such measures shall include a complete PVC blanket over the whole Motor Control Centre or control panel.
- E. The Contractor shall refer to Section 40 for other testing requirement.

5.3 REJECTION OF MOTOR CONTROL CENTRE

- A. If any of the above tests fail to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site, the Engineer may reject the item or defective component thereof, whichever is considered necessary, and after adjustment or modification as directed by the Engineer, the Contractor shall submit that item for further inspection and/or test. In the event of the defective item being of such nature that the requirements of this Specification cannot be fulfilled by adjustment or modification, such item is to be replaced by the Contractor at his own expense, to the entire satisfaction of the Engineer.

5.4 EARTHING

- A. Suitable earthing terminals or studs shall be provided on the frame for the connection of 25 mm x 3 mm copper strip to the main earthing bar in the electrical room or Motor Control Centre Room.
- B. A main earthing bar of HDHC copper with cross-sectional area in compliance with BS7671 and BS7430 50 mm x 6 mm shall be provided in the electrical room or Motor Control Centre room and to which all earthing connections shall be made. This earthing bar shall run along the wall adjacent to the full length of the Motor Control Centre. Two connection to main earthing system shall be provided.

5.05 ***PROVISION OF ELECTRICAL SERVICES AND EQUIPMENT TO MEET LOCAL AUTHORITIES' REQUIREMENT***

- A. All other requirements by Local Authority that are imposed in the course of execution of

the work, particularly those listed below shall be provided.

1. Danger signs;
2. Rubber floor mat of 6m thickness and 1 metre width provided for the full length of the Motor Control Centre;
3. A dry chemical type fire extinguisher of 9 kg capacity with approved label;
4. Framed single line diagram with minimum A1 size endorsed by the Contractor.
5. 'First-Aid' Demonstration sign;
6. Sand for cable trenches after completion of all cable installation work, if applicable.

SECTION 11

LOW VOLTAGE WIRE AND CABLE

PART 1 - GENERAL

1.01 WORK DESCRIPTION

- A. This section specifies the supply and installation of LV power cables. Each type of cables specified shall have been certified by BASEC that it has been manufactured to the appropriate BS.
- B. The routing and the minimum rated current carrying capacity of the LV power cables shall be as indicated on the Drawings. The Contractor shall consider the manufacturer data and engineering the cable sizing to ensure it suit the conditions, viz grouping, ambient temperature etc., and for making any necessary adjustment to the Engineer's approval.
- C. The current carrying capacities and voltage drop of cables shall be in accordance with the latest edition of BS7671.
- D. All LV cables for normal power/control circuitries within buildings shall be copper conductor with XLPE insulated and PVC sheathed, denoted as XLPE/PVC cable or copper conductor with PVC insulated, denoted as PVC cable as specified.
- E. All LV cables for emergency power circuitries serving emergency lightings, Building Management System (BMS), Fire Protection System, Security Systems, emergency communication systems, and sump pump system and fire lifts etc. with back-up from standby generator sets or UPS systems or incoming and outgoing from the Emergency Main Switchboard shall be fire resistant cables as required.
- F. Cablings in service ducts, open trenches, direct-laid underground in soil shall be by means of armored cables. Non-armored cables shall be laid in conduits, trunkings or tray/ladder for mechanical protection.

1.02 STANDARDS

- A. Complete cabling shall be manufactured and constructed in accordance with the latest revision of the following standards and the appropriate BS/IEC :
 - 1. BS1442 - Galvanised mild steel wire for armouring cables
 - 2. BS4066 - Test on electric cables under fire conditions
 - 3. BS4109 - Copper for electrical purposes and insulated cables and flexible cords
 - 4. BS4579 - Performance of mechanical and compression joints in

electric
cable and wire connectors

5. BS5467 - Technical Specification for armoured cables with thermosetting insulation for electricity supply
 6. BS5468 - Technical Specification for XLPE insulation of electric cables
 7. BS6004 - Technical Specification for PVC insulated cables (non-armoured) for electric power and lighting
 8. BS6081 - Technical Specification for termination for mineral insulated cables
 9. BS6121 - Mechanical cable gland for elastomer and plastic insulated cables
 10. BS6141 - Technical Specification for insulated cables and flexible cords for use in high temperature zones
 11. BS6207 - Mineral-insulated cables
 12. BS6346 - Technical Specification for PVC insulated cables for electricity supply
 13. BS6387 - Technical Specification for performance requirements for cables required to maintain circuit integrity under fire conditions
 14. BS6425 - Test methods for gases evolved during combustion of electric cables
 15. BS6724 - Technical Specification for armoured cables for electricity supply having thermosetting insulation with low emission of smoke and corrosive gases when affected by fire
 16. BS6746 - PVC insulation and sheath of electric cables
 17. BS7211 - Specification for thermosetting insulated cable (non-armoured) for electric power and lighting with low emission of smoke and corrosive gases when affected by fire
- B. The manufacturing of the cable shall also conform to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in this Specification and Drawings, whichever is the more stringent and acceptable to the Engineer.
- C. In the adoption of standards and requirements, the Contractor shall take the following precedence:
1. Engineer's decision;
 2. Local codes of practice;
 3. Drawings;
 4. Specification;
 5. International standards and requirements.

1.03 SUBMISSION

- A. All technical submissions shall be approved by the Engineer prior to the respective stages of construction.

B. As a minimum requirement, the submission shall include the following:

1. Equipment submission with manufacturer's data
2. Sample submission
3. Shop Drawings of the cable routings showing the co-ordinated routing of cables, arrangement on cable trays, methods of fixing of cable trays and cables, etc. All conduits including concealed conduit routing drawings shall also be included
4. Cable test reports and BASEC Certification
5. Builder's works requirement
6. Cable schedule indicate the following data include:
 - a. Cable code and type and installation method
 - b. Cable feed from and serve to
 - c. Cable route length and voltage drop
 - d. Cable capacity and
 - e. Upstream protection breaker ratingThe cable schedule shall be prepared in accordance with the cable manufacturer's data.

PART 2 –PRODUCT

2.01 LV CABLES

A. PVC Cables

1. PVC cables shall be of 450/750V grade complying with BS 6004, copper core and PVC insulated.
2. Conductors shall be plain annealed copper conductors complying with BS 6360.
3. PVC cables shall only be used for final power circuits and control circuits, installed in conduits or trunkings, unless otherwise specified.
4. The insulation shall be PVC type TI1 complying with BS 6746, and flame retardant complying with BS 4066.
5. Color coding of the insulation shall be as follows:-
 - a. Phase : red, yellow, blue
 - b. Neutral : black
 - c. Earth : green and yellow
 - d. Control : white

B. PVC/SWA/PVC Cable

1. Cables shall be 600/1000V grade complying with BS 6346, copper core, PVC insulated, extruded PVC bedded, steel wire armored and PVC sheathed.

-
2. Conductors shall be high conductivity stranded copper conductors complying with BS 6360, each conductor core shall be of the same cross-sectional area.

3. The insulation of cores shall be PVC type TI1 complying with BS 6746.
4. The bedding shall be an extruded layer of type TM1 compound complying with the requirements of BS6746.
5. Each core of the cable shall be identified by the appropriate color as specified in BS 6346 throughout the whole of the insulation.
6. Wirearmorshallconsist of a single layer of galvanized steelwire of sizes as shown in the appropriate table in BS 6346 and comply with BS 1442.
7. The over sheath of the cables shall be an extruded layer of black PVC complying with the requirements of BS 6746 type TM1 compound and shall comply with the requirements of BS 4066 for flame retardance. The PVC material shall contain approved anti-termite additives.

D. XLPE/PVC CABLE

1. Cable shall be 600/1000V grade complying with IEC 502, copper core, cross-linked polyethylene (XLPE) insulated and PVC sheathed.
2. The XLPE insulation shall comply with BS 5467 and IEC 502.

E. XLPE/SWA/PVC CABLE

1. Cables shall be 600/1000V grade complying with BS 5467, copper core, cross-linked polyethylene insulated, extruded PVC bedded, steel wire armored and PVC sheathed.
2. Conductors shall be single core high conductivity, stranded conductors complying with BS 6360.
3. Each conductor core shall be of the same cross-sectional area.
4. The insulation of cores shall be cross-linked polyethylene complying with relevant BS 5467.
5. The other specifications on bedding, coloring, armoring and over sheathing shall be the same as those for PVC/SWA/PVC cable.

F. FIRE RESISTANT (FR) CABLE

1. Fire resistant cables shall be provided for essential circuits, especially for fire protection system and lift installation.

2. The insulating thermal barrier must be able to provide electrical integrity prior, during and after exposure to fires with intensities of up to 1100°C. The FR Cables shall be of low smoke, non-toxic gas emission with flame retardant and halogen free. It shall be manufactured to IEC 331, BS 6287 and BS 4066.
3. Fire resistant, low smoke zero halogen materials shall meet the following requirement:-
 - a. IEC 1034 and BS 7622 – Three Meter Cube Smoke Obscuration Test.
 - b. Limiting Oxygen Index of a least 30, to ASTM D-2863.
 - c. A temperature index (TI) of 260°C to ASTM D-2863.
 - d. An insulation is to be moisture and heat resistant, with temperature ratings appropriate to the application conditions and in no case lower than 90°C.
 - e. When a sample of cable is subjected to the combustion test for the determination of the amount of halogen acid gases (other than hydrofluoric acid) as set in IEC 754 – Part 1, and the amount of halogen acid evolved is less than 0.5%, the cable shall be regarded as zero halogen.
4. Fire Retardant, low smoke zero halogen sheathed cable shall be used for all cables in open tray/ladder inside false ceiling and as required by Civil Defence Code for the location of installation.
5. In addition, fire resistant cables shall also comply with the following requirements:
 - a. IEC 331 : Fire Resisting Characteristics of Electric Cables.
 - b. BS 6387 : Fire and Mechanical Tests categories C, W and Z.

G. FIRE RETARDANT (FRT) CABLE

1. Fire retardant, low smoke zero halogen materials shall have a similar specification as the FR cable above.
2. In addition, FRT cables shall also comply with the following requirements:-
 - a. IEC 332 Parts 1 & 3, BS 4066, CEI 20-22, tests on single and bunched cables under fire conditions.
 - b. The flame propagating criteria of US IEEE Standard 383, with a minimum test short circuit time of five minutes, in the IEEE Standard 383 test.
 - c. Fire retardant low smoke zero halogen sheathed cable shall be used for all cables in open tray/ladder inside false ceiling and as required by Civil Defence Code for the location of installation.

H. FLEXIBLE CORD

1. Flexible cord shall comply with BS6007, PVC insulated with flame retardant white circular PVC oversheath to BS 6500 at 450/750V grade.
2. Flexible cord shall be multi-strand copper conductor insulated by vulcanised rubber, PVC, butyl rubber, ethylene propylene rubber (epv), silicon rubber or

glass fibre. Cord shall be twin or three core with colour code brown for line, blue for neutral and green/yellow for earth complete with PVC or CSP (chlorosulphorated polythene) sheath.

3. Cord shall have cross-section area of not less than 0.75 sq. mm and shall be held firmly by cord grips provided in plugs.
4. Cords shall be used for pendant fixtures, portable lamps, portable appliances and stationary equipment. Cord shall not be permanently fastened to building surfaces and shall not pass through holes in wall, ceiling, floor, door-way and window.

I. CABLE GLANDS AND ACCESSORIES

1. For Armoured and Non-Armoured Cables
 - a. All cable glands shall be manufactured and tested to the requirements of BS 6121 and the relevant standard requirements.
 - b. All cable glands shall be manufactured from unplated brass complying with the requirements of BS 2874 and the relevant standard requirements.
 - c. Cable glands for armoured cables shall be accurately machined and have water-tights seals between outer sheath and gland, and between inner sheath and thread component, with electric bond for metallic inner sheath. The brass gland nut shall incorporate a cone-grip armour clamp which shall be manufacturer to ensure that each armour wire contributes equally to the conductance of the bonding connection. Cable glands for non-armoured cables shall be accurately machined and have water-tight seals on outer and inner sheath.
 - d. Each cable gland shall be supplied with a brass gland locknut, plain brass slip- on earth tag and flame retardant and termite repellent PVC outer gland shroud. The earth tag shall be flat circular ring type and placed between the gland and the apparatus into which it is screwed to ensure metal to metal contact between equipment/earth tag and gland. The thread engagement shall not be reduced to below the limits as specified in BS 4683 or BS 5501: Part 5 where appropriate. The PVC shroud shall totally enclose the gland body and form an effective seal down onto the cable's sheathing overall.
 - e. The body of cable glands shall be stamped with identification for the size, type and manufacturer.
 - f. For cables which are protected by ACBs or MCCBs, an integrally cast earth lug shall be provided at the entry portion of cable gland for armour clamp. The lug shall be complete with zinc passivated bolt for earthing the armour to the main earth system at the supply end.
 - g. All cable glands shall have the same IP rating as that of the switchboard or equipment to ensure the water proof integrity of the switchboard and equipment enclosure.

J. HAZARDOUS AREA CABLES & CABLES GLANDS

1. Though as per IEC there is no specific approval requirement for the cables laid in hazardous atmosphere but only provides guidance within IEC 60079-14 on the selection of cables.
2. In all jurisdictions following IEC requirements, there are product standards for hazardous location cable glands. However, there are no specific product standards for hazardous location cables. Requirements for cables are in IEC 60079-14: Electrical installations design, selection, and erection.
3. IEC 60079- 14 is an installation standard, not a product standard and cables are not certified to this standard. This standard provides guidance for the minimum requirements for cable but does not define specific tests or construction specifically for hazardous location cable.
4. Flexible cables that shall be used in fixed installations (excluding intrinsically safe circuits) shall be: (a) ordinary tough rubber sheathed, (b) ordinary poly-chloroprene sheathed, (c) heavy rubber sheathed, (d) heavy poly-chloroprene sheathed, or (e) plastic insulated and of equal robust construction to heavy rubber sheathed flexible cables.
5. Flexible cables for portable and moveable equipment (excluding intrinsically safe circuits) shall have a heavy polychloroprene or other equivalent synthetic elastomeric sheath, heavy tough rubber sheath or an equally robust construction.
6. Cable glands used need to be of the correct type for the cable being used and need to meet the requirements for the area they are being used in and the equipment they are connecting to.
7. Cable glands will provide a degree of environmental and ingress protection and provide protection required for the equipment they are being connected to and the hazardous location they are being installed in.
8. The cable gland is selected to match the cable diameter. The use of sealing tape, heat shrink tube or other materials is not permitted to make the cable fit to the cable gland. If a cable gland is to be used at an ambient temperature range different from -20°C to 40°C or an operating temperature higher than 80°C this must be covered by certification documentation.
9. Cable glands are designed in accordance with IEC 60079-0 and the other 60079 series standards as applicable and selection for use as per the requirements in IEC 60079-14.
10. Table 4 provides information on the selection of gland type according to the enclosure type that it is being used with. Where mineral- insulated metal-sheathed cables are used, the requirement to achieve creepage distances shall be maintained by selecting a certified mineral insulated cable-sealing device.

TABLE 4: SELECTION OF GLANDS, ADAPTERS AND BLANKING
ELEMENTSTYPOFPROTECTIONACCORDING TO THE ENCLOSURE TYPE

Equipment protection technique	Glands, adapters, and blanking element protection technique			
	Ex d	Ex e	Ex n	Ex t
Ex d	X			
Ex e	X	X		
Ex i and Ex nL - Group II	X	X	X	
Ex i - Group III				X
Ex m, Ex o, and Ex q	Ex m, Ex o, and Ex q would not normally be applied to wiring connections. The protection technique for connections shall suit the wiring system used.			
Ex n except Ex nL For Ex nR	X	X	X	
Ex pxb, Ex pyb or Ex pzc	X	X		
Ex pD	X	X		X
Ex s	Only as allowed by the conditions of the certificate.			
Ex t				X
X denotes permitted use.				

11. Cable glands and cables need to be selected to reduce the effects of “cold-flow characteristic” of the cable. “Cold-flow” in cables is the movement of the cable sheath under the compressive forces created by the displacement of seals in cable glands where the compressive force applied by the seal is greater than the resistance of the cable sheath to deformation.
12. Low smoke and fire resistant cables usually exhibit significant cold flow characteristics. Flameproof enclosure required flameproof cable glands. The cable entry system is required to be either (a) barrier cable glands in compliance with IEC 60079-1 and certified as equipment, or (b) cable glands complying with the requirements of IEC 60079-1, certified as equipment and combined with the cables complying with the requirements in IEC 60079-14 and with a minimum length of the connected cable of 3 m.
13. Cables are required to be connected to the electrical equipment by means of cable glands appropriate to the type of cable used and need to maintain the explosion protection integrity of the relevant type of protection.
14. Cable glands shall be installed in a way so that after installation, they are only capable of being released or dismantled by means of a tool. If additional clamping is required to prevent pulling and twisting of the cable transmitting the forces to the conductor terminations inside the enclosure, a clamp shall be provided, as close as practicable to the gland along the cable. Cable clamps within 300 mm of the end of the cable gland are preferred.
15. Cables shall be routed straight from the cable gland to avoid lateral tension that may compromise the seal around the cable. When braided or armored cables have been terminated within the cable gland, the body components that are

intended to retain and secure the cable braid or armor should not be able to be released manually or opened by hand without the use of a tool.

16. Ex d (flameproof) cable glands are required to meet IEC 60079-0 and IEC 60079- 1, Clause 13.4 and IEC 60079-1. Together with the enclosure, the cable glands shall meet the specified joint widths and gaps.
17. The general design testing, and certification requirements for IEC Ex cable glands shall be done by IEC60079-0.

SECTION 12***EARTHING******SYSTEM*****Earthing System****Scope of Work**

The work under this section consists of supply, installing, testing and commissioning of all material and services of the complete earthing 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 electrical lines and equipment.

The earthing system shall also comply with the General Specifications for Electrical Works Section-1 and with other relevant provisions of the Tender Documents.

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.

Applicable Standards /Codes

The latest editions of following standards / codes shall be applicable for the materials in scope of this section:

- BS 95 Earthing clamps
- BS 7430 Earthing
- BS 12163 Nuts, Bolts, washers, screws and rivets for use on copper
- BS 13601 Hard drawn bare copper conductor for earthing
- BS 6346 PVC insulated cables.

Materials

1 Earth Electrodes

The earth electrodes shall comprise a 24" x 24" x 1/8" 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.

2 Earthing Lead

The earthing lead shall connect the earth electrode to earth connecting point or equipment in the building. It shall be of round hard drawn bare electrolytic copper of size shown on the drawings.

3 Earthing of Outdoor Pad Mounted Equipment.

The earth electrode shall consist of copper bonded steel rods 5/8"x 10 feet long thoroughly hammered or drilled into the ground. The rod shall be connected to the earth conductor by means of a clamp/connector or cad welded which shall be tightened properly. After tightening, the connector shall be covered with Bitumen to prevent ingress of moistened soil. The rod shall be hammered to a level of 10 ft. below ground level.

The number of rods forming on earth point shall depend upon the Earth resistance. The earth resistance at any point in the system shall not exceed 05 Ohms and it may be necessary to use more than one rod to achieve the specified Earth resistance. Soil improvement compound is recommended where resistance does not achieve.

4 Earthing (Bore Type)

The earth electrode shall consist of 19mm Dia and 3m long copper bonded steel rod shall be connected to the earth conductor consist of 70 sq.mm. Copper rope conductor by means of welding of connector which shall be tightened properly. After tightening, the connector, the rod shall be penetrated up-to a permanent water table below the ground by means of drill / boring.

Earth conductor shall be run in a 2" dia. GI. Perforated Pipe up-to Earth test point. The test point shall consist of a copper plate of 300mm x 75mm x 12 mm including holes. Stainless steel nut & Bolts and lugs and earth pit as per drawing with water tight cover. The earth resistance of the system shall not exceed 1 Ohms and all arrangements shall be as per provided drawings.

5 Earth Continuity Conductor

Earth Continuity Conductor (ECC) shall be harddrawnbare copper wire or single core PVC insulated copper conductor cable of sizes indicated on the drawings.

6 Earth Connecting Point

Earth connecting points shall comprise tinned copper bar, rectangular in shape, having dimensions of 300mm x 50mm x 6mm thick. At least six terminals for connection shall be arranged on the bar, which can be increased/decreased as required by 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 10mm dia. nut and bolt and shall be insulated by means of rubber gaskets / washers.

Installation

1 General

Complete earthing system as shown on the drawing shall be installed by the Contractor. The earthing system shall give earth resistance, including the resistance of soil, earth leads and ECC equal to or less than one ohm. At all connections of earth continuity conductor to LT switchboard, LT distribution Board 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, 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/ducts 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.

2 Earth Electrodes

The electrode plate shall be installed at a minimum depth of 6 meters from finished ground level or 1 meter below permanent water level whichever is less. The minimum horizontal distance between earth electrodes shall be 3 meters. Proper mixture of low res compound, bentonite clay, lime and charcoal etc whatever is required 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 drawings.

Earth Electrode of rod type shall also be recommended as shown in the drawings. A copper bonded steel rod 19mm Diameter, 3000mm long with spike can be used

for the earthing of poles, steelstructure, transformer neutral and body, Generator neutral and body, MDB and DB local earth. Detail of installation is illustrated in the miscellaneous details of earthing. Contractor shall submit the complete methodology of earthing and grounding with procedure of exothermicwelding.

3 Earth Continuity Conductor

The earth continuity conductor of sizes shown on the drawings 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 be connected to earth by specified size of ECC.

4 Earth connecting Point

The earth connecting point shall be installed at locations shown on the drawing. It shall be fixed on wall surface by means of brass screws.

5 Earth Resistance Test

Earth resistance test will be made by the Contractor 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. Electrical resistance of ECC together with the resistance of electrode to any other positioning the complete installation will not exceed one Ohm.

The earth resistance test shall be performed as per Electrical Inspector's requirements. Where more than one earth electrode is installed the earth resistance test of each electrode will be measured by means of resistance bridge instrument. Complete system shall be tested for continuity and earth resistance. The combined earth resistance at any point in the system shall not exceed 5 Ohms. The value of earth resistance for the HT metering panel and consumer's protection panel shall be upto 3 Ohms.

SECTION 13

AUTOMATIC TRANSFER SWITCH

PART 1 – GENERAL

1.01 SCOPE

- A. Furnish and install where indicated Transfer Switches having the ratings features/accessories, enclosures, etc., indicated on the drawings or noted herein.
- B. The Transfer Switches shall be fully rated to protect all types of loads, inductive and resistive, from loss of continuity of power, without derating, either open or enclosed.
- C. Material and equipment shall be a standard product of a manufacturer regularly engaged in the manufacture of Transfer Switches. The experience shall include applications of equipment and materials of the same detail and/or rating as the Transfer Switches specified.

1.02.1 STANDARDS

- A. The Automatic Transfer Switch shall be engineered and constructed in accordance with the standard specified in the respective circuit breakers section 21.
- B. UL 1008 listing for Transfer Switches.

1.03 SUBMITTALS

- A. Complete list of equipment and materials proposed, with an adequate description of each item to be furnished, shall be submitted prior to approval.
- B. A certificate of compliance to respective circuit breaker standard compliance specified in section 21 and UL 1008 must be submitted for the Transfer Switches to be supplied. The certificate is not required if the manufacturer's published data submitted and approved reflect a UL 1008 listing. Proof of UL 1008 listing does not, however, relieve the contractor of compliance with other provisions of this specification.
- C. A typical schematic diagram with logic table shall be furnished showing normal operation of the Transfer Switch.
- D. Final as-built drawings
- E. As-built wiring diagrams
- F. Certified production test reports
- G. Installation information

1.04 QUALIFICATIONS

- A. The manufacturer of the automatic transfer switch shall be the manufacturer of the major components within the assembly.
- B. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.05 DELIVERY STORAGE AND HANDLING

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.06 MAINTENANCE MANUALS

- A. A test report and Operations and Instructions Manual shall be included with the point-to-point wiring schematic shipped with each Transfer Switch supplied. It shall include results from factory functional testing on the identical unit and shall show each Feature/Accessory as being tested satisfactorily in accordance with the requirements of this specification. The test report shall indicate the manufacturer's Shop Order Number and Serial Number of each Transfer Switch supplied.

PART 2 – PRODUCTS

2.01 RATINGS

- A. The Transfer Switches specified herein shall be 100% equipment rated for continuous duty as shown on the drawings and shall conform to the applicable requirements of respective circuit breaker standard in Section 21 and UL 1008 for emergency total system load. All 3 phase 4 wire Transfer Switches used with ground fault equipment shall be the true 4 pole switched neutral type with all four poles for each source being fully rated and connected to a common shaft. Overlapping neutral shall not be acceptable.
- B. The Transfer Switch shall be rated for non-welding of contacts when used with the upstream overcurrent devices shown on the plans and with the available fault current as specified.
- C. The withstand closing and interrupting ratings of the Transfer Switch shall be no less than those required to be compatible with the available system short circuit current and the type and rating of systems protective devices. Refer to and comply with Sections 1 and 2.
- D. The voltage rating of the Transfer Switch shall be no less than the system voltage rating. The Transfer Switch contacts shall be rated for use up to 600 volts.
- E. The continuous current rating of the Transfer Switch shall be no less than the maximum continuous current requirements of the system.
- F. All pilot devices and relays shall be of the industrial type rated 10 amperes with self-cleaning contacts.
- G. All switches shall be of the amp ratings shown in the attached drawings.

2.02 CONSTRUCTION

- H. Transfer Switches specified herein shall consist of completely enclosed contact assemblies and a separate control logic panel. The contact assemblies shall be operated by a non-fused motor operator or stored energy mechanism, and be energized only momentarily during transfer providing inherently double throw switching action.
- I. Control power for all transfer operations shall be derived from the line side of the source to which the load is being transferred.
- J. Transfer Switches shall be capable of being operated manually under full load conditions and shall be equipped with a permanently affixed manual operator engineered to prevent injury to operating personnel in the event that the electrical operator should suddenly become energized during transfer. In addition, provisions should be provided to allow disengagement of the electrical operator during manual operation. The manual operator shall provide the same contact-to-contact transfer time as provided under normal automatic operation to prevent possible flashovers from switching the main contacts slowly.
- K. Each Transfer Switch shall be positively interlocked mechanically and electrically to prevent simultaneous closing of both sources under either automatic or manual operation. Main contacts shall be mechanically locked in position in both Normal and Emergency positions. A neutral position shall not be possible under normal electrical operation unless a Delayed Transition accessory is required for switching highly inductive loads. Each Transfer Switch shall have a manual neutral position for load circuit maintenance. A Transfer Switch position indicator shall be visible from the front of the switch to show to which source the Transfer Switch is connected.
- L. A logic panel shall be separately mounted from the power switching portion of the Transfer Switch. The two sections shall be connected together by control cables with plug in connectors. The control section shall be capable of being disconnected from the power section for maintenance purposes.
- M. Each Transfer Switch shall be supplied in the appropriate enclosure. The enclosure shall be painted with the manufacturer's standard painting procedures to insure suitability for environmental conditions as referenced in the plans. Wires shall be permanently marked near the terminal at each end with the wire number shown on the approved shop drawings. Terminal facilities shall be arranged for entrance of external conductors from the top or bottom of the enclosure. Main Transfer Switch terminals shall be suitable for the termination of conductors shown on the plans.

2.03.1 WIRING /TERMINATIONS

- A. Terminal facilities shall be arranged for entrance of external conductors from the top or bottom of the enclosure. The main transfer switch terminals shall be suitable for the termination of conductors shown on the plans.

2.03.2 SEQUENCE OF OPERATION

- A. Upon loss of phase-to-phase voltage of the normal source to 70% of nominal, and after a time delay, adjustable from 0.5 to 15 seconds, to override momentary dips and/or outages, a 10 ampere, 48VDC contact shall close to initiate starting of the emergency or standby source power plant. Transfer to the alternate source shall take place immediately upon attainment of 90% of rated voltage and frequency of that source. For switches not involving engine generator sets as a power source, transfer shall occur after an adjustable time delay of 1 to 60 seconds to override momentary dips and outages.
- B. When the normal source has been restored to 90% of rated voltage, and after a time delay, adjustable from 0.5 to 30 minutes (to ensure the integrity of the normal power source), the load shall be retransferred to the normal source.
- C. A time delay, adjustable from 0.5 to 30 minutes, shall delay shutdown of the emergency or standby power source after retransfer to allow the generator to run unloaded for cool-down, after which the generator shall be automatically shut down.
- D. If the emergency or standby power plant should fail while carrying the load, transfer to the normal power supply shall be made instantaneously upon restoration of the normal source to satisfactory conditions.

2.05 ACCESSORIES

- A. The logic of the transfer switch shall function through mechanical interlock. LED lights shall be included on the exterior of the switch to show:
 - 1. Normal Source Available
 - 2. Emergency Source Available
 - 3. Normal Source Connected
 - 4. Emergency Source Connected
 - 5. Load Energized
- B. A digital readout shall display each option as it is functioning. Readouts shall display actual line voltage, line frequency. The switch shall include the following options:
 - 1. Provide a timer to delay transfer from the normal power source to the emergency power source (0 seconds - 30 minutes). This option does not effect the engine start circuit.
 - 2. Provide a timer to override a momentary power outage or voltage fluctuation (0 seconds - 120 seconds).
 - 3. Provide a timer to delay transfer from the emergency power source to the normal power source (0 seconds - 30 minutes).
 - 4. Provide a timer to allow the generator to run unloaded after re-transfer to the normal power supply (1 second - 30 minutes).
 - 5. Provide single phase under voltage and under frequency sensing on the emergency power source. Voltage shall be factory set at 90% pickup and 80% dropout. Frequency sensing shall be set at 48 hertz pickup and 46 hertz dropout.
 - 6. Provide a maintenance selector switch to disconnect the motor circuit to allow testing of the logic circuit without transferring the load.
 - 7. Provide a pilot light to indicate that the switch is in the normal position.
 - 8. Provide a pilot light to indicate that the switch is in the emergency position.
 - 9. Provide a pilot light to indicate that the normal power is available.
 - 10. Provide a pilot light to indicate that the emergency power is available.
 - 11. Provide 4NO/4NC auxiliary relay contacts that are energized when the power is available on the normal source.
 - 12. Provide 4NO/4NC auxiliary relay contacts that are energized when the power is available on the

emergency source.

13. Provide a time delay in the neutral (or both OFF) position when the load is being transferred in either direction to prevent excessive in-rush currents or out of phase transfer. An in-phase monitor is not an acceptable alternative.
14. Provide a pre-transfer signal device to open/close on a timed basis to allow the load to be de-energized up to 10 devices prior to transfer in either direction.

PART 3 - EXECUTION

3.01 EXAMINATION

3.02 FACTORY TESTING

- A. Each switch shall be factory tested in accordance with circuit breaker standard and UL standards. In addition the manufacturer shall perform the following tests:
 - 1. Insulation check to ensure the integrity of insulation and continuity of the entire system.
 - 2. Visual inspection to ensure that the switch matches the specification requirements and to verify that the fit and finish meet quality standards.
 - 3. Mechanical tests to confirm compatibility of the switch's logic and power sections and to verify that they are free of mechanical hindrances. Switches shall be cycled through a minimum of 50 operations by alternately removing normal and emergency power sources.
 - 4. Electrical tests to verify the complete electrical operation of the switch and to set up the time delays and voltage sensing settings of the logic.

3.03 INSTALLATION

- A. Installation of all switches shall be in accordance with all applicable codes, standards, and practices as well as in accordance with the recommendations of the manufacturer.
- B. The contractor's field wiring terminating within the enclosure shall be either colour coded or wires shall be permanently marked near the terminal at each end with the wire number shown on the approved shop drawings.
- C. The contractor shall supply grounding lugs as required to meet with the local inspection and applicable codes.

3.4 FIELD ADJUSTMENTS

- A. The contractor shall field adjust all timing and voltage settings of the transfer switch as necessary for proper operation of the unit.

SECTION 14

TRANSIENT VOLTAGE SURGE SUPPRESSION

PART I - GENERAL

1.01 WORK INCLUDED

- A. The work required under this division shall include all materials, labor and auxiliaries required to furnish and install complete surge suppression for the protection of building electrical and electronics systems from the effects of line induced transient voltage surge and lighting discharge as indicated on the electrical plans or specified in this section.

1.01 QUALITY ASSURANCE

- A. All surge suppression devices shall be manufactured by a company normally engaged in engineering and manufacture of such devices for electrical and electronics systems equipment. The said firm shall offer a FIVE-YEAR (5) warranty.
- B. The surge suppressor manufacturer shall offer the technical assistance of a registered professional electrical engineer. The manufacturer shall also provide the support of a factory representative and local stocking distributor.
- C. Submittals: Surge suppression submittal shall include:
 - 1. Manufacturer's performance data on each suppressor type to comply with part 1.4.
 - 2. Dimensioned drawing of each suppressor type to be submitted for approval.
- D. To establish the type and operating characteristics of the surge suppression devices, equipment will be considered for approval provided the submitted information is submitted to the Engineer's satisfaction.
- E. Equipment certification: Items shall be tested and be marked in accordance with referenced standard.
- F. Surge Suppression devices shall be installed and located in accordance with requirements of all applicable National Fire Protection Association (NFPA) codes and IEC 61643-11.
- G. It should be noted that all TVSS panels are parallel operated/connected and therefore are not required by NFPA 70 to have a nameplate rated ampacity assigned to the equipment or required connection to a dedicated circuit breaker.

1.02 WARRANTY

- A. All surge suppression devices shall be warranted to be free from defects in materials and workmanship under normal use in accordance with the instructions provided for a period of five (5) years.
- B. Any suppressor which shows evidence of failure or incorrect operation during the warranty period shall be repaired or replaced by the manufacturer and installer.

1.01 CODES AND STANDARDS

- A. The following standards and publications referenced in various parts of this specification shall apply
 - 1. IEC 61643-11
 - 2. UL 1449-1987 - Standard for safety, transient voltage surge suppressors.
 - 3. UL 1363-1986 - Standard for temporary power taps.
 - 4. ANSI/IEEE C62.41-1991 (IEEE 587) - Guide for surge voltages in low voltage AC power circuits.
 - 5. ANSI/IEEE C62.33-1982 - Standard test specifications for varistor surge protection devices.
 - 6. ANSI/IEEE C62.45-1987 - IEEE guide for surge testing for equipment connected to low voltage AC power circuits.

1.03 REQUIRED SUPPRESSORS AS PER ELECTRICAL PLANS

- A. Provide surge suppression for the equipment for all incoming cable and any outgoing cable exiting the building to external and/or to the roof and/or open area.

PART 2 - PRODUCTS

2.01 PRODUCTS: PANEL PROTECTOR (MODULAR FIELD SERVICEABLE)

- A. The surge suppressor manufacturer shall offer a complete line of surge suppressor products to support the requirements for main service entrance panels.
- B. The panel mount suppressor unit shall be manufactured with replaceable modules for purposes of in-service replacement. One extra set of replacement modules shall be furnished to the job site. The unit suppressor shall be manufactured with redundant back-up surge protection in the event of a module failure.
- C. Suppressor Network configuration. The work required under this section consists of furnishing, installing and connecting of TVSS devices as specified and as shown on the drawings. The TVSS device shall be installed in a NETWORK configuration, consisting of one TVSS panel device at the service entrance switchboard. All TVSS panel devices in this network configuration shall be of the same manufacture. All TVSS panel devices shall be of the modular detail and be field replaceable, without any interruption of electrical distribution service.
 1. Module status indicators shall be provided to indicate individual module status. When a module has failed, the module LED status indicator shall indicate said failure.
 2. Unit status indicators LED's shall be provided to indicate the status of the complete suppressor unit. The LED status indicators shall be located on the hinged front cover to indicate the status of all modules and will identify any modules that have failure.
- D. Suppressors shall be manufactured for the specific type and voltage of the electrical service and shall provide clamping for both normal (L-N) and common (L-N-G) mode protection.
- E. Suppressors shall be of a hybrid detail, and include circuitry with full cycle tracking of the (AC) sine wave, in both the normal and common modes of operation. Unit clamping characteristics must meet the standards set forth in Suppressor criteria.
- F. Suppressors shall be manufactured to withstand a maximum continuous operating voltage of not less than 115% of normal RMS line voltage.
- G. Suppressors shall contain internal safety fusing, when required, to disconnect the suppressor from the electrical source for routine maintenance, suppressor module failure and in order to prevent catastrophic failure modes.
- H. Suppressors shall be a fail-safe type device, shall allow no follow-through current, shall have repeated surge capability, shall be solid state, shall be self-restoring and be fully automatic in all modes of operation.
- I. Suppressors shall be UL-1449 listed or comply with IEC 61643-11 and shall be approved for the location in which they are installed.
- J. Suppressors shall have an operating temperature 85 degrees C.

2.01 SUPPRESSOR CRITERIA

- A. The Maximum Continuous Operating Voltage (MCOV) for surge protective devices connected phase- neutral and phase to ground shall not be less than the values shown in Table 1:

Nominal Voltage Rating (Vrms)	Maximum Continuous Operating Voltage (Vrms)
120	150
277	346
350	440
480	600

B. Listing

1. The Surge Protective Device and associated hardware must be Listed to UL 449, as defined by ANSI/NFPA 70-1990 or comply with IEC 61643-11. The suppression voltage of the complete panel mount surge protective device shall be type test to these figures must not exceed the values shown in Table 2.

2. Suppression voltage ratings for MODULES OR SUBASSEMBLIES ARE NOT ACCEPTABLE.

Service Voltage	UL 1449
------------------------	----------------

	Suppression Voltage
120	400
240	800
277	800
350	1500
480	1200

C. Maximum Single Withstand Surge Current

1. Surge Protective Devices (including all fusing and over current protection) for application at Low Voltage AC panels shall have a maximum surge current withstand, exceeding that shown in Table
3. The failure of, or operation of, any fuse or over current device during this test is not permissible.

Application: Panel Location	Max Single Withstand Current (8/20 μ)
Service Entrance	75kA
Main Distribution	40kA

2. Compliance to this specification must be provided in the form of a certificate from an independent testing laboratory.

D. Joule Ratings" and "Response Times"

1. The selection of Surge Protective Devices shall not be made solely, or in part, based upon either of these two ambiguous specifications. These terms currently are no longer recognized by ANSI, NEMA, IEEE or IEC Standards as bonafide suppressor performance parameters. The key selection elements of a quality suppressor is its low clamping capability and its maximum surge handling capacity.

E. Suppressors shall meet or exceed the following performance criteria as specified.

1. Service Entrance: Installer MUST VERIFY VOLTAGE of each panel protector to be installed. Panels available in the following voltage; single phase & three phase, 120/240/277/346/480/600 volts. Modified NEMA-12 enclosure, with collar for flush mounting as standard.
2. Manufactured to comply as described in section 1.4 UL 1449-1987 a. ANSI/IEEE C62.41-1991 & C62-45-1987.
 - b. Category B-1 ANSI C62.41 (2kv-1.2/50 us, 1ka-8/20us)
 - c. Category B-2 ANSI C62.41 (4kv-1.2/50 us, 2ka-8/20us)
 - d. Category B-3 ANSI C62.41 (6kv-1.2/50 us, 3ka-8/20 us)
 - e. Category C-1 ANSI C62-41 (6kv-1.2/50 us, 3ka-8/20 us) combined Wave.
 - f. Category C-2 ANSI C62-41 (10kv-1.2/50 us, 5ka-8/20 us) combined Wave.
 - g. Category C-3 ANSI C62-41 (20kv-1.2/50 us, 10ka-8/20 us) combined Wave.
3. Minimum surge capacity of 125,000 AMPS, Peak, per Phase.

F. Minimum surge capacity of 50,000 AMPS. Peak, per Phase.

1. Although section 240-21 of the National Electric code does not require the installation of an over current protection device up to 3m of tapped conductors, it is recommended that a 30 Amp. Over current protection device be installed to disconnect all energized terminals. (i.e.: interrupting capacity of the device shall be

rated to comply as per sections 110-9, 110-10 and 110-22 of the National Electrical Codes).

2. Suppressor shall be of the replaceable modular type, protector shall provide both normal and common mode protection provide EMI/RFI noise rejection a minimum of -20 to -40 dB in both normal and common modes.
3. Manufacturer shall supply Documentation of testing and compliance to all described IEC 61643-11, UL 1449 and ANSI/IEEE C62-41, C62-45 tests. Note: No calculations or formulas may be submitted as claim of compliance.

2.02 SURGE PROTECTION DEVICE SAFETY

A. Fusing

1. Surge Protective Devices shall contain both (within each replaceable protection module) accurate thermal and short circuit safety fusing.
2. The fusing mechanisms employed must effectively coordinate their performance in conjunction with the full surge handling capabilities of the suppressor.
3. Replacement of any suppression module requires mandatory and simultaneous replacement of all safety fuses and individual diagnostics associated with that module.

2.04 STATUS INDICATION AND DIAGNOSTICS**A. On-Board Diagnostics Indication**

1. Surge Protection Devices shall provide (on-board) visual status of their operational readiness by both electrical and mechanical indication.
2. Separate visual indication is to be provided for both stages of the (2 stage redundant) protection module.
3. Surge Protection Devices shall indicate their operational capability even though AC power may not be present.
4. Surge Protection Devices shall incorporate a visual warning indication for the presence of high neutral to ground voltages.
5. Surge Protection Devices shall have the ability to externally observe, monitor and inspect on board diagnostics, wiring and module configuration without actually having to open the door of the device. (This feature eliminates the need for internal access of the device by unqualified individuals, thereby, decreasing their exposure to the dangers of medium voltages.)

B. Remote Monitoring

1. Surge Protective Devices shall be equipped with normally open and normally closed dry contacts to interface with remote monitoring unit through building management systems.

PART 3 - EXECUTION

3.01 INSTALLATION OF SUPPRESSION

- A. Suppression shall be installed as close as practical to the electrical panel or electronic equipment to be protected, consistent with available space. Suppressor shall be close nipped to the device being protected in a position near the neutral bus which will minimize the lead length between suppressor and the buses or circuit breaker to which the suppressor connects. Suppressor leads shall not extend beyond the suppressor manufacturer's recommended maximum lead length.
- B. Suppressor shall be installed in a neat, workman like manner. The lead dress shall be as short and straight as possible and be consistent with recommended industry practices for the system on which these devices are installed.
- C. Supplementary grounding and bonding connections required between the bonding bus or ground plane for each equipment cluster and other locations as indicated herein shall be accomplished using 10mm² copper conductor and approved connections unless otherwise noted. Reference to a common earth ground.
- D. Suppressor shall be installed in a manner that allows simple replacement within a short period of downtime.
- E. Although Section 240-21 of the National Electrical Code (NEC) does not require the installation of an over current protection device when installed within 3m feet of the tapped conductors, it is recommended that a 30 ampere overcurrent protection device be installed to disconnect all energized terminals. (i.e. interrupting capacity of such device shall be rated to comply as per sections 110-9, 110-10 and 110-22 of the National Electrical Code) Label the disconnect or overcurrent protection device "SURGE SUPPRESSOR".

SECTION 15

STATICUNINTERRUPTIBLEPOWERSUPPLY(UPS)

PART 1 - GENERAL

Section Includes

- A. Charger/rectifier unit.
- B. Inverter unit.
- C. Batteries.

Reference Standards

IEEE 519	IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems; Institute of Electrical and Electronic Engineers; 2004.
NEMA PE 1	Uninterruptible Power Systems (UPS) - Specification and Performance Verification; National Electrical Manufacturers Association; 2003.
NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2008.
NFPA 70	National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
BS EN 62040	Uninterruptible Power Systems (UPS)

Submittal

- A. Shop Drawings: Indicate electrical characteristics and connection requirements. Provide battery rack dimensions; battery type, size, dimensions, and weight; detailed equipment out lines, weight, and dimensions; location of conduit entry and exit; single-line diagram indicating metering, control, and external wiring requirements; heat rejection and air flow requirements.
- B. Product Data: Provide catalog sheets and technical data sheets to indicate physical data and electrical performance, electrical characteristics, and connection requirements.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product. Include equipment installation outline, connection diagram for external cabling, internal wiring diagram, and written instruction for installation.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Operation Data: Description of operating procedures.
- F. Maintenance Data: Description of servicing procedures; list of major components;

recommended remedial and preventive maintenance procedures; spare parts list.

Quality assurance

- A. Conform to requirements of NFPA 70.

- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience with service facilities within 300Killo meter of Project.
- C. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years documented experience.
- D. Products: Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and indicated.

Delivery, Storage, and Handling

- A. Protect equipment from extreme temperature and humidity by storing in a conditioned space.
- B. Protect equipment from dust and debris by wrapping unit in dust tight cover and storing away from construction activity.
- C. Deliver batteries no sooner than 7 days before charging.

PART 2 –PRODUCT

System Operation

- A. The UPS shall be an on-line double conversion system designed to operate in the following modes:
1. Normal:
The UPS shall deliver power to critical loads without interruption. The rectifier/charger shall draw alternating current (AC) from the mains and convert it into direct current (DC) for the inverter. The inverter shall convert it back into clean AC current for the load. The rectifier/charger shall also charge the battery.
 2. Mains Power failure:
In the event of a mains failure, the critical loads shall be supported by the inverter with power from the battery.
- B. Recharge Cycle:
When mains power has been re-instated, the rectifier/charger shall again supply the load via the inverter and recharges the battery.
- C. Static bypass mode:
The static switch shall transfer the load to the bypass AC power in the event of an inverter shutdown without interrupting the supply of power to the critical loads.

Transfer back occurs when the inverter has returned to normal operation.
- D. Maintenance by pass/ Test mode:
A manual bypass switch shall be used to isolate the inverter output and the static bypass for maintenance purposes. Isolation is achieved without load interruption.
- E. Mode of operation and UPS ratings
UPS shall be single module (non-redundant) with built-in static and maintenance by-pass. Furthermore, external bypass facility shall be provided and this bypass facility shall automatically switch to mains power in case of total UPS failure period. A key switch has to be provided for manual changeover from

U.P.S to external bypass facility. External bypass facility has to be completely monitored by BMS.
- F. Rectifier/Charger:
A solid state six pulse rectifier, fully microprocessor controlled, shall convert the AC power from the mains into regulated DC power. A temperature sensor shall be used to control temperature compensation. The power shall be filtered to supply the inverter and charge the battery. The rectifier/charger shall be sized to support the inverter at full rated load and simultaneously charge the battery to 95% of its full capacity over a period equal to ten times the battery backup duration. The rectifier/charger shall be of modular construction to facilitate maintenance.
- G. Input protection:
1. The input of the rectifier/charger shall be protected by fuses.
 2. Input current shall be limited to 125% for the nominal input current.
- H. Battery Bank :

1. Battery shall be maintenance free VRLA batteries (internal gas recombination type) with a design life of 10years.

2. Inverter

Operation:

The inverter shall be made of three inverter legs with IGBT transistors and pulse width modulation (PWM). The built-in output transformer shall be of the delta/zigzag type.

I. Output voltage and frequency 400VAC 50Hz

J. Thermal overloads

The inverter shall continue to operate for a maximum time that depends on the current drawn, before shutting down to protect the various components against excessive temperature rise.

- 2 hours from 1.05 In to 1.1In
- 30 mins from 1.1 to 1.15 In
- 10 mins from 1.15 In to 1.25 In
- 3 mins from 1.25 In to 1.35 In
- 1 min from 1.35In to 1.65 In

K. Steady state regulation

- $\pm 1\%$ voltage for the RMS values of the phase to neutral and phase to phase voltages.

L. Synchronization range :

- From 0.25 to 2 Hz in 0.25 Hz steps. May be personalized.

M. Transient conditions :

- Operation with battery power : $\pm 2\%$ for 100% load steps
- Operation without battery power $+2\%/-4\%$ for 100%load
- Return to the $\pm 1\%$ voltage range in less than 20 milli second.
- Non-linear loads
- All phase conductors shall be sized for the rated current.
- The neutral conductor shall be sized for 1.5 times the rated current.
- Load crest factor up to 3
- Ph/Ph output voltage distortion =2% maximum
- Ph/N output voltage distortion=3% maximum

N. Overload

125% for ten minutes and 150% for one minute

O. Mains (AC input to bypass):

Mains tolerances/transfer conditions:

The inverter shall transfer the load to the mains 2 supply without interruption provided the following conditions prevail:

1. voltage within the $U_n - 10\%$ to $U_n + 10\%$
2. Frequency within the personalized tolerancerange
3. phase shift between inverter and Main voltages less than 3 degrees
4. Overload capability of the staticswitch:
 - Thermal overloads $< 1.35 I_n$: Same overload capability as the inverter (not dependent on power factor)
 - Overloads $> 1.35 I_n$
5. Maintenance by pass :

On -line UPS units, parallel redundant type shall be equipped with a maintenance bypass which may be used to transfer the load directly to Mains. This is carried out using three switches. Step by step help shall be provided on the front panel of the UPS when the doors are open. Prior to transferring the load to the maintenance bypass the inverter must be shut down.
6. Static by pass :
 - Static bypass shall be sized for continuous operation under the following conditions :

- Transfer without interruption of power to the load

- The static bypass shall enable automatic transfer to the Main supply without interruption of power to the load, following detection by the control electronics of one of the following conditions:
- Load on inverter greater than the rated output
- Battery discharged to the end of its back up time, Main within tolerances.
- Inverter malfunction.

7. Microprocessor based control functions :

UPS controls circuits shall be microprocessor based. All operations and parameters shall be managed by internal software thus eliminating the need for manual settings and potentiometers. Self-test and diagnostics circuits are used to detect and isolate a fault, right down to the PC-board itself or the connections. All individual circuits on the PC-board and all connections can be checked.

8. Control and indication panel :

- The UPS shall be equipped with a control panel comprising system-status indications that may be used to control, monitor and display various system functions and parameters. The graphic LCD display shall be set to display data in English
- Monitoring System parameters : Parameters displayed (RMS)
- Input voltage phase-to-phase;
- Input current per phase;
- Bypass input voltage (phase to phase & phase to neutral);
- Bypass input frequency;
- Inverter output voltage (phase to phase & phase to neutral);
- Inverter output current per phase;
- Input, output current & bypass frequency;
- Percentage load at the inverter output;
- Inverter output power factor
- Inverter output in kVA and kW;
- DC voltage
- Load crest factor
- Battery current (charge/discharge);
- Battery backup time and remaining service life;
- Temperature in the battery cubicle

9. Mimic panel:

LEDs shall indicate the status of the following elements:

- Rectifier/charger
- Battery;
- Static switch
- Inverter
- Load

10. Buzzer reset button

- Button shall be used to stop the buzzer. However, a new malfunction shall activate the buzzer again full shutdown.
- Pressing the "full shutdown" button activates:
- Shut down of the inverter
- Opening of the static switch on the bypass
- Opening of the battery circuit breaker;
- Opening of an isolated relay contact

It is possible to activate the "full shutdown" function

externally via a relay contact. The UPS shall also

include

the following functions:

1. Cold Start: This function shall make it possible to start the UPS even when Main is absent. The power is supplied by the battery for a period determined by the battery charge level and the power required by the load. However, the battery discharge time can never exceed three times the rated back uptime plus two hours.
2. Advanced Battery management: By using the Battery device, the UPS shall optimize the service life of the battery and continuously maintain a high degree of operation security by ensuring the following functions:
 - (a) Calculation of the true available backup time, taking into account the battery age, the temperature and the charge level;
 - (b) Estimation of the battery servicelife;
 - (c) Protection against excessive discharges;
 - (d) Regulation of battery voltage depending on the temperature, which increases battery service life;
 - (e) Limiting of battery current;
 - (f) Automatic battery testing
 - (g) Battery discharge at programmable time intervals
 - (h) Battery status used for preventive detection of battery faults; (i) Continuity of the battery circuit
 - (j) Protection against deep discharges depending on the discharge curves and battery isolation by the circuit breaker
 - (k) Progressive buzzer indicating the end of back up time
 - (l) Temperature monitoring
 - (m) Regulate the charger voltage depending on the temperature in the UPS room
 - (n) Warn the operator if the set permissible temperature are overrun to enhance the accuracy of the battery backup time calculation carried out by the standard UPSfunction
- P. Event Log: This Monitoring system shall store 500 events (alarms, UPS status information etc). It also provides statistical information on a number of UPS parameter (battery backup time, number of transfers to battery power, number of transfers to the static bypass, current limiting, and operating time on the inverter and on Main). This information may be accessed locally on the standard display or on a remote terminal via TCP/IP
- Q. Communication Card: This board shall provide 6 isolated relay contacts that may be used to activate indicating lights or buzzers to inform the user of the operation status of the UPS and the battery, for the following information:
 1. Load on UPS;
 2. Load on battery power;
 3. Load on bypass (maintenance position);
 4. Low battery warning;
 5. General alarm;
 6. Complete shutdown.
- R. UPS Software/Communication: Shall be installed on computer-network management platforms, & will be used to manage electrical power with customized supervision screens with desired equipment names
 1. UPS programming

2. Display of mains voltage and frequency
3. Display of the battery status, charge level and remaining back up time
4. Logging of events occurring on the mains supply, etc

In the event of incidents on the mains supply, it will be possible to program the system to send warning messages to BMS PC

S. Remote Monitoring: Remote Monitoring through the BMS

Electrical Characteristics	
Power rating	Refer to drawing.
Power Factor	0.8 lagging
Normal AC input	
Rated voltage	400V $\pm 10\%$, three phase (adjustable $\pm 15\%$)
Frequency	50 Hz $\pm 10\%$
Bypass AC input	
Voltage	400V $\pm 10\%$ three phase + neutral
Frequency	50 Hz $\pm 10\%$
Output	400 V $\pm 1\%$ three phase + neutral
Frequency	50 Hz ± 0.05 Hz
Permissible overload	150% for one minute and 125% for ten minutes
Battery back up	15 minutes each (minimum)
Battery type	Sealed Lead acid maintenance free batteries (10 years design life)
Overall Efficiency	
Double-conversion load	up to 93%
ECO mode	up to 97%
Noise level	60dBA
Storage temperature	
UPSs with batteries	-25°C +45°C
Operating temperature	0 to 35°C
Humidity condensation at temperature.	45% up to 95% without ambient
Standards & Certifications	
Design and manufacture	ISO 9001, ISO 14001, IEC 60146
Construction and safety	IEC 60950, EN 50091-1, IEC 62040-1
Protection level	IEC60521, IEC 62040-2, EN 50091-2

Certifications	TUV, CEC
----------------	----------

Performance and topologies	IED 62040-3, EN50091-3
Degree of Protection	IP20

PART 3 – EXECUTION

Installation

Install in accordance with manufacturer's instructions.

Tests

Demonstrate operation uninterruptible power supply by simulating an outage.

SECTION 16

FIRE ALARM

SYSTEM

PART 1 -GENERAL

1.01 WORK DESCRIPTION

- A. The work under this section consists of supplying, installing, testing and commissioning of all material and services of complete Fire Alarm System as stated herein, as shown on Tender drawings and as given in the Bill of Quantities.
- B. The Contractor will discuss the electrical layout with the Engineer and coordinate at site with other services for exact route, location and position of electrical lines and equipments.
- C. The Fire Alarm System with accessories shall also comply with the basic electrical requirement for Electrical Works Section 1 and with other relevant provisions of the Tender Documents.

1.02 SUBMISSION

- A. All technical submissions shall be approved by the Engineer prior to the respective stages of construction.
- B. As a minimum requirement, the submission shall include the following:
 - 1. Equipment submission with manufacturer's data.
 - 2. Sample submission including all types of detectors, sounder, manual call points etc.
 - 3. Drawings for field equipment showing the co-ordinate routing of cable routings and details coverage calculations of detectors.
 - 4. Builder's work requirements.

1.03 APPLICABLE STANDARDS / CODES

- A. The following standards & codes shall be applicable for the materials covered within the scope of this section:
 - 1. NFPA 72 : National Fire Alarm Code
 - 2. NFPA 101 : Life Safety Code

The system shall have ability to perform satisfactory under conditions of electrical surges and transients, and shall comply fully with the requirement of the following standards as required by EN 54:

1. IEC 801 – 2 : Electrostatic discharges
2. IEC 801 – 3 : Radiated Electro magnetic interference
3. IEC 801 – 4 : Voltage transients – Fast transient bursts.

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 Underwriters Laboratories (UL) & shall bear the UL label. Equivalent DIN or British standard shall also be acceptable.

1.04 GENERAL

1. The network facility shall provide alarm reporting, coordinated evacuation and cross panel cause and effect operation. System control and graphic display computer shall be provided for the network. The building Control Panel shall act as system master, displaying complete system status, system control and graphic display computer shall also show complete network status and allow control functions to be operated separately. Remote diagnostics facility shall be provided for both fault diagnosis and system configuration offsite.
2. Relevant AHU and fire dampers shall be closed upon receiving an alarm signal from the area smoke/heat detector.
3. Automatic FM 200 / Novec system, if installed shall function on dual detector principal with dual progressive alarm warning prior to flooding. Flooded rooms shall remain in the alarm state till reset at theFACP.
4. In the event of fire the lifts shall automatically remain at their position or stop at the next floor. Restarting shall only be possible from the controlpanel.
5. Activation of any fire alarm detector including manual call point of terminal building shall result in all alarms delay for the period of either of two programmable timers "T1" and "T2". During this delay, only a local alarm shall be given (stage-1). If the local alarm is not acknowledged before timer "T1" expires, this shall result in all alarms being operated continuously (stage-2). If the local is acknowledged while "T1" is still running, "T1" shall reset and the general alarm is delayed for the reminder of timer "T2", so providing time for human investigation of the alarm cause. If no reset action takes place before "T2" runs out, a general alarm (stage-2) results.
6. The power to Main Fire Alarm Control Panel, printer, and Repeater panel shall be supplied by UPS which shall have an autonomy of 12 hours.
7. Repeater panel shall display alarm and fault indication of fire alarm control panel.
8. The main fire alarm control panel shall facilitate communication with other fighting stations so that additional help can be obtained in case of emergency.
9. A printer shall give a hard copy of all alarms, detector number, location and time. The printer pages shall be numbered and page number resetting shall be pass-word protected.
10. All outlet boxes shall be considered part of the devices installed on them and shall be supplied alongwith the devices.
11. The system shall operate on 24 VDC from a battery charger with standby batteries. The incoming supply shall be 230 VAC from emergency circuit.
12. The Addressable Fire Alarm System shall be used for early detection, warning and control function in case of fire. The system shall monitor and report the status of manual call points and automatic fire detectors. All the Intelligent Sensors detailed above shall incorporate the

following facilities:-

- Up to 99 Sensors and 99 control modules shall be connected to each loop.
 - The Sensors shall be ceiling - mount and shall include a twist-lock base.
 - The Sensors shall provide a means of test whereby they will simulate an alarm condition and report that condition to the Control & Indicating Equipment (C.I.E.) Such a test may be initiated at the Sensor itself (by activating a magnetic switch) or initiated remotely on command from the C.I.E.
 - The Sensors shall provide address setting on the Sensor head using decimal switches. Addressable Sensors that use binary address setting methods, such as a dip switch, code cards or soft addressing are not acceptable. The Sensors shall also feature an internal identifying code that the C.I.E. shall use to identify the type of Sensor.
 - The Sensors shall provide dual LED's. Both LED's shall flash under normal conditions, indicating that the Sensor is operational and in regular communication with the C.I.E. Both LED's may be placed into steady illumination by the C.I.E., indicating that an alarm condition has been detected. If required, the flashing mode operation of the Sensor LED's shall be controlled through the system field program. An output connection shall also be provide in the base to connect an external remote alarm LED.
 - The Sensor sensitivity shall be set through the C.I.E., and shall be adjustable in the field through the field programming of the system. Sensitivity may be automatically adjusted by the C.I.E. on a time-of-day basis.
 - Using software in the C.I.E. the Sensors may automatically compensate for dust accumulation and other slow environmental changes, that may affect their performance.
13. The Contractor shall provide wall chart for operation and maintenance of Fire Alarm System. The wall chart shall contain following minimum information in both English and Urdu languages.
- Complete layout of Fire Detection & Alarm system showing locations of all fire zones, and bells zones in two different colours.
 - 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.

PART 2 –MATERIAL

2.01 Analogue Addressable Fire Alarm Control Panel

1. The system shall be easily configured using 'plug-in' addressable loop drivers and communication modules. Further 'plug-in' modules shall be available to allow the expansion of programmable inputs and outputs.
2. The Power Supply shall operate on 230 VAC, 50 Hz, and shall provide all necessary power for the controlpanel.
3. In the event of a mains electrical failure, the fire alarm control panel shall have the capability of being supported in its intended state by standby batteries for 12 hours. The fire alarm control panel shall be fitted with an integral battery charger, current limited with DDP for 24 V lead acid batteries. The battery charger must be capable of being up- graded in capacity to facilitate larger systems.
4. The panel shall provide required number of fully programmable fire outputs each with volt-free changeover contacts rated at 24 VAC/DC, 1 Amp maximum.
5. The panel shall have 14 general panel status LED's. An alphanumeric liquid crystal display shall give 80 characters of information on a 2-line display. The display will be illuminated to aid viewing under dim ambient light conditions.
6. Zonal fire indicators (LED's) and zonal fault/test/disabled (LED's) shall be provided. It shall be possible to increase the number of zonal fire and fault/test/disabled LED's simply by "plug-in" extender cards.
7. An on-board alphanumeric keypad with keys shall allow the complete control and configuration of the system. Alternatively the panel shall be programmed using PC based upload/download software.
8. Four separate push buttons shall provide control of Sound Alarms (Evacuate), Silence/Resound, Mute/Accept and Reset, and shall be located adjacent to the main LED indication.
9. The panel shall have two serial communication ports. An optional "plug-in" RS485 or RS232 card will support a PC front-end graphics package or panel network connection. An RS485 peripheral bus shall support a further 126 addresses in addition to the detection loops. Peripheral bus shall support a further 126 addresses in addition to the detection loops. Peripheral devices shall include; display only and active repeater panels, remote printers, 8-way input cards and 4-way sounder & relay cards.
10. A dedicated RS232 port shall also be provided for both connection to a local printer and upload/download of configuration data via the manufacturer's standard PC programming tool.

-
11. **User Control Levels:** - The fire alarm control panel shall have three user control levels.

At all three levels, the LED displays shall indicate the condition of the installation, the zone LED's shall indicate the location of any fire alarm or fault and the alphanumeric display shall provide detailed fire alarm or fault information.

Level 1 - All displays shall be functional, but the front panel controls shall be inhibited.

Level 2 - All displays and all front panel controls shall be functional. Changes to the system configuration shall not be accessible at this level. User Level 2 shall be reached by entering a unique 4 digit password from level 1.

Level 3 - All front panel controls shall be functional and full system configuration and programming shall be possible. User level 3 shall be reached by entering a unique 4 digit password from either level 1 or level 2. User level 3 shall be for use by the system installer

/ maintenance contractor.

A level 2 password shall not allow access to level 3 functions. Up

to 10 level 2 passwords shall be definable from level 3.

12. A program integrity option shall display the panel software version along with ROM and RAM checksums. The RAM checksum shall alter whenever the configuration is changed. For example, the checksum figure shall change when either adding or removing devices or changing text assignments. After the final configuration has been entered the program integrity shall be checked and the RAM checksum figure recorded.
13. **Day Modes:** - The fire alarm control panel shall have the ability to automatically invoke different operating modes according to the time of day. Each mode shall have adjustable start and finish times. Outside of the designated start and finishing times, the panel shall revert to normal operation. The operating modes will consist of:
14. **Delayed mode** - During the day or night the alarm signal from the detection points shall be immediately recognized and identified on the panel display, but no outputs switched on until staged timers have expired.
15. **Sensitivity mode** - Shall allow smoke and temperature detectors to use different pre-alarm and fire alarm thresholds during day and night mode.
16. **Verification mode** - Shall allow smoke detectors to tolerate transient alarms according to the programmed verification delay time during either day or night.
17. **Control Module** - Addressable Control Modules shall be provided for fan shut down and other auxiliary control functions, the control module may be set to operate as a Volt Free relay contact.

-
18. The indicating circuit may be wired for a maximum of 1 Amp (inductive) or 2 Amps of Resistive A/V Signal operation, or as a Volt Free Contact (Form C) Relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to ensure that 100% of all auxiliary relay or indicating circuits may be energised at the same time on the same loop.

- 19 The Control Modules shall provide address setting on the module using decimal switches. The modules shall also feature an internal identifying code that the C.I.E shall use to identify the type of module.

20. A magnetic test switch shall be provided to test the module without opening or short line its wiring. The isolator module shall be installed on the semi flush mounted box.

21. **Isolator Module:** - Isolator Modules shall be provided to automatically isolate circuits on a loop. The Isolator Module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the loop. At least one isolator module shall be provided at either side of each zone of the building.

If a wire-to-wire short occurs, the Isolator Module shall automatically open-circuit (disconnect) the affected segment of the loop. When the short circuit condition is corrected, the Isolator Module shall automatically reconnect the isolated section of the loop.

The Isolator Module shall not require any address setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an Isolator Module after its normal operation.

The Isolator Module shall be installed on the semi flush mounted box. It shall provide a single LED that shall flash to indicate that the Isolator is operational and shall illuminate steady to indicate that a short circuit condition has been detected and isolated.

Zone module shall be provided to monitor a zone of 2-wire conventional automatic and manual detectors. It shall respond to regular polls from the control panel and reports its type and status (open/normal/fire/short) of its zone circuit. A flashing LED shall indicate that the module is in communication with control panel.

22. **Event Log:** - The fire alarm control panel shall store the last 500 events. It shall be possible to set the event log to either "diagnostic" or "normal" mode. Normal is the default mode.

When in diagnostic mode the log shall record every event including single response failures from a device. The diagnostic mode shall aid the engineer to determine spurious or transient fault conditions including loop wiring and detector problems, particularly if these are intermittent.

23. **Displayed Identification :-** During normal panel operation, when the fire alarm control panel is operating correctly, the LCD display shall display a message that identifies the system installer / maintenance company, this display shall feature up to 20 characters.

If a fault occurs on the fire alarm control panel the LCD display shall automatically show a telephone number to call for assistance, this display shall feature up to 20 characters.

-
24. **Cause-and-effect programming:** - The panel shall provide a flexible way of performing cause-and-effect programming. This shall include mapping individual detectors and call points to outputs as well as mapping outputs relative to zones in alarm.

In the event of a fire alarm, the indications shall be as follows:

- The zone alarm LED indicators on panels shall illuminate to show the zones in alarm on the overall system.
- It shall be possible to configure or 'inspect' devices from the panel.
- Upon actuation of any automatic detector and manual call point following shall occur automatically:
- FACP LCD display shall provide information pertaining to Fire Zone, type of device and location.
- Communicate alarm indication at the Master alarm panel of building.

2.02 Manual Call Points

Manual Call Points shall be constructed of flame retardant plastic with clearly visible operating instructions provided on the glass or resettable plastic element. The word FIRE shall appear on the front of the Call Points.

Manual Call Points shall be suitable for semi-flush mounting as required.

The addressable Manual Call Points shall provide address-setting means using decimal switches.

2.03 Ionization Smoke Sensors

The Smoke Sensors shall be of ionization type and will work on disturbance of current following between two electricity charges plates, caused by a radioactive material placed between the plates.

- | | | | |
|---|-------------------|---|---|
| - | Operating Voltage | : | 16 – 26 V DC |
| - | Monitoring | : | Open and short circuit fault, sensor removal and device |
| - | Area Coverage | : | type.
100 m ² |

2.04 Multi Sensors

The multi sensors shall incorporate ionization type smoke sensor and high sensitivity thermal sensor and provide early warning from all types of flaming and thermal fires. The smoke element shall have a small amount of radioactive material between two electricity charged plates which ionizes the air and cause current to flow between plates. The thermal element shall utilize high sensitivity, high speed thermistors optimized to measure small changes in temperature and rate of change. The detector shall be capable of protecting an area up to 100 m² at a height of up to 12 m.

2.05 Heat Sensors

The heat sensors shall use an electronic sensor to measure thermal conditions caused by a fire. Heat sensor shall have following minimum technical specifications.

- Operating Voltage : 16 – 26 V DC
- Monitoring : Open and short circuit fault, sensor removal and device type.
- Area Coverage : 80 m²

2.06 Multi-Criteria Detectors

Multi-Criteria detector has the ability to detect all four sensing elements of a fire (Smoke, Flame, CO, Heat). The integration of continual monitoring for these elements leads to a detector that responds more quickly to an actual fire with the highest immunity to nuisances.

2.07 Sounder

Sounder shall be addressable devices and shall connect to one of the C.I.E. loops / sounder circuits. Multiple tones shall be provided with automatic tone synchronization of all sounders connected to the loop. Dual sound path shall allow a wide angle of sound distribution with a constant sound level. Self test facility shall allow all sounders to be tested from the control panel by one person. Sounder shall provide high output 90 dBA to 112 dBA at 1m.

2.08 Audio Visual Alarm Device

Audio Visual Alarm device shall be addressable and shall connect to the C.I.E. loop/sounder circuits.

Audio Visual alarm device shall provide following minimum features:

Operating Voltage	:	24 VDC
Strobe output rating	:	110 Cd
Strobe flash rate	:	Once every two seconds
Sound output	:	75 dB @ 3 m
Housing colour	:	Red with white "FIRE" lettering
		Mounting
		Semi flush

2.09 In-duct Smoke Sensor Housing

In-Duct Smoke Sensor Housing shall accommodate through an addressable Ionisation Sensor to provide continuous analogue monitoring and alarm verification from the C.I.E.

When sufficient smoke is present within the sensor detection chamber, an alarm signal is initiated at the C.I.E. and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.

2.10 Repeater Panel

Repeater panel shall show the same information as the main control panel, but at a remote location.

2.11 Computer

The branded computer with licensed software which shall include operating system and Application Software. Back up software shall be supplied on separate CDs. Computers shall be of the latest Specifications and shall minimally comply with the following:

Processor	Latest
Hard Disk	> 500 GB
RAM	> 8 GB
Monitor	22" LCD

2.12 Wiring and Cabling

Wiring and cabling of Fire and alarm system shall be carried out in conduits. 2 Core Twisted pair 1.5sqmm (minimum) untinned annealed copper cable with PVC insulation and LSF sheath shall be installed for Fire Alarm System or as recommended by manufacturer for addressable detectors.

All wires and cables shall be colour-coded, tagged and checked for open, short or ground faults. No transposition of colours 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.

2.13 Conduits, Pipes and Accessories

Conduits, pipes and accessories for Fire alarm system shall have same specifications as given in section 'Conduits system, Cable Tray, Cable Ladder and Trunking Installation' of these specifications.

PART 3 –INSTALLATION

3.01 Fire Alarm System Equipment

The installation of 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 sensitivity tests. The automatic detectors shall be tested in various ways to check real and false alarm behaviors.

3.02 Wiring and Cabling

Wiring and cabling of fire alarm system shall be carried out as per instructions given in Section 'Wire & Cable' of these specifications.

3.03 Conduits and Accessories

Conduits and accessories for FA system shall be installed as per instructions given in section 'Conduits system, CableTray, CableLadder and Trunking Installation', of these specifications.

PART 4 –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:

1. Detailed explanation of wall charts as mentioned in Article 1.04 of this section.
2. Function of each control switch
3. Periodic operational testing of panel/devices.
4. Maintenance of fire log book supplied by manufacturer.
5. Actions to be taken upon receiving following signals:
 - False alarm indication
 - Trouble on any initiating or indicating zone
 - Common alarm or common trouble indication
 - Low battery voltage indication
6. Field modifiable programming.

PART 5 –TESTING

Provide the service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and commissioning of the system.

1. Before energizing the cables and wires, check for correct connections and test for short circuits, earth faults, continuity, and insulation.
2. Verify activation of all flow switches.
3. Open initiating device circuits and verify that the fault signal actuates.

4. Open signaling line circuits and verify that the fault signal actuates.
5. Open and short indicating appliance circuits and verify that fault signal actuates.
6. Earth initiating device circuits and verify response of fault signals.
7. Earth signaling line circuits and verify response of fault signals.
8. Earth indicating appliance circuits and verify response of fault signals.
9. Check presence and audibility of tone at all alarm notification devices.

10. Check installation, supervision, and operation of all intelligent smoke sensors during a walk test.
11. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the C.I.E. and the correct activation of the control points.
12. When the system is equipped with optional features, the manufacturer's manual should be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

SECTION 17

CLOSED CIRCUIT TELEVISION SYSTEM

PART 1 - GENERAL

1.01 WORK DESCRIPTION

- A. This Section specifies the minimum acceptable requirements on the quality, performance and standard of the Close Circuit Television (CCTV) System.
- B. The System shall be used for general surveillance and security monitoring of public and dedicated areas.
- C. The System shall be constructed in accordance with the manufacturer's specification. Any equipment modifications to meet the Specification shall not be acceptable.
- D. All equipment shall be current model, no replacement problem of components.
- E. The CCTV System shall, in addition to the compliance of minimum requirement stipulated in this Specification and as shown on the Drawings, allow at least 20% spare on both software and hardware facilities including a camera wiring termination panel for future expansion.
- F. All cablings shall be laid in conduits and trunkings. No cabling shall be run exposed.
- G. The CCTV system shall be equipped with multi-screen controller to view several camera pictures on a single monitor. It shall be protected by password for accessing to the system programming to prevent tampering and misused by unauthorized personnel.
- H. All programmed settings for the controller shall be stored in non-volatile memory and render no re-programming is necessary in the event of a power failure.
- I. Motion detection alarm signals shall be provided under the CCTV system for transmission to the Intrusion Alarm System. The CCTV system shall provide whatever interfacing requirement to complete the installation.

1.02 SYSTEM INTERFACE

- A. Interface with Access Control System (CACS)
 - 1. The CCTV system shall provide input interfacing to the CACS. The CACS shall provide "Normally Closed" dry contact output (free voltage) to the CCTV console. The CCTV system shall then connect these CACS alarm outputs to its input module.
 - 2. Upon receiving an "open contact" signal from the CACS system, the CCTV controller shall

immediately display the pre-programmed camera to the monitor. At the same time, the Digital Video Recorder (DVR) shall also be recorded in normal speed.

B. Interface with Electrical System

1. A power supply shall be provided for the CCTV system inside the security room. The Contractor shall be required to provide his own power distribution system to all central control and monitor equipment inside the security room and FCC room.
2. A 13A non-switched fused connection unit/Spur outlet shall be provided for each CCTV camera by the Contractor.

C. Interface with Intrusion Alarm System

1. The CCTV system shall provide input interfacing to the Intrusion Alarm System. The Intrusion Alarm System shall provide "Normally Closed" dry contact output (free voltage) to the CCTV console. The CCTV system shall then connect these Intrusion Alarm System outputs to its input module.
2. Upon receiving an "alarm contact" signal from the Intrusion Alarm System, the CCTV controllershallimmediatelydisplaythepre-programmedcamera to themonitor. At the same time, the Digital Video Recorder (DVR) shall also be recorded in normal speed.

D. Interface with Fire Alarm System

1. The CCTV system shall provide input interfacing to the fire alarm system. The Fire Alarm System shall provide "Normally Closed" dry contract output (free voltage) to the CCTV console. The CCTV system shall then connect these Fire Alarm system outputs to its input module.
2. Upon receiving an "alarm contact" signal from the Fire Alarm System, the CCTV controller shallimmediately display the pre-programmed camera to the monitor. At the same time, the Digital Video Recorder (DVR) shall also be recorded in normal speed.
3. The interface with Fire Alarm System shall share the interfacing signal for Public Address System given by the Fire AlarmSystem.

1.03 SUBMISSION

A. All technical submissions shall be approved by the Engineer prior to the respective stages of construction.

B. As a minimum requirement, the submission shall include the following:

1. Equipment submission with manufacturer's data.
2. Sample submission including camera housings, mounting brackets with accessories for flexible conduit entry, cables, and lens covers for lift camera, etc.
3. Drawings for field equipment showing the co-ordinate routing of cable routings and details coverage calculation on the selection of lens for each camera.
4. Builder's works requirements.

PART 2 – SYSTEM DESCRIPTION

2.01 CENTRAL CONTROL & MONITORING EQUIPMENT

- A. Unless otherwise specified, the system shall be a multiplexer based system with the following central control and monitoring equipment housed in the security room:
 - 1. Video controller – for pan/tilt/zoom/focusing of cameras.
 - 2. Multiplexer – for selection of different modes of split screen
 - 3. CCTV monitor – for monitoring and playback purpose
 - 4. Digital Video Recorder (DVR)
- B. Video signals from cameras shall be transmitted through multiplexer simultaneously to CCTV monitors and DVR. Selection of monitoring and recording can be performed through the multiplexer. The location codes shall also be displayed onto the monitor screen to identify the locations of cameras.
- C. Cameras shall be wired back to the multiplexer and the digital selection and control keyboard allowing the operator to select the cameras for recording and/or pan/tilt/zoom/focus control.
- D. Through the multiplexer, video signals from cameras shall be recorded in the Digital video Recorder. Date, time and the location code of the cameras shall also be recorded.
- E. The multiplexer shall be able to receive alarm signals to perform automatic video recording by appropriate alarm activation.
- F. The control keyboard shall be provided for user interfaces, including the generating texts in pictures by showing setup menu, video identification, alarm and control text.
- G. The alarm management system shall detect and respond to mechanical alarms, video loss alarms and recorded alarms. Alarm messages shall be displayed on screen by default. The system shall provide alarm input for each camera input and triggers the DVR's alarm recording speed when alarm input is received.

2.02 FIELD EQUIPMENT

- A. CCTV cameras shall be installed in strategic locations where local surveillance is required as indicated on the Drawings.
- B. All CCTV cameras shall be wired back to the central CCTV equipment as indicated on the Drawings for the central monitoring by the security personnel.
- C. Solid state CCTV cameras of CCD type shall be used for indoor and outdoor applications.
- D. CCTV cameras shall generally complete with standard lens. Fixed type cameras with wide angle lenses shall be employed inside lift cars. Camera with zoom lens, telephoto lens or pan/tilt mechanism shall be used to extend the coverage. Details shown on the Drawings are reflecting

the performance requirement. Specialist selection of proper lens to suit the location of use and coverage shall be responsibility of the Contractor.

- 2.03** The exact location, installation detail and finishing for each camera housing shall match the interior detail and subject to the approval from the Engineer. The Contractor shall be responsible to co-ordinate with Building work and make necessary provision for mounting of the CCTV cameras.

PART 3 – CENTRAL CONTROL & MONITORING EQUIPMENT

- 3.01** All central hardware equipment shall be housed in a control console. This section shall indicate the major central equipment required for the operation and control of the CCTV System. Exact system configuration and quantity of equipment shall be as indicated on the Drawings and as required to complete the installation.

3.02 VIDEO CONTROLLER

- A. The video controller shall contain numeric/function keys for recording selection, camera selection, pan / tilt / zoom / focus and control sequential display etc.
- B. The video controller shall also be able to perform the following functions as minimum requirements:
 - 1. Provide full capability to display any camera to any monitor including camera sequencing and alarm display with pre-position call up capability for pre-position cameras.
 - 2. Alarm handling depending on the number of multiplexer. Alarm shall initiate an audible alert on the keyboard.
 - 3. Generating text in picture by showing setup menu, video identification, alarm and control text.
 - 4. Monitor output and DVR output with time, date, camera number, camera description, alarm number and description display.
- C. The video controller shall be a micro-processor based self-contained matrix video switching device to enable multiplex video inputs (i.e. camera pictures) to be switched to a number of video outputs (i.e. monitors) and incorporating camera control functions, text in picture options and alarm handling. The unit shall be capable of switching 200 colour or monochrome video inputs to 12 video outputs.
- D. The unit, when used in conjunction with cameras, monitors and printer, enables the operator to control and monitor, with the aid of text in picture, a complete security control monitoring system.
- E. The unit shall enable a number of colour or monochrome video inputs to be switched to a number of video switching systems. Operation can be from either a keyboard or a PC. The unit shall be provided with a number of features to enhance operation and control as follows:
 - 1. Text in picture generator for setup menus, video input/output identification, alarm and control text including time and date.
 - 2. Video input/output handling for selection of monitors and cameras, grouping of cameras to monitors, displaying of alarms etc.
 - 3. Camera control for remote pan, tilt, auto-pan, zoom, focus, wiper and washer controls etc.

4. Events handling to switch pre-selected inputs to dedicated outputs in case of alarms and/or preset events, displaying with all details on alarm contents, time, date etc.
 5. Video presence detector to indicator loss of video input signal (sync pulses) with a warning text on the default monitor.
- F. A maximum of 8 keyboards shall be able to connect via a multi-drop line or in a “star” configuration. Keyboard selections shall be as follows:-
1. Numeric keys for camera, monitor and text selection.
 2. Directional cursor key for searching through the menu screens when edition/inserting or viewing configuration data.
 3. Monitor function keys for monitor selection, salvo, sequencing and sequences hold selection.
 4. Camera lens control keys for zooming and focusing.
 5. Camera function keys for wiper and washer functions.
 6. Alarm acknowledge button.
 7. Camera directions keys; for camera tilt/pan control.

3.03 MULTIPLEXER

- A. As a minimum requirement, the technical specification of multiplexer shall be as follows:

- | | | |
|-------------------------------|---|--|
| 1. Type | : | Time division multiplexer, high quality colour and monochrome recordings |
| 2. Camera Inputs | : | 16 x BNC with loop through |
| 3. Monitor Outputs | : | 1 for main monitoring
(digital output)
1 for spot monitoring \ (analogue output) |
| 4. DVR Connection | : | 1 no. |
| 5. Pixel Resolution | : | 720 H x 576 V |
| 6. Playback Display | : | Full, Zoom, 4-way split, 9-way split, 6-way split, 8+2 display, picture in picture |
| 7. Text on Screen | : | Time, date, 8 characters (minimum) camera identification |
| 8. Alarm Inputs | : | 16 |
| 9. Aliasing (anti-flickering) | : | Yes Auto |
| Configuration | : | Yes |
| Digital Action Deletion | : | Yes |
| Cascading | : | Yes |

- B. Additional features shall be incorporated as standard to further enhance the surveillance, viz.

1. Freeze picture
 2. Multiple Sequential Switching in each sector
 3. Alarm activation c/w output to trigger other equipment (eg DVR) or devices.
 4. Zooming of picture
 5. Camera Identification and time/date
- It shall be flexible and user friendly and can be easily configured to meet all basic applications for any CCTV Surveillance System.

- C. Alarm inputs shall be programmed for different response for each individual alarm activation. Enable and disable of alarm shall be through the multiplexer keyboard.
- D. Together with the interface unit to the Card Access Control System, Intrusion Alarm System and Fire Alarm System, the pre-programmed camera shall automatically be switched to the monitor for quick and closer examination.
The alarm inputs shall be enable or disable from the keyboard. Alarms shall be indicated as flashing LEDs on the keyboard individual camera giving the ease of recognition and operation.

3.04 CCTV MONITOR

- A. CCTV Monitors shall be solid state type, colour monitors (unless otherwise specified) complete with front controls including power on-off switch, brightness, contrast, vertical and horizontal hold.
- B. As a general requirement, monitors shall be of 21-inch (as specified) for split screen and 21-inch for playback use. The exact quantity and requirements shall also be referred to the Drawings.
- C. Each monitor shall have high resolution LCD or plasma display with the remaining circuitry of solid state construction.
- D. High resolution colour monitors shall be maintained by using 10 MHz (± 3 dB) bandwidth video amplifier with a maximum geometric distortion of 2%.
- E. Other technical specifications shall be as follows:

- | | | | |
|----|-----------------------|---|------------------------------|
| 1. | Video Input Level | : | 1.0v p-p |
| 2. | Video Input Impedance | : | 75 ohms or high impedance |
| 3. | Resolution | : | High |
| 4. | Linearity | : | 2% or less of picture height |
| 5. | Operating Temperature | : | 50°C |
| 6. | Operating Voltage | : | 230VAC \pm 10%, 50Hz |

3.05 DIGITAL VIDEO RECORDER

- A. The Digital Video Recorder described in the following specification shall be IP based & function as a digital video recorder interface with the Multiplexer. The DVR shall allow simultaneous recording and playback of video images and provide overwrite protection of marked video clips to prevent loss of vital material.
- B. The images per second record rate and image quality shall be selectable for each connected camera. The Digital Video Recorder shall provide external alarm inputs and video motion detection operation.
- C. Supplied Control Center software shall allow remote viewing of live and recorded video.

- D. Video may be archived to a PC and then recorded to a CD-ROM. The DVR shall use video authentication that can automatically detect any alteration of the recorded video.

- E. The system shall be fully compatible with any standard and protocol of 10/100 Base T network making it ideal for distributed security surveillance systems. Storage arrays shall be connected to allow expanding the storage capacity.
1. General Requirements:
 - a. The system shall display a quick install menu the first time the unit is started to minimize the installation startup time. When the menu is closed, the unit shall begin to record automatically.
 - b. The system shall provide 6, 9, or 16 looped-through, auto-terminating camera inputs as required by the application.
 - c. The system shall provide 320GB hard disk storage as required by the application (Unless otherwise specified).
 - d. The system shall have a function that blocks the playback from any or all cameras after a specified period of time. When the specified time has elapsed, no recordings before that time can be played back from the selected camera(s). Programming of the block time shall range from No Blocking at all up to 31 days.
 - e. The system shall record multiple camera signals while simultaneously providing live multi-screen viewing and playback.
 2. The system shall provide two modes of recording:
 - a. The first mode shall continuously record to the disk by overwriting older data, but shall also provide overwrite protection of the latest files for a period of up to 15 weeks.
 - b. The second mode shall record to the disk and then provide a warning when the disk is nearly full and will stop when the disk is full. Older recordings must then be manually deleted.
 - c. The images per second record rate and image quality shall be selectable for each connected camera so as to allow prioritisation between high-risk and low risk areas of surveillance.
 - d. A main monitor composite video output shall display full-screen, quad, or multiscreen live or playback camera pictures. This monitor displays status messages, events, alarms, and video loss warnings. This monitor also displays the menu when selected.
 - e. A secondary composite video output shall display a single full-screen picture of a selected camera or a sequence of full-screen pictures. This monitor also displays alarmed or action detected video and will sequence the video in the case of multiple alarms or action.
 - f. The system shall provide on-screen help for all topics.
 - g. The system shall accept external alarm inputs via NO/NC contacts.
 - h. The system shall have a pre-event function that records up to 30 seconds of video that occurred prior to the activation of an alarm.
 - i. The system shall provide Motion Detection capability.
 - j. System shall be expandable using an optional control keyboard allowing AutoDome control and enhanced playback control.
 - k. The system shall provide video loss detection.
 - l. The system shall provide an authenticity check for playback at the local unit and at the remote unit. A dedicated PC player shall be provided for playback of secure video files.
 - m. The system shall be capable of interfacing up to 16 units when used with a Video Management System (Unless otherwise specified).

- n. The system shall provide digital storage arrays to be connected so as to provide mass storage of video files.
3. Control Center Software:
- a. The system shall allow for remote access software to view live video, playback pre-recorded video, and to configure the system via a network.
 - b. Each system shall be capable of supporting up to six remote users in other security room and office room.
 - c. The system shall be capable of streaming live video to the remote PC.
 - d. The remote camera control functions provided at the Control Center shall include pan, tilt, and zoom of the cameras, selective video archiving, and search of video by either time or alarms.
 - e. A stand-alone software player shall be provided so that saved video recordings can be viewed outside the Control Center remote access software.
4. System Configuration Tool:
- a. System setup shall be programmed from the front panel buttons of the unit or via A Configuration Tool supplied with the system and used from the remote workstation. The remote Configuration Tool shall be available only to the system administrator and will be password protected. The system setup using the configuration tool can be programmed to restrict the functions available to the users including search and playback functions.
- PAL Record Rates (images per second): 25, 12.5, 10, 7.5, 6, 5, 4, 3, 2, 1, 1/2, 1/5, 1/10, 0.
5. Electrical Specifications:
- a. Rated voltage and power: 230 VAC; 0.7- 0.3 A; 50Hz.
 - b. Video standard: PAL/NTSC auto-detect.
 - c. Video inputs: Composite video 0.5-2Vpp, 75-ohm auto-terminating.
 - d. Outputs: 1Vpp, 75 ohm.
 - e. BiPhase Control: Impedance 128 ohm, maximum overload protection $\pm 40V$,
 - f. Maximum cable length 1.5km.
 - g. Resolution: 720x484 NTSC; 720 x 576 PAL.
 - h. AGC- Automatic or manual adjustment for each video input.
 - i. Digital zoom: 2 or 4 times
 - j. Compression: Wavelet
6. Alarm Handling:
- a. Inputs: Configurable NO/NC, maximum rated input voltage 40VDC.
 - b. Outputs: Relay outputs, configurable NO/NC, maximum rated 30VAC, 40VDC,
 - c. 0.5A continuous 10VA.
 - d. Mechanical Specifications:
 - e. A rack mount kit shall be included to mount one unit in an EIA 19-inch rack.
7. Environmental:
- a. Operating temperature: 50°C
 - b. Relative humidity: Operating: 100% non-condensing

3.06 CONTROL CONSOLE

- A. Conduits or trunking must be installed in the console for proper cable laying. No cables shall be loosely placed. Each cable shall be clearly marked for ease of maintenance.

PART 4 – FIELD EQUIPMENT

4.01 CCTV CAMERA

- A. Cameras shall be manufactured to give maximum performance and dependability for indoor and outdoor applications. The proposed camera for lifts shall be hidden in false ceiling or hidden behind a mirror or dark glass panel.
- B. The cameras shall have high quality printed circuit boards for maximum durability and ease of service. The camera shall be low light level type, interline transfer charge coupled device type to allow operation in any practical security application.
- C. The camera shall have beam and electrical focus control and be accessible without cover removal. All other adjustments shall not be possible without cover removal.
- D. Line lock synchronisation shall be applicable for all cameras. The Contractor is responsible to ensure all cameras can be adjusted by line lock tools, if necessary.
- E. Each camera shall incorporate a vertical control pot that shall adjust the vertical phase of the signal from 0° to 360°. The unit shall be used to maintain the camera signals vertically in phase so that the applications of vertical interval switching, sequential camera scanning, Digital Video Recorders can be adopted to the system. Switching from one camera output to another shall be crisp clean and immediate without visual disturbance characteristics of random interlace.
- F. The system used shall be CCIR 625 lines 50 fields per second. The solid state camera shall be tropically finished, tamper and weatherproof with CCD image sensor and automatic light compensation suitable for operation at minimum illumination of 1 lux, with f1.4 lens and having a resolution of at least 380 lines at centre. The minimum S/N ratio shall not be less than 43dB.
- G. Camera number identification shall be integrated into the camera and a particular location code shall be assigned for each camera. No two cameras shall bear the same code in the whole development.
- H. Fixed Type Camera

The camera shall have the following technical specification:

- | | |
|-----------------------------|---|
| 1. Lens | : Auto Iris, focal length ranged from 3.7mm to 16mm subject to the required CCTV coverage and to be submitted for approval of the Engineer before ordering. |
| 2. Scanning Standards | : CCIR 625 lines, 50 fields. |
| 3. Video Frequency Response | : Greater than 8 MHZ. |
| 4. Horizontal Resolution | : Better than 330 Lines(colour) |
| 5. Video Output | : Volt p-p composite video 75 ohms. |

- 6. Synchronisation : Internal line lock, 2:1 interlace and external genlock.
- 7. Single to Noise Ratio : Better than 45dB.
- 8. Automatic Light Compensation : 60,000 to 1 with auto-iris-spot filter lens.

- 9. Required Illumination : 1lux to 10,000 lux with f1.2 lens (colour).
- 10. Ambient Temperature : Up to 60°C. (For outdoor usage)
Up to 50°C. (For indoor usage)
- 11. Type : 1/3 inch interline transfer charge coupled device (CCD) type for indoor and outdoor cameras.

I. Automatic Pan/Tilt Type Camera

The automatic pan/tilt camera shall be similar to that of the fixed type except that the following additional facilities shall be incorporated:

1. Horizontal (Pan)
 - Panning angle : 20° to 320° (adjustable)
 - Speed : 6 Deg per sec.
 - Direction : Adjustable, remote control.
2. Vertical (Tilt)
 - Tile angle : +20° and -40°
 - Speed : 3 Deg per sec.
 - Direction : Adjustable, remote control.

Automatic light compensation device shall be provided for all Pan/Tilt type cameras.

J. Camera with Remote Control Mechanism

This type of camera shall either be fixed type or automatic pan/tilt type, complete with remote control box for remote control from the control console for the following operations:

1. Pan : Auto-Manual mode, left and right
2. Tilt : Auto-Manual mode, up and down (for all camera with zooming mechanism)
3. Zoom : Short and long
4. Focus : Near and far

Automatic light compensation device shall be provided for all cameras with remote control mechanism.

K. Video Amplifier (if applicable)

1. Video amplifier shall be provided if the video transmission signal is degraded by the coaxial cable. The Contractor shall be responsible to ensure of a good video signal transmission in order to achieve a clear picture in the control console's monitor.

4.02 CAMERA HOUSING

A. Indoor Camera Housing

1. All indoor cameras, including those for lift cars, shall be equipped with indoor housings to provide protection for the cameras and to prevent tampering. This shall be done by equipping necessary tamper alarm circuit which shall be connected back to the respective control console for warning if being tampered. Tamper alarm switch and signal shall be provided for each camera. Such camera signal shall be automatically displayed onto the monitor for immediate identification.

2. The construction of the housing shall be one piece extruded aluminium housing not less than 1.2mm thick with keylocked.
3. Mounting bracket shall be provided for each camera and housing. Mounting brackets shall be so manufactured to provide rigid support and to resist tampering and environmental conditions. To facilitate durability, mounting brackets shall be constructed of steel and aluminium, zinc plated and capable of supporting a minimum weight of 20 kg.
4. Proper cable entry by means of G.I. flexible conduits with PVC insulation into the cameras housing shall be provided. Samples shall be submitted for approval.
5. For housings inside ceiling void, maintenance access shall be co-ordinated by the Contractor with Buildingwork.

B. Outdoor Camera Housing

1. The housings shall be water-tight of an insulation rating IP65, and be manufactured to protect the cameras from dust, water, moisture and temperature outside the ambient limits of the cameras.
2. The housings shall be constructed in two pieces to suit the camera; which are the mounting base and removable housing cover. The mounting base shall be of plated steel. The cover shall be of brushed, anodised aluminium to eliminate the need for sun shroud. Tamper alarm circuit shall be provided similarly to the indoor housing.
3. The following shall be provided for each housing:
 - a. Filtered Blower System – thermostatically controlled to operate in all housing.
 - b. Close Circuit Warning System – tamper alarm circuit to be reported to the control console.
4. Proper cable entry by means of G.I. flexible conduits into the cameras housing shall be provided. Samples shall be submitted for approval.

4.03 **CABLING**

- A. The coaxial cables used in the CCTV System shall be 75 ohm impedance copper cable specially manufactured for transmitting video signals. The cable shall consist of a single wire or stranded conductor of 1/1.12mm minimum, insulated with cellular, a braided copper screen forming the second conductor with a PVC sheath to protect the screen. The cable shall comply to BS EN 50117-2 Part 3.
- B. The coaxial cable shall be protected against mechanical damage, electrical interference causing malfunction, and free from excessive attenuation of signal strength. No joint shall be allowed in between termination boxes.
- C. All multicore cables for control and monitoring purpose shall conform to BS 3573.
- D. For those cables running outdoor and inside PVC pipes, special coaxial cable and multicore cables of armoured type shall be employed to prevent any mechanical damage that may arise.
- E. Control and power cables shall be terminated by means of approved type terminations. Positive connectors may be used with prior approval from the Engineer. Video signal shall be terminated with coaxial plug connectors of acceptable type.

- 4.04 The Contractor shall co-ordinate with the Lift installation on the specification of the co-axial cable for the lift shaft. Selected cable shall be suitable and compatible to ensure a clear and optimum image from the CCTV system.
- 4.05 Lightning arrestors shall be provided for the circuit serving any outdoor cameras prior to connection back to the system.

SECTION 18

LIGHTNING PROTECTION SYSTEM

PART 1 - GENERAL

1.01 WORK DESCRIPTION

- A. The work to be done under this section comprises the supply and installation necessary for the complete installation of the Lightning Protection System.
- B. The Lightning Protection System shall be installed generally in accordance with BS EN 62305 and additional requirements of this specification. The system shall be of the Faraday-cage type and shall consist of air terminations, down conductors, joints and bonds, testing joints, earth terminations and earth electrodes. The general arrangement shall be as indicated on the Drawings.
- C. The lightning protection system shall comprise:-
 - 1. Air Terminations;
 - 2. Down Conductors;
 - 3. Joints and Bonds;
 - 4. Test Links
 - 5. Earth Terminations.
- D. Lightning protection system employing minimum 50sqmm stranded bare copper conductor as part of the down conductors shall be adopted as per Drawing specified. All requirements in the specification included down conductors shall be applied unless otherwise specified.
- E. Lightning protection of refer gantry shall not consist of air terminal and down conductor as specified in item C.

1.02 STANDARDS

- A. Complete installation shall be engineering and constructed in accordance with the latest revision of the following standards and the appropriate BS/IEC :
 - 1. BS EN 62305 - Protection against Lightning
 - 2. AS1768 - Lightning Protection
 - 3. BS7671 - Requirements for Electrical Installation
 - 4. IEC 61024-1-2 - Protection of Structures against Lightning
- B. The detail of the lightning protection system shall also conform to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in this Specification and Drawings, whichever is the more stringent and acceptable to the Engineer.

- C. In the adoption of standards and requirements, the Contractor shall take the following precedence:
1. Engineer's decision;
 2. Local codes of practice;
 3. Drawings;

4. Specification;
5. International standards and requirements.

1.03 SUBMISSION

All technical submissions shall be approved by the Engineer prior to the respective stages of construction.

- A. As a minimum requirement, the submission shall include the following:
 1. Equipment submission with manufacturer's data;
 2. Sample submission;
 3. Shop Drawings showing the co-ordinate routing of air terminations, down conductors bonding to re-bar and foundation earth terminations, methods of fixing etc.
 4. Builder's works requirement.
 5. Proposal on testing procedures and report format for testing of the Lightning Protection System.
 6. Detail of the Contractor's installation Professional Engineer who supervise and endorse the installation for occupation permit application.

PART 2 - PRODUCT

2.01 AIR TERMINATION

- A. The Contractor shall supply and install an air termination system consisting of continuous horizontal conductors.
- B. The conductors shall comprise of minimum 50sqmm Stranded Bare Copper unless otherwise specified, located as shown on the Drawings and securely fixed in place to the building structure. Wherever possible, the horizontal conductors shall be continuous lengths.
- C. Where saddled to masonry, the fixing screws shall be set in expansion type plugs contained in properly formed holes.
- D. All roof conductors are to be secured at intervals not exceeding 900mm.
- E. The Drawings showing the various roof levels of the building indicate the general arrangement and layout of the air termination system. The Contractor shall ensure that the whole of the air termination system is installed over its total route of the roof areas maintaining absolute electrical continuity.
- F. Provision shall be made with suitable fittings to allow for expansion and contraction of the horizontal conductors.
- G. 600mm height vertical copper air terminal shall be provided for the Air Termination network fixing next to masonry material at the highest points and any connection to down conductor.

-
- H. Air termination on the vertical side of the building above 45m as required by code shall be provided with maximum 30m spacing and minimum 2 points. The Contractor shall co- ordinate the installation detail to allow for bonding of the curtain wall to the embedded down-conductor re-bar to Engineer satisfaction and comply with BS code requirement. All additional materials and installation as required shall be included in the Contract.

2.02 DOWN CONDUCTOR

- A. The down conductor routes shall be embedded in column as indicate on drawing and shall be as direct aspossible.
- B. The bonding conductor at roof conductor shall be of soft annealed copper strip minimum size 25mm x 3mm or 70 sqmm Cu cable. Where the conductors penetrate the roof, the holes shall be effectively sealed and waterproof with proprietary sealant to the approval of the specialist roofing contractor.
- C. All exposed metal running vertically external to the structure shall be bonded to the 50sqmm Stranded Bare Copper down conductor. This shall be included but not limited to curtain wall frame, pipes, ducts and other metal components running through the Buildings.
- D. The down conductors shall be run according to the route as shown in the Drawings or as required to BS coderequirement.
- E. The Sub-Conductor shall ensure that the proper material and equipment are used in accordance with the manufacture's recommended installation.
- F. Lightning protection system shall employing 50sqmm Stranded Bare Copper as down conductor as per Drawing if specified.

2.03 JOINTS ANDBONDS

- A. Stainless steel connection plates shall be provided for termination of exposed copper conductors to steel rebar down conductors concealed in structure. All joints and bonds shall be soundly secured and shall be of low resistance. The cross-sectional area of the material used e.g. Copper shall not be less than the main conductor (i.e. 25mm x 3mm) unless otherwise specified.
- B. Where possible, joints shall be kept as few as possible. All joints shall be carried out with manufacturer's recommended compress type clamp. Two (2) screw minimum shall be provided for each joint.
- C. Bonding Points shall be carried out with manufacturer's recommended sets. Customer's self-made items are notacceptable.
- D. Joining of dissimilar metals shall be protected from moisture by applying recommended compound on the material. Bi-metal joint shall be provided where dissimilar metals are used.
- E. All junction and bonding clamps shall be brass/phosphor bronze material.

2.04 TEST CLAMP / EARTH CONNECTING POINT(ECP)

- A. A ECP shall be provided for testing earthing pit at ground floor. The ECP shall be of copper and shall

be located in an easily accessible position for testing.

- B. The ECP shall be protected from unauthorized interference. It shall be of an approved type and shall not constitute an electrical resistance within the system.

- C. Test clamps suitable for copper conductor shall be provided at air termination network and Earth Termination for each down conductor and so arranged that all parts of the network can be tested independently.
- D. After installation and completion of testing, all test clamps shall be painted with bituminous paint to prevent corrosion.

2.05 EARTH TERMINATION

- A. Down Conductor will be bonded to earth pit's ECP after Test Clamps by 50sqmm HDBC conductor in G.I pipe at the ground level along the perimeter of the building to comply with IEC 61024-1-2.
- B. The maximum permissible earth resistance of the Lightning Protection System shall be 10 ohms. Testing earth electrode shall be provided for earthing test.
- C. The top of each electrode shall be protected from damage by placing it in a heavy duty pre-cast concrete inspection chamber with heavy duty cover. The actual connection of the conductor to the electrode shall be accessible and visible when cover is removed.

2.06 RING CONDUCTOR

A continuous ring conductor shall be provided to connect all Lightning protection's earth pits. The cross sectional area of ring cable shall be 50 sqmm Cu/PVC installed in UPVC Class- D conduit buried inground.

PART 3 –EXECUTION

3.01 METALLIC CURTAIN WALL BONDING

- A. All elements of the façade shall be directly earthed to the structure for the purpose of lightning protection. The Contractor shall make himself aware of the requirements under the latest revision of BS latest code and IEC 61024-1-2. All necessary connections, conductors, earthing connectors etc shall be deemed to be included in this Contract.
- B. The Contractor shall co-ordinate with the Curtain Wall Supplier/Contractor for the exact interface and bonding requirements. The curtain wall is to be electrically continuous and the installation shall comply with BS EN 62305. Tests shall be carried out by this Contractor to the satisfaction of the Engineer to ensure electrical continuity as stipulated in the code.
- C. Lightning protection bonding terminals along re-bar down conductor shall be provided by the Contractor at the lowest levels and roof levels for bonding with curtain walls. Intermediate bonding terminals shall be provided at an interval of not exceeding 30m apart at each of the vertical intervals of each down conductor.
- D. As a general practice, bonding points shall be provided and located on the internal face of the claddings. A conductor shall be provided and installed by the Contractor for lightning protection

bonding at the down conductors.

- E. The Curtain Wall Supplier/Contractor shall be required to confirm his details on the lightning protection bonding of curtain walls. It is the responsibility of this Contractor to ensure all details (both locations and quantity) agreed complied with BS latest code.

- F. All metal cladding components including panels, glazing frames, mullions, transoms, fixings and support structures shall be fully bonded electrically to ensure electrical continuity of the building development.

3.02 EQUIPMENT/STRUCTURE BONDING ON ROOF & OTHER EXTERNAL AREA

- A. The Contractor shall be responsible for bonding of all metal equipment/structure on roof and other exposed external area on flat roof and ground level, complete cabling by means of 25 x 3mm copper tape or 70sqmm Cu cable up to the termination point provided by respective Contractor. Bonding within the equipment for maintaining electrical continuity of all metal components will be provided by the respective work in the Contract.
- B. All metallic projections, chimneys, vent pipes, cooling towers, railings, antenna masts, fuel tanks, etc. on or above the main surface of the roof and other external areas shall be bonded to and form the part of the air termination network.
- C. For equipment with plan area above 100sq.m, bonding shall be provided at distance not more than 30m apart equally spaced along the perimeter of the equipment.
- D. All bonding shall be to the nearest down conductor by most direct route available.

PART 4 - TESTING & COMMISSIONING

- A. The Contractor shall arrange with the Engineer for inspection and testing of lightning conductor system. Before the joint testing, the Contractor shall have conducted his own inspection and testing to ensure that all requirements are met as specified. Test report certified by Contractor's installation Professional Engineer shall be submitted to the Engineer. All equipment, transportation, manpower and other necessary costs for the joint inspection and testing shall be borne by the Contractor.
- B. The system shall also be tested at not greater than twelve (12) months intervals for earth resistivity, resistance to earth of the electrodes and electrical continuity of the system during the course of building construction and Defects Notification Period. The results of these tests shall be by the Contractor's installation Professional Engineer compiled in report prepared by the Contractor.
- C. The Contractor shall supply facilities for the recording of the test results referred to above, arranged in such a manner that comparisons can be readily made with earlier readings.
- D. The Contractor shall submit a detailed layout drawing showing the positions of testing carry out on site.
- E. The record sheet and layout drawing shall be kept on site at all times during the course of construction.
- F. The Contractor shall carry out monthly inspection on the lightning protection system including the earthing pits to ensure that the system is in good working order.

SECTION 19

TELEPHONE CABLING SYSTEM AND ACCESSORIES

PART 1 - GENERAL

1.01 WORK DESCRIPTION

- A. This Section specifies the minimum acceptable requirements on the quality, performance and standard for the Telephone Cabling System.
- B. The Contractor shall be responsible for the engineering, supply, installation, testing and commissioning of a cabling system for the complete Telephone System including, lead-in pipes, Local Authority's telecom manholes, cable tray, conduit, intermediate distribution frame (IDF) and telephone wiring between the Telecom riser and the terminal blocks or telephone points in each area.
- C. The Contractor shall install and terminate, where necessary, faceplates, jacks, cables, backboards, connection blocks, hubs, patch panels, patch cords, racks, brackets and all other hardware necessary to meet Local Authority's requirement.
- D. All works shall be performed in accordance with Rules and Regulations of the Local Authority's Guidelines for the provision of Telecommunication Facilities and to the satisfaction of Engineer.
- E. The work shall include all attendance and liaison with the Local Authority for the installation of main distribution frame, running of main cabling and all other telephone equipment.
- F. All equipment shall be current model, no replacement problem of components. All equipment and materials shall be as specified in the contract and to local Authorities acceptance.
- G. The Contractor must be licensed in Khushab, Pakistan to carry out the telephone cabling system installation to Local Authority's requirement.

1.02 SUBMISSION

- A. All technical submissions shall be approved by the Engineer prior to the respective stages of construction.
- B. As a minimum requirement, the submission shall include the following:
 - 1. Equipment submission with manufacturer's data.
 - 2. Sample submission including telephone outlets, terminal blocks, cables, etc.
 - 3. Drawings for field equipment showing the co-ordinate routing of cable routings and details on the equipment mountings.
 - 4. Builder's work requirements.

1.03 REGULATIONS

- A. The whole installation shall be engineering and installed in accordance with the Drawing and Specification and also the regulations of the Local Authority having jurisdiction over the installation work.
- B. The Contractor shall co-ordinate with the Local Authority and submit required shop drawing for Engineer's approval prior to work carried out on site.
- C. The Contractor shall co-ordinate with Local Authorities for the inspection and Handling over of the MDF room, Telephone Risers, Telephone Tray to Local Authority's acceptance. All time and cost require to arrange for the inspection and carry out the installation to meet inspection requirement shall be included in the Contract.
- D. All work by the Contractor shall be in accordance with the practices set forth in TIA/EIA 568-A and to Local Authority's requirement.

PART 2 –PRODUCTS**2.01 MANHOLES**

- A. The manholes shall be constructed in accordance with the Local Authority's requirements for Telecom manholes details. All underground pipes shall be of heavy duty uPVC type and size(s) as indicated in the Drawings. The proportions and thickness of pipes and details of manholes shall comply with the requirements of the Local Authority.
- B. All lead-in pipes as specified on the drawing shall be provided according to Local Authority's Requirement.
- C. Multi Cable Transit (MCT) shall be provided to Local Authority's acceptance.

2.-2 CABLES TRAY, TRUNKING, CONDUITS, ETC

- A. Reference should be made to the relevant Section of the Specification for details and requirements of construction and installation for cable tray and trunking, conduits as specified.
- B. All the installation of Cables Tray, Trunking, conduits shall comply with the requirement of the Local Authority.

2.03 SEALING OF TELEPHONE RISER

- A. All openings in the telephone riser ducts shall be sealed up with approval type fire-stop material. The sealing of all riser duct openings shall be carried out by this Contractor after the cable installation.

2.04 JUNCTION BOXES

- A. Junction boxes shall be provided at interval for easy installation of Telephone cable and also to comply with the Local Authority's requirements.

- B. Screwed cover plate shall be provided for the junction box.

2.05 INTERMEDIATE DISTRIBUTION FRAME (IDF)

- A. IDFs shall be provided in every Telecom riser in accordance to Local Authority guidelines.
- B. All angle iron and bracket used shall be of galvanized including bolts and nut.
- C. IDC cross connect shall be provided with backboard, D-rings mounting to Local Authority's specification.
- D. Category 5 modular plug to eight position modular plug, patch cords shall be snagless, pre-assembled and factory tested, with modular plugs to Local Authority's specification.

2.06 TELEPHONE CABLES AND TERMINAL BLOCK

- A. The box shall be of heavy duty PVC modular type with screwed cover similar to 'Egatube' boxes or approved equivalent.
- B. A flush mounted box with approved terminal block shall be installed as specified on drawings. The terminal block shall be able to accommodate the numbers of pair of the block terminals as specified in the Drawings plus 15 percent spare pair terminals for future connection.
- C. Telephone cable shall be Cat 6, unshielded twisted pair (UTP) plenum rated with solid copper conductors. The cable provided shall comply with Local Authority's requirement. The numbers of pair shall be as per the Drawing.
- D. The termination of telephone cables to the terminal block shall be carried out by skillful personnel by means of proper tools and links. A neat arrangement with proper labeling shall be provided. The Engineer reserves their right to reject any improper termination and arrangement of cables.

2.07 OUTLET

- A. Outlet compatible with telephone equipment approved by Local Authority shall be provided. RJ-45 style modular jack(s), with wire caps to provide strain relief and contamination protection, and able to accommodate coloured icons shall be provided to Local Authority's specification.

2.08 EARTHING

- A. An independent earth mat of earth resistance value of not exceeding one (1) ohm shall be provided for the telephone system. The main earth bar shall be installed inside the MDF Room or otherwise indicated in the Drawings.

- B. The main distribution frame (MDF) shall be:
- Of robust construction
 - With sufficient number of terminals for incoming and outgoing circuits, spare capacity of 30% shall be provided, unless otherwise specified.
 - With surge suppression device for incoming circuits, if required.

- With isolation links and jumpers to facilitate testing.
 - With labels for easy identification
- C. The design of the MDF shall be to the approval of Local Authority

2.09 TELEPHONE CABLES

- A. Telephone cables shall generally be multicore polyvinyl chloride insulated and sheathed cables for indoor however for outdoor purpose Jelly filled cable shall be used, unless otherwise specified:
1. Designed for communication use. Final sub-circuit wiring of each telephone outlet shall be provided with CAT6 four pair wire.
 2. Conductor – multi strand annealed copper
 3. Insulation – polyvinyl chloride to BS6746

PART 3 –EXECUTION

- A. The Contractor shall carry out the installation according to the requirement in the Contract.
- B. The installation shall be carried out in accordance with Local Authority Regulations.

SECTION 20**PUBLIC ADDRESS SYSTEM****PART 1 - GENERAL****1.01 WORK DESCRIPTION**

- A. This Section specifies the minimum acceptable requirements on the quality, performance and standard of the Public Address / Background Music System.
- B. The work shall include all engineering, supply, installation, testing and commissioning of the Public Address / Background Music System to the satisfaction of the Engineer.
- C. Exact locations, quantities and types of loudspeakers shall be as indicated on the Drawings.
- D. Power supply to the control equipment inside the security rooms shall be back up by emergency power with battery banks for 4 hours.
- E. The System shall comply with Civil Defense and all relevant local authority's requirements for emergency announcement.
- F. All equipment and control accessories shall be current model for which replacement parts shall be available for at least five years after completion of Defects Liability Period.

1.02 SUBMISSION

- A. All technical submissions shall be approved by the Engineer prior to the respective stages of construction.
- B. As a minimum requirement, the submission shall include the following:
 - 1. Equipment submission with manufacturer's data.
 - 2. Sample submission including loudspeakers, volume control switches, speaker and microphone cables, etc.
 - 3. Drawings for field equipment showing the co-ordinate routing of cable routings and details on the selection of loudspeakers.
 - 4. Builder's works requirements.

PART 2 - SYSTEM DESCRIPTION**2.01 SOUND MANagementsystem****A. GENERAL**

1. The system shall be a highly sophisticated, microprocessor controlled and modular unit.
2. It shall be built around 19 inch rack mounted Euro card circuit boards where the configurations can be tailored and expanded to meet every need precisely.
3. All routing, switching and priority functions shall be easily programmed and changed by non technical personnel.
4. It shall accept input signals from call stations, microphones, music sources, pre-recorded message source, etc.
5. When a call is made to a particular zone or combinations of zones, music playing in remaining zones shall not be interrupted.
6. The configuration of the sound management system shall basically consist of a sound distribution system and a surveillance system.

B. SOUND DISTRIBUTION SYSTEM

1. The call station is the primary input to the sound distribution system.
2. When the desired zones are selected by pushing the numeric keypad keys or zone selector switch the microprocessor shall detect which keys are pressed and, if another call is being handled at that moment, it shall check the priority of the new call.
3. If the new call has a lower priority, it shall be ignored. If the new call has a higher priority, the original caller shall be overridden.
4. After this, the microprocessor checks which chime tone and/or pre-recorded message has been programmed to precede the call.
5. Music is muted in the selected loudspeaker zones, the programmed announcement tone or message will be transmitted, the microphone is switched on and the call is transmitting.
6. At the end of the call, the PRESS-TO-TALK key is released and the music shall return to its original volume level.
7. Function keys shall be provided on the call station to route a call to a pre-programmed selection of zones.
8. The call shall be programmed with functions such as priority, attention signal, message, zone combination and control relay operation.
9. Alternative functions shall be given to a function key, such as music source select, volume up, down and mute, control relay switching or toggling.
10. A separate direct routing control input to the sound distribution system complete with RS 232

interface shall be provided.

11. The control input shall be fed by an addressable fire alarm signal from the main fire indication board.

12. Upon receiving the addressable fire alarm signal, the micro-processor shall decode it, activate an emergency message announcement system and a voice logging system, and route the emergency message to the corresponding alarm zone.
13. If the fire expands to more places, the alarm zone in question shall be switch in automatically.
14. The Contractor shall co-ordinate with the Fire Services work on the interfacing of the addressable fire alarm signal to the sound distribution system.

C. SURVEILLANCE SYSTEM

1. The surveillance system shall be engineering to monitor the status of loudspeakers, amplifiers and cables in the sound distribution system by scanning the presence of a 20 kHz pilot tone signal in monitoring devices located at amplifier outputs, loudspeaker cabling junction boxes and inside loudspeaker enclosures throughout the distribution system.
2. On detection of a malfunction, error messages shall be generated automatically, giving the precise time, location and nature of the fault.
3. If the system becomes faulty itself, an 'internal error' message shall be generated.
4. The error message shall be relayed to a LCD display of the system.
5. Provision shall also be made to send the error message to either a personal computer or an external printer through RS 232 interface for a permanent hard copy record of the malfunction.
6. An external warning light shall also be provided for monitoring of any malfunction of the sound management system.
7. The Contractor shall provide and install pilot tone monitoring devices at all power amplifiers 100 V outputs, loudspeaker cabling junction boxes and inside all loudspeaker enclosures.

2.02 ZONING OF LOUDSPEAKERS

- A. Zoning of loudspeaker shall be basically for background music (BGM) and non-background music (non-BGM) board castings.
- B. BGM speakers shall be for public and common areas including public corridors, lobbies, lifts, toilets, retail areas etc.
- C. Non-BGM speakers shall be for staircases, car parks, staff areas, office spaces, tenanted areas etc.
- D. Unless otherwise specified, zoning of loudspeaker for each PA sub-systems shall generally be as follows:
 1. Per floor for BGM loudspeakers
 2. Per floor for non-BGM loudspeakers

3. Per staircase

- 4. Per lift
- E. All-call buttons shall at least be provided for each PA sub-system as follows:
 - 1. All BGM loudspeakers
 - 2. All non-BGM loudspeakers
 - 3. All lifts
- F. For the entire PA system, all-call buttons shall also be engineered for each PA sub-system and the entire PAsystem.

2.03 BACKGROUND MUSIC SYSTEM (BGM)

- A. During normal operation background music (BGM) shall be broadcasted to specific areas.
- B. The background music shall be individually adjusted to a comfortable level for all the zones. The distribution of the sound energy in each zone shall be as evenly distributed as possible so that there is no audible difference in loudness when walking within the zone. The difference in sound pressure of 1.5m height shall be less than ± 3 dB. Loudspeaker positions proposed shall take into consideration the aesthetic appearance of the ceiling. The Contractor shall check and ensure that beating of low music frequencies will not occur and shall advise the Engineer if in his opinion it may occur.
- C. The Contractor shall be responsible to adjust the speaker output to meet the required sound level. The minimum sound pressure at the hearing level shall not be less than 15 dB above the ambient noise level which is generally indicated as follows:

<u>Area</u>	<u>Ambient Noise Level (dB)</u>
1. General public area	70
2. Retail area	70 – 75
3. Office, security room	60 – 65
4. Toilet	50
5. Staircase	50
6. Plantroom, service area	80 – 90
7. Carpark	75 – 80

- D. The overall frequency response of the system shall be better than 200 Hz to 9000 Hz. The uniformity of sound coverage at 1.5m shall not be more than ± 2 dB for frequency up to 4000 Hz and not more than ± 8 dB for frequency up to 8000 Hz for each of the aboveareas.

2.04 SOUND REINFORCEMENT SYSTEM

- A. The system shall provide sound reinforcement or amplification within designated areas from a local source.
- B. Microphone receptacles shall be standardized to a 3-pin female connector and shall be appropriately connected to a single channel of a microphone preamplifier. Sound reinforcement system shall override the general background music within designated areas.

- C. Microphone preamplifiers shall be installed in each area at appropriate location to service the above receptacles, one channel of preamplification for each receptacle. Preamplifiers shall be easily accessible to the users of the system.

- D. Local power amplifiers shall be integral with or located adjacent to the preamplifiers serving that particular area.
- E. This unit shall be permanently connected to the speaker of the area without switches.
- F. Power amplifiers and preamplifiers shall be provided with easily separated plugs and sockets for quick circuit access, testing and emergency replacements.
- G. Speakers shall be installed flush in the ceiling of each area in a pattern which will deliver to a plane 1200mm above the floor a sound level uniform within ± 2 dB at 2000 Hz.
- H. Provision shall be made for the injection into the amplification channels signals from projectors, recorders and other audio source which produce level from 0 dBm to 40 dBm.
- I. For areas which are divisible, the sound system shall allow the rooms to be operated in all possible combinations, either individually or collectively, by patching. No switching to achieve combinations shall be permitted.

2.06 FIREMAN EMERGENCY OPERATION

- A. The security rooms and FCC room shall be provided with an emergency paging facility. During a fire emergency, the fire officer shall have priority to make announcement to any one floor and any number of floors or to the whole building.
- B. An emergency 3-sound one-tone chime shall precede the announcement. The loudness of the announcements shall be set at maximum un-distorted level by-passing the local volume control.

2.07 RECORDING OF FIRE EMERGENCY ANNOUNCEMENT

- A. A Digital Audio Recorder shall be provided at the Fire Command Centre with 12 hours duration to record simultaneously all alarm signals and voice traffic over the loudspeakers on one track and voice traffic over the two-way fireman intercoms on the other track.

2.08 AUTOMATIC MESSAGE ANNOUNCEMENT

- A. Pre-recorded message shall be sent through an automatic CD player repeatedly when the fire signal has been triggered. A continuous visual shall be actuated when the pre-recorded message player is operating.
- B. A flashing light shall be provided when the CD is not in the player. The Contractor shall provide minimum two nos. of recorded message CD for each public address system.
- C. The voice message shall comply with Civil Defence Authority requirement and subject to Engineer's approval.

PART 3 - CENTRAL CONTROL EQUIPMENT

3.01 CENTRAL MICROPROCESSOR UNIT

- A. The Central Microprocessor shall control the following:
 - 1. Up to 4 callstations
 - 2. Up to 64 loudspeaker circuits

- B. The Central Processor module shall communicate and address all function modules and interface circuitry. The Microprocessor shall continuously check and guard the system hardware for errors, malfunctions and disconnections. If a malfunction is detected, a message shall be displayed on the display of the display and keyboard card.
- C. The system shall be engineered to handle different commands at the same time.
- D. A display and keyboard module shall be provided to perform the programming of the system for user, installer and maintenance/servicing purposes. The display shall show the sequence of programming and store the system configuration details; during programming, it shall also display any system errors or faults.

3.02 MATRIX CONTROLLER

- A. Matrix controller shall be provided for the routing of the inputs of the system to the output loudspeaker circuits. Input switching shall be for areas with background music, whereas for areas with paging and emergency announcement, output switching shall be used. The offered system shall have the flexibility of expansion up to its maximum capacity required for project of this size. The zonings shall be as shown on the Drawing.
- B. The system shall be able to handle a maximum of 32 matrix which shall give the following matrix configuration:
 - 1. 16 x 64 matrix : 16 audio inputs to 64 audio outputs
 - 2. 32 x 32 matrix : 32 audio inputs to 32 audio outputs
- C. The Matrix meets the following technical specifications:
 - 1. Frequency response : 100 to 60 000 Hz, -3dB range
 - 2. Signal-to-noise ratio : ≥ 80 dB
 - 3. Maximum output level : +15 dBV
 - 4. Distortion at 1 kHz : $< 0.1\%$ at 0 dB output level
 - 5. Cross-talk : > 85 dB at 5 kHz

3.03 AUDIO MIXER

- A. Technical Specification shall be as follows:
 - 1. Frequency : 20 Hz to 20 KHz
 - 2. Total harmonic distortion : Less than 0.5%
 - 3. Inputs : 6 Mic/line selector switch
 - 4. Input sensitivity : a. Microphone: 1.5 mV to 180 mV low impedance.
b. Line : 50 mV to 6V 50K ohm input impedance.
 - 5. Output level : 0.775V into 600 ohms
 - 6. Noise level : 85 dBm

3.04 LIMITED AMPLIFIER

- A. Technical Specification shall be as follows:
 - 1. Frequency response : 20 Hz to 20 KHz
 - 2. Threshold : + 4 dBm to + 12 dBm by 2 dB steps
 - 3. Attack : Auto-nominal 5 m-sec at 12 dB of control
 - 4. Release : 0.1, 0.2, 0.5, 1, 2 sec and auto
 - 5. Noise : 85 dBm

6. Output : Adjustable up to + 20 dBm into 600 ohm

3.05 1/3-OCTAVE GRAPHIC EQUALIZER

A. Technical Specification shall be as follows:

1. No. of filters : 27
2. Centre of frequency : 40 Hz – 16 000 Hz
3. Input impedance : Unbalanced 10 ohms, short circuit protected
4. Operating level : -20 dBm to + 24 dBm
5. Input protection : -60Vms
6. Centre frequency : $\pm 2\%$ accuracy
7. Calibration accuracy : $\pm 0.5\%$
8. Frequency response : 20 – 20,000 Hz ± 0.5 dB
9. Output clipping : + 22 dBm into 600 ohmspoint
10. Distortion : a. Less than 0.01%, 1 KHz at + 4 dBm into 600ohms.
b. Less than 0.05%, 20 Hz –20,000 Hz at 18 dBm into 600 ohms.
11. Equivalent input : 2-20,000 Hz unweighed-90dBm

3.06 AM/FM TUNER

- A. The unit shall be rack mountable and modular construction of quartz crystal oscillator controlled AM and FM receiver, with phase locked loop FM multiplex decoder and digital frequency read out. All controls shall be front accessible and with preset station selection, AM/FM selection, field strength indication, accurate FM tuning indication and ON/OFF control.

B. FM Tuner

1. Tuning Range : 87.5 to 108 MHz
2. Frequency Response : 20 Hz to 15kHz ± 11 dB
3. Sensitivity : 2.5 micro volt/98 MHz for 30 dBquieting
4. Selectivity : 75 dB alternate channel
5. Distortion : Less than 1%
6. S/N ratio : Better than 65 dB at 20 Hz to 20kHz

C. AM Tuner

1. Tuning Range : 522 to 1611 kHz
2. Frequency Response : 20 Hz to 8000 Hz ± 1 dB
3. Sensitivity : 20 micro volt/999 kHz for 20 dB quieting
4. Selectivity : 20 dB
5. Distortion : Less than 1%
6. S/N ratio : Better than 65 dB at 20 Hz to 20kHz

3.07 AUTOMATIC DIGITAL COMPACT DISC PLAYER

- A. This unit shall be rack mountable and engineered for continuous operation and capable of pre-loading 5 discs. All controls should be front accessible.

B. The CD player shall be equipped with the following features:

1. Automatic and continuous play of up to 5 nos.CD discs,

2. Direct programming of 30 tracks from up to 5 discs,
3. Four times over sampling digital filter,
4. Full 16-bit dual D/A converter,
5. Multi-function player status display,
6. Volume control.

C. Technical Specification shall be as follows :

- | | | |
|------------------------------|---|----------------------------|
| 1. Frequency range | : | 2 Hz to 20 kHz |
| 2. S/N ratio | : | Better than 100 dB |
| 3. Dynamic range | : | Better than 96 dB |
| 4. Channel separation | : | Better than 96 dB at 1 kHz |
| 5. Total Harmonic Distortion | : | Less than 0.0025% at 1 kHz |
| 6. Max. output level | : | 2V rms |
| 7. Min. load impedance | : | 10 kohm |

3.08 PRE-AMP MODULES

- A. The pre-amp shall be fully solid state of modular detail with volume and separate bass/treble control and accepts input from microphone, tuner or CD player and chime inputs.
- B. Electronic switching for line remote control to be incorporated. Built-in priority circuit for microphone circuits shall be provided.
- C. Technical Specification shall be as follows :
- | | | |
|-----------------------|---|-------------------------|
| 1. Frequency Response | : | 50 Hz to 15 KHz +/- 2dB |
| 2. Distortion | : | Less than 1% |
| 3. S/N ratio | : | Better than 60 dB |
| 4. Output Impedance | : | 600 ohm balanced |
- D. A test tone generator module shall be incorporated to provide test zone to power amplifier for calibration purpose.

3.10 POWER AMPLIFIER

- A. The unit shall be fully solid state, professional, monaural audio amplifier of rugged construction detailed for 24 hours continuous duty at rated output and with high audio output quality.
- B. The unit shall have presettable input level and with output via transformer or direct. Output line voltage from transformer shall be selectable by voltage tapping. All controls shall be front accessible with ON/OFF switch and output level indication by VU-meter.
- C. The unit shall be suitable for standard equipment rack mounting and complete with drawer handle.
- D. The amplifier shall be protected from misloading, short-circuiting of output or grounding by thermal protection and electronic means.

- E. The amplifier shall withstand adverse overload conditions without major distortion.

- F. Ample thermal capacity heat sink shall be employed for heat dissipation of output stage transistor.

G. Technical Specification shall be as follows :

1. Input : 500 mV to 10V adjustable at 10K ohm with input transformer
2. Output : Rated output nominal to IEC 268-3 as per drawings
3. Output voltage : 100V/70V/50V through transformer
4. Frequency response : 50 to 10000 kHz +/- 3dB
5. Distortion : Less than 1% at rated power at 1 kHz
6. S/N Ratio : Better than 85 dB preset control flat from 20 – 20 kHz

3.11 AUTOMATIC MESSAGE ANNOUNCIATOR

- A. The system shall be a fully automatic unit which repeats recorded messages at predetermined interval during background music broadcast and emergency. The unit shall accept CD and shall be front loading. All controls shall be front accessible including power ON/OFF, CD loading, track selection and, message selection buttons and indication etc. The unit shall have automatic gain control (AGC) circuit, message skipping, built in timer, announcement priority and live announcement features. Interval timer shall be switch selectable including OFF.

B. Technical Specification shall be as follows :

1. Frequency Response : 100 – 7 kHz +/- 3dB (CD)
100 – 15 kHz +/- 3dB (Mic)
2. Wow and Flutter : Less than 0.1% WRMS
3. Distortion : Less than 3% at 1kHz (CD)
Less than 2% at 1kHz (Mic)
4. S/N Ratio : Better than 50 dB (CD)
Better than 55 dB (Mic)

3.12 VOICE LOGGING MACHINE

- A. The unit shall be an automatic Digital Audio Recorder which automatically records all alarm signals and voice traffic over the loudspeakers on one track and voice traffic over the fireman's intercom on the other track. The capacity shall be 12 hours recording.
- B. All controls shall be front accessible including power ON/OFF, start/stop button and indication, track selection button.

- C. The unit shall be complete with 'DOLBY Noise Reduction' system.

D. Technical Specification shall be as follows :

1. E. Frequency Response : E. 100 – 8 kHz +/- 3dB
2. Wow and Flutter : Less than 0.35% WRMS
3. Output Impedance : Balance 600 ohms
4. S/N Ratio : Better than 50 dB

3.13 CHIME/TONE SIGNAL GENERATOR

- A. The unit shall be modular type and suitable for rack mounting.
- B. Two chime modules and two alarms signal modules shall be provided.
- C. Signals shall be programmed to precede an announcement from a call station or either used as an independently alarm for hazardous events.
- D. Adjustable output level and sounding time features shall be provided for the chime and alarm signal modules.

3.14 MONITORING UNIT

- A. A monitoring unit shall be provided to monitor the output of various input sources by push- button type selector.
- B. A VU meter with adjustable sensitivity shall be incorporated.
- C. The output shall be connected to a 1 W speaker with volume control.
- D. Headphone jack with speaker mute function and headphone shall be provided.

3.15 CALL STATION

- A. Call station shall be provided in the security rooms or where mentioned in the drawing.
- B. The call station shall be constructed of hairline stainless steel panels and built into custom made console complete with the following:
 - 1. Condenser microphone on a gooseneck stem of high quality with a built-in bass roll-off filter giving a clear voice reproduction, even in difficult acoustic environments.
 - 2. 100 pre-select loudspeaker zone illuminated push buttons.
 - 3. 10 different call tones, chimes and alarm signals selection illuminated push buttons.
 - 4. Press-to-talk and all-call illuminated buttons.
 - 5. 4 levels of priority/talk selections.
 - 6. 10 illuminated user function keys for selections of pre-recorded messages, routing of a low priority call preceded by an attention tone to pre-programmed selection of zones, routing of an alarm tone followed by a pre-recorded evacuation message to all loudspeaker zones, toggling a control relay on and off which switches a warning lamp, etc., selecting a music source, turning the music volume up/down, muting the music and resetting the system.
 - 7. Busy LED to advise the operator whether a call may be activated. Red busy LED flashing means

that another call is in progress. Red busy LED lights up continuously indicates that the call has been blocked by another call with a higher priority.

8. Wait/Talk LED to advise the operator whether a call is accepted. Green wait LED flashing indicates that the call is accepted and the attention tone or pre-recorded message is being transmitted. Green talk LED lights up continuously when the attention tone or message finishes and the microphone is switched on to enable speech broadcast.

9. LED intensity preset to compensate for various local lighting conditions. The illumination intensity of the LED shall be adjustable.
10. Built-in compressor to keep the signal output level of the call stations constant even in situations where the operator's speech volume level changes radically. The degree of compression shall be preset over a range of 30 dB from 84 to 114 dB (SPL).
11. Balanced line level output allowing call stations to be located up to 1000 m from the control centre using only standard 2-core screened cables.
12. Loudspeaker zone template onto which the name of the loudspeaker zones can be written.
13. Built-in monitor loudspeaker complete with volume control.
14. Key switch protection to prevent unauthorised access.

3.14 DC POWER SUPPLY

- A. A regulated DC power supply for the pre-amplifiers, DC relays and chimes shall be provided. It shall be not greater than 50V DC and of sufficient current capacity to operate simultaneously all the pre-amplifiers, relays and chimes. The ripple factor shall be less than 1% at rated DC current.
- B. The step-down transformer shall be protected at input and output by fuses. It shall also at the same time provide alternating current to light up the bulbs of the buttons.
- C. Unless otherwise specified, a four hour battery (maintenance free totally sealed off lead acidic type) backup power shall also be provided with automatic changeover contractor to back-up the whole PA System during the mains failure. Specification according Section 29.

3.15 EQUIPMENT RACK

- A. Wall / Floor mounted central equipment racks as per requirement shall be provided by this Contractor for housing the power amplifiers, pre-amp mixers, CD player, microphone, and zone selector panel etc. of the system as mentioned above.
- B. All amplifiers shall be rack-mounted, and all heat sinks for transistors and circuitry shall be arranged such that amplifiers can be mounted one on top of the other without incurring ventilation problems. All amplifying components shall be a modular construction to permit easy removal and replacement of faulty circuits.
- C. The equipment rack shall be filed and sanded to a smooth surface, sprayed with a final coat of duly grey lacquer as approved by the Engineer.
- D. All equipment shall be mounted and arranged in a manner so that easy access can be achieved by the operator.

PART 4 - FIELD EQUIPMENT

4.01 CEILING AND SURFACE MOUNTING SPEAKERS

- A. All speakers shall be recess mounted with metal grille in the false ceiling. Where there is no false ceiling, panel type with surface mounting box shall be provided. Exact type shall refer to the Drawings. The speakers shall be 200 mm diameter high quality type off-white finish. The speakers shall have a frequency response of 200 to 1400 Hz \pm 3dB and a sound pressure level of at least 90 dB at 1kHz octave, 1 m, 1 W input according to IEC standard. Voice coil shall be 25 mm diameter with an 8 ohm impedance.
- B. Each speaker shall be equipped with a line matching transformer. Transformer shall be provided for each speaker with power tap settings of 1 and 2 watts for 100V lines. Insertion loss of the transformer shall not exceed 1 dB. Metal cover with self support shall be provided for all ceiling speakers to prevent acoustic transmission.

4.02 HORN SPEAKERS

- A. The horn speakers shall be splash-proof, light weight and made from drawn aluminum sheet. Adjustable rigid bracket and clamps shall be provided to fix the speaker firmly. Each horn speaker shall be equipped with a 100V line matching transformer. Tapping for full, half and quarter power selection shall be provided.
- B. The horn speakers shall be 150 mm diameter with at least 10 W power handling capacity. The speaker shall have a frequency response of 250 to 10000 Hz \pm 10 dB and a sound pressure level of 104 dB at 1 kHz octave 1 m, 1 w input according to IEC standard.
- C. Lightning arrestors shall be provided for the circuit serving any outdoor speakers prior to connection back to the system.

4.03 LOCAL VOLUME CONTROL UNIT

- A. The local volume control unit shall consist of:
 - 1. Auto-transformer type for power rating above 10W,
 - 2. Inductor type for power rating between 3 W and 10 W,
 - 3. Potentiometer type for power rating below 3W,
 - 4. Remote-controlled by-pass switch for emergency announcement.
- B. Appropriate type shall be selected to match system requirement. All volume control shall have stainless steel face plate with stamped and filled dial scale and matching dial knob.
- C. The units shall have not less than 6 positions including off position and with 3 dB attenuation per step. All switch contacts shall be silver plated for noise free operation. The unit shall be suitable for flush wall mount or surface mount in junction box. Samples shall be submitted for approval.

4.04 TERMINATION AND CONTROL UNIT

- A. This unit shall be provided at all floors. It serves for audio cable tee-off and control cable

termination. Cable termination blocks, fuse unit in appropriate rating for audio cables and emergency announcement control relay shall be housed inside this unit. Metallic box shall be provided equip the unitcomponents.

- B. Each tenant retail shop unit and all the location specified with future sound reinforcement system shall be provided with one Termination and Control unit to cater for tenant fitting out connection. The termination and control unit shall cut-off the tenant sound system and allow emergency announcement audio signal to be delivered.

PART 5 - CABLING

- 5.01 The speaker wires from the amplifiers shall run in zones in conduits/trunkings and terminated in the termination boxes on each floor. Measures should be taken to avoid any signal be picked up along the communication route. The Contractor shall provide all connection boxes complete with necessary termination block for the system, such connection boxes should have a fire resistance rating not less than one hour and to Civil Defence fire rating requirement.
- 5.02 Pigtail leads on speakers, etc, shall be connected to cables by means of connectors with backing screws, or soldered and taped. Wire nuts are not acceptable.
- 5.03 All wiring shall be numbered for identification at each end of cable run, using printed or embossed symbols permanently attached to the cable. Each terminal strip shall be numbered in a similar fashion, and each terminal of the strip shall be labeled. All conductors which carry supply energy shall be labeled as to voltage and polarity. The wiring diagram and the numbering system shall be submitted for approval before installation.
- 5.04 Multi-pin plug and socket connectors shall be used for fast connection and disconnection. All low voltage wires shall be continuous, no-splice and shall terminate at connectors or terminals only.
- 5.05 All speaker cables shall be monitored by means of impedance measurement method for open circuit fault, short circuit fault and ground fault.

5.06 Coaxial Cable

- A. Coaxial Cable shall include:

1. Feeder distribution coaxial cable,
2. Final distribution coaxial cable.

- B. Feeder distribution coaxial cable shall be:

1. low loss type,
 2. inner conductor of plain annealed copper wire,
 3. outer conductor of plain annealed copper wire,
 4. outer conductor of copper wave wire screen over plain annealed copper type,
 5. a layer of dielectric insulation between conductor of polythene thread and tube arrangements,
 6. outer sheath of black polythene,
- Characteristic Impedance : 75ohm
 Return Loss : Better than 30 dB at 20 – 400 MHz
 Maximum Attenuation : Less than 10 dB/100 m at 400MHz

C. Final distribution coaxial cable shall be:

1. inner conductor of plain annealed copper wire,

2. outer conductor of plain annealed copper wave wire screen over plain annealed copper tape,
3. a layer of dielectric insulation between conductor of cellular polythene of tube arrangement,
4. outer sheath of cream PVC.
Characteristic Impedance : 75ohm
Return Loss : Better than 30 dB at 20 – 400 MHz
Maximum Attenuation : Less than 14 dB/100 m at 400 MHz

5.07 CABLE - PVC INSULATED

- A. Polyvinyl Chloride Insulated Cables:
1. Conform to B.S. 6004 450/750V grade,
 2. Conductor - Single or stranded annealed copper,
 3. Insulation - Polyvinyl Chloride,
 4. Minimum size of cables shall be 1.5 sq. mm copper,
 5. Cables shall be coloured coded and ferruled at both ends.

5.08 CABLE - AUDIO DISTRIBUTION

- A. Audio distribution cable shall be multicore fire resistant cable with twisted pair conductors:
1. UL listed or equivalent with working voltage to 300V,
 2. Conductors – tinned annealed copper, stranded with minimum conductor arranged in twisted pair, 1.5 sq. mm for main feeder riser and 0.75 sq. mm for others,
 3. Insulation - polyvinyl chloride
 4. Cables shall be colour coded and ferruled at both ends,
 5. Engineered for audio sound broadcast use.

5.09 CABLE - MULTICORE

- A. Multicore Polyvinyl Chloride Insulated and Sheathed cables:
1. Engineered for communication and instrumentation use,
 2. Conductor - Single annealed copper,
 3. Insulation - Polyvinyl Chloride to B.S. 6746, Multicore, with PVC insulation for individual core, with PETP tape laminate and rip cord,
 4. Outer overall sheathe shall be PVC,
 5. Cable core shall be colour coded to IEC Publication 189,
 6. Minimum conductor size shall be 0.5 mm (diameter),
 7. Identification numeral or ferrule at both ends of individual core for identification.

5.10 FIRE RESISTANT CABLE

- A. All cable as specified above required to maintain the Emergency Announcement shall be fire resistant to rating as per Civil Defence requirement.

PART 6 - SETTING, TESTING AND MAINTENANCE

6.01 SETTING

- A. The Contractor shall make all the necessary setting of the equipment after installation. The volume of each zone shall adjusted to suit the usage of the zone. The loudspeaker line transformers shall also be set to give an appropriate loudness in that zone taking into consideration the ambient noiselevel.
- B. The pre-amplifiers shall also be present to give a clear pleasant loudness for emergency announcement. All automatic background music players, CD payer. AM/FM turner, audio mixer and limiter amplifier shall be adjusted to give optimum output to the graphic equalizer. The equalizer shall be adjusted so that the output frequency response from the loudspeakers are as "flat" aspossible.
- C. The power amplifier shall be set so that a maximum power may be delivered to the system.

6.02 TESTING

- A. The Contractor shallbeforehandling over the installed PA system, conduct performance tests in the presence of the Engineer.
- B. All mode of operations and each microphone lines and amplifiers shall be tested and ascertained to be functioning. Every floor shall be checked to ascertain that all loudspeakers polarities are connected correctly so that there is no cancellation low frequencies sound. Also all wattage shall be correctly set. Sample measurements of loudness, distribution of energy and frequency response shall be made randomly.
- C. The Contractor shall submit test reports prior to conducting acceptance test in the presence of the Engineer. All volume controls shall be checked. The performance of all music equipment shall also be tested to ascertain they meet the Specifications.
- D. The calibration test of equipment shall also be carried out before testing on the PA system.
- E. An overall system performance check shall be carried out during commissioning.
 - 1. A Pink Noise generator shall be used as sound sourceand the output level of all equipment shall be brought up to OVU. The output volume control of every speaker shall be adjusted as to give 90 dB SPL at 1 meterfrom the speaker. Thefrequency response of everyspeaker measured shall not be worse than that specified in the Specification and this shall apply to all types ofspeakers.

2. With the main fader of the mixer off, the noise level measured at the output of all power amplifier shall not be worse than that stated in the Specification.

3. Standard test CD of the following frequencies shall be used to measure all CD machines and the level output variation measured at the output stage of the mixers shall be small than ± 4 dB.

Frequency: 31.5, 63, 125, 250, 500, 1K, 2K, 4K, 8K, 16K

6.03 MAINTENANCE

During the Defects Notification Period, comprehensive maintenance shall be provided. The maintenance services to be carried out shall be, but not limited, to the follow:

A. Monthly Services

1. Dust and polish all PA equipment in the security rooms.
2. Clean all heads of CD Player, automatic background music players.
3. Check, automatic background music players and CD Player are functioning. All faulty sliding control, push button, rubber belts, etc. shall be replaced.
4. Check indicating lamps, LEDs, dial reading, lamps, UV meters, push buttons rotating knobs, etc. of all musical equipment. Any faulty parts shall be replaced. Also check for poor contact of all switches.
5. Check volume control of all zones.

B. Three-Monthly Services

1. Check and measure all musical equipment performances.
2. Test all modes of operation of the PA system.
3. Check all loudspeakers to ensure they are functioning. Faulty loudspeakers shall be replaced.

C. Yearly Services.

1. Replace all rubber belts used in the CD Player, automatic background music players.
2. Check conditioning of all interconnecting cables of the musical equipment.
3. To calibrate all necessary equipment.

D. Call-Service

The Contractor shall also provide call services within one day from the time of call. Any sudden breakdown shall be attended to and faulty equipment or components shall be quickly replaced. Competent engineer shall be provided to detect the fundamental cause of a fault. Temporary quick fix will not be accepted and similar fault shall not re-occur.

PART 7 - EXECUTION

- A. The Contractor shall carry out the installation according to the requirement in the contract.
- B. The installation shall be carry out in accordance with manufacturer's instructions.

SECTION 21

DATA CABLING

SYSTEM

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. The following specifications are for the installation of the communication and data wiring. The Contractor shall provide all labor and materials for installation of the data communications systems as noted on drawings and in these specifications. The Contractor will install and terminate, where necessary, faceplates, jacks, cables, backboards, connection blocks, hubs, patch panels, patch cords, racks, brackets and all other hardware necessary to effect a workable cable plant fully compliant with that as described in these specifications and in the drawings, and to the Local Authority's requirement and to the satisfaction of the Engineer. The contractor shall also submit as built drawings that reflect the installed cable routes, port locations and labeling information.

1.02 GENERAL REQUIREMENTS

- A. The work shall consist of the following:
 - 1. Provide and install conduit, cable, connectors, wall plates, terminators, pullboxes, patch panels, panel racks/brackets, hubs and other items necessary for a complete working data/communications system. All work by the Contractor shall be in accordance with the practices set forth in TIA/EIA 568-A and comply with Local Authority's requirement.
 - 2. Provide electrical services to support the data systems required under this contract.
 - 3. Construct data communication closets as required to comply with these specifications and to Local Authority's requirement.
- B. Provide As-Built drawings identifying the cable path and note any deviations from the original drawings. Also provide all documentation on label and testing information prior to system acceptance.

1.03 CONTRACTOR QUALIFICATIONS

- A. The Contractor must be licensed in the Lahore, Pakistan and has expertise to carry out the data cabling system installation to Local Authority's requirement.
- B. The Contractor must show proof of being in experience in Data Communication trade in Pakistan for a minimum of five years.
- C. All the above information must be provided at the time of the contract award, prior to signing the contract.

PART 2 – MATERIALS

2.01 SUBMITTALS

- A. Submit for review by the Engineer a compilation of material specifications to be incorporated in the work. Support submittals by descriptive means, i.e.: catalog sheets, product data sheets, and other literature by the manufacturer.
- B. Acceptable materials and manufacturers are listed in Appendix (Approved list of Supplier/Manufacturers) are used only for reference. If acceptable materials & manufacturers listed in Appendix Z are not available then materials and products considered as equivalent by the contractor, other than those listed, shall be submitted for Engineer approval. Submittals shall consist of substantiation of Local Authority's acceptance, catalog pages with items marked, referenced part numbers for which the substitution is intended, with specification sections and paragraphs referenced. In addition, samples of cables, connectors, and wallplates are required to be submitted for approval prior to installation.
- C. Manufacturer's cable markings shall consist of manufacturer's name, cable type/catalog No., 1987 NFPA type code compliance, and the latest NEC code compliance.
- D. Make submittals for each of the following items as included in the scope of this work:
 - 1. Horizontal cables
 - 2. Jumper cables
 - 3. Patch cords
 - 4. Connectors
 - 5. Wallplates
 - 6. Conduit, bushings, sleeves, raceway, etc.
 - 7. Patch panels
 - 8. Racks and brackets
 - 9. Hubs/Switches

2.02 STATION OUTLETS

- A. Each communication workstation location, except as noted otherwise, shall consist of the following:
 - 1. Simplex or Duplex type data plate with IOs shall be provided. Faceplates must have label fields top & bottom.
 - 2. The faceplate for the data communication cable shall be the same color and height coordinate with the electrical faceplate. Only one color faceplate shall be used throughout the project. Only flush mount type jacks are to be used on this project (unless otherwise noted on the drawings).
- B. Category 6A modular jack with an RJ45 connection, with wire caps to provide strain relief and contamination protection, and also to accommodate colored icons.

2.03 HORIZONTAL CABLE

- A. Category 6A :

All station cables shall be Category 6A, Unshielded Twisted Pair (UTP), 24 AWG, plenum rated with solid copper conductors. The station cable shall run from the station jack to the

appropriate Patch Panel in the data/telecom room.

The length of each station cable shall not exceed 90 meters. The cable to be used for "Data" shall have additional markings and/or striped colors on the outer jacket that will differentiate it from the other voicecables.

The Contractor shall provide a 4-pair cable to each Data jack as indicated on the Drawings. The cables shall be clearly labeled "Data" at each end.

2.04 PATCH PANEL

- A. Patch Panels for the Data Distribution Cables shall be Category 6A, preloaded, with 110 connection blocks on the rear and 8 position modular jacks on the front. Panels shall be mounted on Relay Racks or Wall Mount Brackets as required.
- B. Wire Management panels shall be provided by the Contractor.

2.06 BACKBOARDS

- A. Backboards shall be 18mm thick plywood, coated with fire-retardant paint. Confer with the Local Authority's specification to ascertain size, placement, etc. Size shall be adequate to support all specified/required devices as minimum.
- B. The backboards shall be painted with fire-retardant paint and color coded to Local Authority's requirement.

2.07 PATCH CORDS

- A. CATEGORY 6A— Eight position modular plug to eight position modular plug: Patch cords shall be pre-assembled and factory tested, with Category 6A cable & eight position snagless modular plugs.

2.08 WALL MOUNT BRACKETS

- A. Wall Mount Bracket shall be provided and installed for the Patch Panels as required.

PART 3 – EXECUTION

3.01 STATION JACK INSTALLATION - FLUSH MOUNT

- A. All cable installation and termination shall adhere to the provisions in TIA/EIA 568 and TIA/EIA TSB40-A.

1. The Contractor is required to submit a sample of assembled cable, connectors, raceway and accompanying specification sheets prior to installation for approval of quality, workmanship and materials.
2. The length of each station cable shall not exceed 90 meters. Station cable is defined as that length of cable from the back of the workstation outlet to the back of the Patch Panel or connecting block in the telecommunications closet. Station cable shall be a continuous run of cable with no splices, bridges, or other discontinuities.
3. Maintain cable twist-rate at all termination points. The amount of cable untwist shall be

no more than 15mm. Do not strip back the cable jacket any more than is necessary to punch down the individual conductors.

4. All 110 connections shall be installed using a single 110 punch down tool and all terminations shall be trimmed flush with connector blocks.
5. Leave enough cable (2 meter at each outlet and 5 meters at the backboard, rack, or hub locations) to allow proper cable connections.
6. Station cable that runs outside the walls shall be in surface-mounted raceway, cable tray, or conduit.
7. Minimum 20mm conduit shall be installed in all walls and shall be run to above ceiling line. Terminate all conduits with plastic bushings. A minimum 200 ts polyline pull string shall be provided the entire length of each conduit.
8. When conduit runs from room to room, provide a metered tape and a minimum 200 ts polyline pull string to run the entire length of the conduit.
9. Conduit bends must be long, sweeping bends with radius not less than: 6 times the internal diameter of conduits 50mm or smaller; or, 10 times the internal diameter of conduits larger than 50mm.
10. Each cable installation shall be accompanied by a minimum 200 ts polyline pull string.
11. Cables shall not be tie wrapped to electrical or gas conduit. Maintain a minimum 150mm separation between low voltage cabling and electrical raceways, lights, etc.
12. D-rings will be provided and mounted to route the station cables at the backboard locations (& in chase locations as designated on the drawings).
13. Enough cable slack will be provided to neatly route the station cable through the "ID" rings to the appropriate 110 type block.
14. No communications or data circuit shall be run in the same conduit or raceway with power conductor except where the raceway is separated by a divider.
15. Cable routing shall follow the routes dictated by the detail while avoiding locations of high RFI/EMI radiation or adverse environmental conditions.
16. All plastic type molding must be anchored to the wall with the appropriate type of wall screw every 1.5 meters.
17. The Voice/Data cable plant shall be grounded and bonded in accordance with ANSI/TIA/EIA-607.
18. All cable coming from ceiling shall be placed in cable trunks.

- A. Contractor shall provide all necessary testing equipment to test all cables.
 - 1. Each cable terminating in a station jack shall be tested from the telecommunications

closet with a 4-pair wire tester. The tester shall verify continuity, faults, reversals, swaps and pairing.

2. Each Category 6A cable link shall also be tested for near-end and far-end crosstalk and attenuation up to and including 500 MHz and shall be verified for acceptable length.
 3. A hard copy of the test results for each cable run shall be provided to the Employer. Acceptable test results shall be agreed upon by the Employer and contractor prior to testing. It is the contractor's responsibility to replace or repair any cables, connectors or jacks which test outside the agreed-upon ranges.
- B. Before the system is approved by the Engineer, the Contractor will be required to "walk-through" the installation with the Employer and verify proper installation and conformance to specifications, drawings, and other agreed upon, written details.
- C. All cable-related documentation and As-Built Drawings will also be required for reviewing purposes at this time.

SECTION 22

LUMINAIRES AND

ACCESSORIES

PART 1 -GENERAL

1.01 WORK DESCRIPTION

- A. The luminaires schedule indicates the detail requirement of the luminaires selection. The exact luminaires of the installation subject to Engineer approval on the sample. The Contractor shall be responsible to ensure the selected luminaires suit the location of installation. No time and cost adjustment for the Contractor to provide the approved selected luminaires.
- B. The Contractor shall co-ordinate the fixing detail of the luminaires, any accessories, brackets, waterproof termination box etc, required to complete the installation shall be included in the Contract
- C. Certain types of electrical equipment or systems involving sudden changes, or low frequency or of direct electric current such as fluorescent lamps, contactors, etc. shall be fitted with radio and television interference suppression components suitable to meet the levels specified in BS EN 55014-1:1997 "Limits of Radio Interference characteristics of household electrical appliances".

1.02 STANDARDS

- A. The manufacturing of the luminaires shall also conform to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in this Specification and Drawings, whichever is the more stringent and acceptable to the Engineer.
 - B. Following Standards to be followed
 - IEC 62031 - LED used in Luminaries
 - IEC 62471 - Photo-biological Safety
 - IEC 61347-1 / 2 - LED drivers
 - IEC 62384 - Independent driver Performance
 - IESNA LM80:2008 - Lumen Maintenance of LED light source
 - C. In the adoption of standards and requirements, the Contractor shall take the following precedence
-

1. Engineer's decision;
 2. Local codes of practice;
 3. Drawings;
 4. Specification;
 5. International standards and requirements.
-

1.03 SUBMISSION

- A. All technical submissions shall be approved by the Engineer prior to the respective stages of construction.
 - B. As a minimum requirement, the submission shall include the following:
 - 1. Luminaires colour cutsheet submission with manufacturer's data, lamp data, IP rating, location of installation, quantity.
 - 2. Sample submission;
 - 3. Lit-up sample submission as required by Engineer.
 - 4. Lit-up sample for all lamp with indication of location of installation and manufacturer recommended lamp life span.
 - 5. Illumination computer print out for area as required by Engineer.
 - 6. Shop Drawings of the fixing details showing the coordinated installation details.
 - 7. test reports for all emergency use luminaires.
 - 8. Builder's works requirement.
-

PART 2 –PRODUCT

2.01 INTERNAL WIRING WITHIN LUMINAIRES

- A. Cables interconnecting components shall be heat resisting cables and shall be neatly bundled by nylon self-locking cable ties and shall be properly routed and secured away from heat generating accessories like control gear, etc.
- B. Cables used for internal wiring of the luminaires shall be of appropriate type and size. The insulation of the cables shall be able to withstand throughout the life of the luminaires the maximum temperature of not less than 105°C.
- C. Where wiring passes through the edge of any metal section of the fitting, it shall be protected by an approved grommet. All connections of wires to terminals shall be of approved types. All wirings shall be concealed from view with the luminaires installed.
- D. All cable terminations within the luminaires shall be suitably shrouded. At every luminaire, an earthing terminal shall be provided for connection to the circuit protective conductor.

2.02 LED LIGHTFIXTURE

- A. The LED lamp / light fixture shall comply and conform the following specification:

Luminous Efficacy	> 90 lumens/Watt
CRI	> 80
Colour Temperature	2700K to 6000K (as per BOQ & drawings)
UGR	Within the prescribed limits.
Useful Life	Depreciation to 70% of initial Lumen Output
Warranty	2 years or above

- B. The body of the light fixtures shall be minimum 18 SWG sheet steel or die cast, properly de-rusted, degreased, finished in heat resistant paint, stove enamelled. Appropriate size bushed wire entry holes, fixing holes, and earth terminal shall be provided. The lamps for these fixtures shall be made with Light Emitting Diodes capable to emit the desired colour as mentioned in drawings or BOQ. The fixture shall be supplied with appropriate driver either fixed or detached and shall be selected according to the wattage/type as indicated on drawings/Documents.
- C. Weatherproof light fixtures shall comprise of UV treated plastic body or aluminium body and gasketed clear glass cover secured to the body by means of wing nuts/screws to give a weatherproof and watertight fit. The gasket shall be weather resistance type.
- D. The glass shade of the light fixtures shall be opal white or clear as furnished by the manufacturer with the light fixture unless specified and free from any air bubbles or voids. The shade may be spherical, cylindrical, flattened bottom or any other shape as specified in the drawings or BOQ.

2.03 LED FIXTURE FITTING & INSTALLATION

- A. The mounting heights of light fixtures are indicated on the drawings, and position of fixtures are according to the mentioned scale.
 - B. The Contractor must ensure that the light fixtures are installed uniformly with respect to the dimensions of the area. Any modifications due to site conditions may be made with the approval of Engineer. All fixtures shall be carefully aligned before fixing in position.
 - C. Glasses, shades, reflectors, diffusers, etc., must be in a clear condition after installation. All light fixtures shall be earthed by an earthwire connected to the earth terminal in the fitting.
 - D. The LED light fixtures on the surface of ceiling shall be installed with the back of the body flush with the ceiling surface, and in a manner so as to facilitate wiring. Nylon plugs and galvanized steel bolts or screws shall be used for fixing the light fixture to the ceiling. For light fixtures installation on false ceiling the installation method/detail shall be coordinated with ceiling design and submitted for approval of Engineer. Care shall be taken to prevent the weight of the fixture from being transferred to the false ceiling.
 - E. After fabrication, metal surfaces shall be thoroughly cleaned back to the parent metal and all dust, moisture grease or oil shall be removed.
 - F. All scale and corrosion products shall be removed after which the finished article shall be cleaned with trichloroethylene.
 - G. The metalware shall be spray painted with high grade polyester powder coat on both sides and stoved. Total thickness of paint build up shall be not less than 50 micron. Finished colour shall be to approval on all surfaces.
 - H. All plastic diffuser shall be of non-deteriorating, colour stable material and of acrylic material.
 - I. Recessed lighting fittings shall be supported from the RC ceiling slabs using appropriate fixing accessories such as steel rod, spring clips, ceiling brackets, suspension hooks, profile brackets, etc. to ensure proper Installation of the fittings on different types of ceiling panels. Where light fittings are installed directly below large ductworks etc., the Contractor shall install suitable brackets, channels, etc. to facilitate suspension/support of the light fittings from the ceiling slabs. An adjustable resilient spring-clip shall be provided to enable the suspension length to be adjusted to fine tolerances. Suspension sets shall be adjustable proprietary make type manufactured to carry the weight of the lighting fittings and shall be of adequate lengths for installation on the false ceiling panels concerned. Suspension rods shall be of least 5mm diameter and shall be fixed at positions recommended by the lighting fitting manufacturers.
 - J. At least four (4) suspension rods shall be provided for each fitting (Hanging Type). Lighting fittings shall be supported in a manner that will ensure that the weight of each fitting is equally distributed to all supporting rods with the fitting remaining in level position. Suspension sets where exposed to sight shall be of adjustable rod type of minimum diameter 20mm with all necessary accessories.
-

- K. All diffusers shall be hinged at one side of the fitting for maintenance purposes and snap fit back into position.
- L. All light fittings used as emergency lights including exit signs shall be constructed and installed In accordance with the current edition of BS5266 Code of Practice for the Design, Installation and Maintenance of Emergency Evacuation Lighting and Power Supply Systems in Buildings. Exit signs shall be complied with Civil Defence requirements.
- M. Identification symbol in accordance with BS5266 shall be displayed on or adjacent to each emergency lighting fitting. The symbol shall not be fixed to the diffuser of an emergency lighting fitting or to removable ceilingtiles.

2.04 EXTERNAL LIGHTING

- A. Lighting poles for the pole lights shall be constructed using hot-dip octagonal steel columns with the base compartment housing the lamp fusegear which shall consist of a single fully shrouded single pole and neutral single entry type cut-out with HRC fuse, appropriate size MCB complete with cable sealing box, armour clamps and compression gland, where required, suitable for reception of looping PVC/SWA/PVC cables or PVC cables of the sizes as required. The finishing colour coat shall be subject to the Engineer's approval.
- B. Wiring between lamp and cut-out MCB shall be three core 2.5sq mm tinned annealed circular copper conductor PVC insulated black PVC sheathed.
- C. Weather proof connection board shall be provided for the supply of landscape lighting as indicated on the drawings.
- D. Lightning protection earth electrode for pole lighting higher than 6 m shall be provided by the Contractor.

2.05 EMERGENCY LIGHTFITTINGS

- A. EmergencyLEDlightfittingsshallcomplytoBS5266andIEC598-2andshallbeindividually equipped with battery pack to provide illumination upon sensing of power failure. The emergency fluorescent fittings are required to be type tested by approved testing laboratory to meet BS5266 and IEC598-2.
 - B. Individual control unit and battery pack shall be integrated within the light fittings
 - C. Batteries shall be sealed nickel-cadmium re-chargeable type to IEC 285 and shall be capable of continuous operation at cell wall temperature of 70°C
 - D. The batteries shall be capable to maintain the LED Lamp for up to two (2) hours after the main supply fails. The lumen output of the light fittings shall not be less than 50% of those under main supply condition throughout the two (2) hours of discharge period.
 - E. The charger shall be fully automatic, solid state constant voltage type, with electronic circuitry
-

to protect the batteries against over-charge and over-discharge. The charging system shall be capable of re-charging the battery to full capacity in not more than sixteen (16) hours after a total discharge of the battery.

- F. The control circuits shall be suitable for 230 volt \pm 10% mains operation and shall be manufactured to enable the luminaires to operate exactly like normal conventional light fittings. An unswitched live wire shall be connected to each and every luminaire with emergency pack so that the luminaires can be switched off either from the associated lighting switches, timers, contactor, etc. However, irrespective of the status of the light switch or the controlling contactor, the light fitting shall automatically illuminate or remain illuminated upon mains failure. Upon restoration of the mains supply, the lamp shall be switched back to mains supply operation and the batteries shall be re-charged again automatically.
- G. A circuit switch shall be incorporated in the control circuit to enable testing of the circuit to be carried out. A red neon light shall be provided to show 'mains supply healthy'.
- H. A fused terminal block fitted with cartridge fuses of appropriate rating shall be provided separately for both the charge and the maintained circuit.
- I. All Emergency use luminaires supplied by battery or UPS shall comply with Civil Defence code. All time and cost required to obtain subject test certificate to Civil Defence code shall be included in the Contract.

2.6 EXIT SIGN

- A. Exit sign shall be surface or recess mount to suit the Architectural detail.
 - B. The exit sign shall be complete with battery pack of specification refer to Emergency Light Fittings under this Section.
 - C. The exit sign shall be constructed from plastic or fiber material.
 - D. All fittings shall be adequately ventilated to maintain the tube wall operating temperature below 65°C (50°C ambient).
 - E. The Exit Sign shall manufacturer with details to Civil Defence requirement.
 - F. The fluorescent lamps and control gears shall comply with specification in this specification.
 - G. All light fittings used as emergency lights including exit signs shall be constructed and installed In accordance with the current edition of BS5266 Code of Practice for the Design, Installation and Maintenance of Emergency Evacuation Lighting and Power Supply Systems in Buildings. Exit signs shall be complied with Civil Defence requirements.
 - H. Identification symbol in accordance with BS5266 shall be displayed on or adjacent to each emergency lighting fitting. The symbol shall not be fixed to the diffuser of an emergency lighting fitting or to removable ceiling tiles.
-

2.13 LED FIXTURE LIFE SPAN

- A. The selection of luminaires shall take into account the requirements for heat dissipation, weatherproofing, insect proofing and the vibrations at the location of the installation. All luminaires installed in the Works shall have a minimum fixture operation life of not less than 80% of the average lamp life stated by the lamp manufacturer. If any lamps fail before this time, this will be treated as evidence of non-compliance of all the lamps of the same type in the installation concerned and in other installations which have the same performance criteria. The Contractor will be held responsible for the replacement cost of the affected lamps and all lamps of the same type in installations with the same performance criteria.

LIST OF APPROVED MANUFACTURERS/SUPPLIERS

01	<u>PVC Conduit & Accessories</u>	<u>Beta pipes, Lahore</u>	M/s. Shafisons Engg. Pvt. Ltd., 151, Bank Square Market, Model Town, Lahore. <u>Tel: 583 4907</u>
		<u>Galaxy (GALCO), Karachi.</u>	M/s. Galaxy Corporation, 4 th Floor, Bank House-1, Habib Square, M. A. Jinnah Road, Karachi. <u>Tel: 242 6970</u>
		<u>Civic, Karachi</u>	M/s. Pelikan Industries, Plot No. 60-H, Street No. 7, 1-10/3, Industrial Area, Islamabad. Tel: 547 6557, 443 1226, Fax: 547 6557 Karachi Office: 5D-1, Block B, Commercial Area, N. Nazimabad, Karachi 74700. <u>Tel: 6683198, 6688613; Fax: 6688613</u>
		<u>Dadex, Karachi</u>	M/s. Dadex Eternit Ltd., Dadex House, 34-A/1, Block 6, P.E.C.H.S., Shahr-e-Faisal, P.O. Box 20040, Karachi. Tel: 111 000 789, 431 3860-79, 4315710-14 Fax: 4315716
02	<u>Steel Conduit & Accessories</u>	<u>ILL, Karachi</u>	M/s. ILL International Industries Ltd., 101 Beaumont Plaza, 10 Beaumont Road, Karachi - 75530 <u>Tel: (92 21) 3568 0045-54 Fax: (92 21) 3568 0373 UAN: (92 21) 111 019 019 Email: inquiries@iil.com.pk, sales@iil.com.pk</u>
03	<u>G.I Pipes</u>	<u>ILL, Karachi</u>	M/s. ILL International Industries Ltd., 101 Beaumont Plaza, 10 Beaumont Road, Karachi - 75530 <u>Tel: (92 21) 3568 0045-54 Fax: (92 21) 3568 0373 UAN: (92 21) 111 019 019 Email: inquiries@iil.com.pk, sales@iil.com.pk</u>
		<u>Steelex, Karachi</u>	Steelex Private Limited <u>Head Office & Unit 1: B-30(A), Estate Ave, Karachi 75700, Pakistan info@steelex.com.pk, Tel: 0092 21 3256 4237</u>
04	<u>Cable Tray / Trunking, Ladder & Accessories</u>	<u>Ezzi, Engineering,</u>	M/s. Ezzi Engineering 80-B, 1 st Floor, Sasi Arcade, Clifton, Karachi. Tel: <u>5832540, 5832541 Fax: 5863971</u>
		<u>Ghafoor Engineering</u>	M/s Ghafoor Engineering Pvt Ltd. Address: A-22, C- Block, Gulshan-e-Jamal, Karachi. +92 21 34580310 Usman.ghani@gepl.pk Factory: KM-1 Karol Ghati, Mehmood Booti Road, Lahore. +92 42 36885457-6
		<u>Universal Switchgear</u>	M/S Universal Switchgear, Universal apartment, plot#51-C, 11 th com. St. phase-II.(EXT) DHA, Karachi. info@unieng.com.pk , 0300-2342395
		<u>Power Engineers</u>	M/s Power Engineers. Godhra Factories, Karachi. Tel: <u>0321-3818285</u>
05	<u>Cables & Internal wiring</u>	<u>Pakistan Cables Ltd.,</u>	M/s. Pakistan Cables, B/21, S.I.T.E, Karachi. <u>Tel: 256 1170, Fax: 256 4614</u>
		<u>Coppergat Cables Ltd.,</u>	M/s. Coppergat., Main Industrial Zone Kahna nu, Ferozpur Road, Lahore, Pakistan. <u>Tel: 0335-0912585, 0334-5391661</u>
		<u>Newage Cables (Pvt) Ltd.</u>	M/s. Newage Cable (Pvt) Ltd. Suite # 605-A, The Forum Khayaban-e-Jami, Clifton, Block-9, Karachi. Tel: 587 9121, 583 7577, Fax: 582 1506. Lahore Office: Newage Mansion, Mcleod Road, Lahore-54000. <u>Tel: 111-777-300, Fax: (42) 6363081</u>

06	<u>Bus tie ducts</u>	<u>Schneider</u>	M/s.Schneider D-163, SITE, Karachi. Landmarks : Abdullah Ahmed
----	----------------------	------------------	--

			Road, Central Avenue, Ghani Chowrangi, Shell PumpCity : Karachi Phone : +92-21-32576005, 32576006, <u>32576007, 32576008, 32576009</u>
		<u>EAE</u>	<u>M/s.Libra Engineering</u>
		<u>Power Bar</u>	M/s.Silk Engineering , Suite #08, Topra Plaza, Sb-27/28, Block 13-c, Gulshan-e-iqbal, Karachi, <u>21-34966706, 34810863</u>
07	<u>Cable Lugs and Ferrules</u>	<u>Cembre. Italy</u>	Consumer Electric Corp. Pvt Ltd. The Forum, Suit # 115, G-20, <u>Block 9, Khayaban-e-Jami, Pakistan. Tel:35360916, 35361516</u>
		<u>Raychem</u>	<u>Shaheen Chambers,A-4,Block 7&8Central Commercial Area,KCHS. Tel: 4543069 4543068 4385304</u>
		<u>3 M. USA</u>	M/s. Consumer Electric Corporation Ltd., 1 st floor, The Forum, Clifton, Karachi. <u>Tel: 536 0916 Fax: 536 0917</u>
08	<u>Back – boxes & Pull - boxes</u>	<u>Ezzi Engineering</u>	M/S Ezzi Engineering Email : info@ezziengineering.com URL: www.ezziengineering.com Phone.no:+92-300-8222577
		<u>Universal Switchgear</u>	<u>M/S Universal Switchgear , Universal apartment, plot#51-C, 11th com. St. phase-II,(EXT) DHA, Karachi. info@unieng.com.pk, 0300- 2342395</u>
		<u>Leiamra Engineering & Control</u>	M/SLeiamraEngineeringAddress:Suit#211,2 nd FloorPECHS CommunityCenterBlock2,PECHS,Shahrah-e-QuaideenKarachi Tel:21-34558611-20300-2318277 <u>Email:shoaib@leiamra.com, 0300-2318227</u>
09	<u>Switches and Socket outlets</u>	<u>MK, Singapore</u>	M/SLeiamraEngineeringAddress:Suit#211,2 nd FloorPECHS CommunityCenterBlock2,PECHS,Shahrah-e-QuaideenKarachi Tel:21-34558611-20300-2318277 <u>Email:shoaib@leiamra.com, 0300-2318227</u>
		<u>Clipsal (Schneider). Australia</u>	M/s Clipsal Pakistan Pvt Ltd, 101-102, Sector 15, Korangi Industrial Area, Karachi, <u>Tel: 5067278-9, Fax 5063369. 0322-2880062</u>
		<u>Legrand</u>	<u>M/s MegaPlus</u>
10	<u>Light Fixture for Indoor & Outdoor Lighting Emergency/Exit lights</u>	<u>Philips</u>	<u>M/s. Philips Pakistan Limited, 6th Floor Bahria Complex 1, 24, M.T Khan Road</u>
		<u>Emax</u>	M/s Emax, B-204, Block 12 , Gulshan-e-jhor Karachi, <u>Tel: 0336-8416328</u>
		<u>Gewiss</u>	<u>M/S.Overseas Enterprises, Address: Suit#101, 1st floor, Sea Breeze Plaza, Sharae-e-Faisal, Karachi Tel: 32787711-22-33-44, 03353035706</u>
		<u>BI Enterprises</u>	M/S. BI Enterprises, F-59, S.I.T.E, Mauripur Rd, Sindh Industrial Trading Estate, Karachi, Karachi City <u>Phone: 0323-2501927</u>
11	<u>Fan</u>	<u>Royal. Gujranwala</u>	<u>Local Market</u>
		<u>Pak Fan</u>	
		<u>GFC Fan</u>	
12	<u>Hand Dryers</u>	<u>Starmix. Germany</u>	<u>Local Market</u>
		<u>Siemens. Germany</u>	
		<u>Clipsal, Australia</u>	
13	<u>Insect Killer</u>	<u>Moel. Italy</u>	M/s. Kiran International. C-67, 11 Commercial Street Phase II, DHA, Karachi. <u>Tel:5893142-3, Fax: 5892295.</u>
		<u>P+L System. UK</u>	M/s. Telarma Link International, Bungalow No. 176-E, Block 11, PECHS, Karachi. <u>Tel: 5439975, Fax: 4539976.</u>
		<u>Insectocutor, UK</u>	

14	<u>Data Structured Cabling System (Active Equipment)</u>	<u>Vivanco, Germany</u>	M/S MM Corporation Bangalow No. A-13, Al-Hilal Society, Opp Askari Park, KDA Scheme No.7, Karachi Ph #(+92)2134923200-01-02 ; Email: sales1@mmc.biz.pk 0334-3451978
		<u>Cisco/Dell/Lenovo/Huwei</u>	M/S MM Corporation Bangalow No. A-13, Al-Hilal Society, Opp Askari Park, KDA Scheme No.7, Karachi Ph #(+92)2134923200-01-02 ; Email: sales1@mmc.biz.pk 0334-3451978
		<u>3 Com</u>	M/s. Friends Ration Corporation, 71 Saddar Cp-op, Market, Abdullah Haroon Road, Saddar, Karachi. Tel: 568 6291, 568 3142 Fax: 568 1747
15	<u>Voice / Data Structured Cabling System (Passive Equipment)</u>	<u>3M, Germany / France</u>	M/s. 3M Pakistan (Pvt.) Ltd., Islamic Chamber of Commerce Building, ST-2/A, Block-9, KDA Scheme 5 Clifton, Karachi. Tel: 111-2255-36 Fax: 5877865
		<u>Clipsal (Schneider), Australia</u>	M/s Clipsal Pakistan Pvt Ltd, 101-102, Sector 15, Korangi Industrial Area, Karachi, Ph: 5067278-9, Fax 5063369
		<u>Vivanco, Germany</u>	M/S MM Corporation Bangalow No. A-13, Al-Hilal Society, Opp Askari Park, KDA Scheme No.7, Karachi Ph #(+92)2134923200-01-02 ; Email: sales1@mmc.biz.pk 0334-3451978
16	<u>Telephone & Data sockets</u>	<u>3M, Germany / France</u>	M/s. 3M Pakistan (Pvt.) Ltd., Islamic Chamber of Commerce Building, ST-2/A, Block-9, KDA Scheme 5 Clifton, Karachi. Tel: 111-2255-36 Fax: 5877865
		<u>Clipsal (Schneider), Australia</u>	M/s Clipsal Pakistan Pvt Ltd, 101-102, Sector 15, Korangi Industrial Area, Karachi, Ph: 5067278-9, Fax 5063369
		<u>Vivanco, Germany</u>	M/S MM Corporation Bangalow No. A-13, Al-Hilal Society, Opp Askari Park, KDA Scheme No.7, Karachi Ph #(+92)2134923200-01-02 ; Email: sales1@mmc.biz.pk 0334-3451978
17	<u>Server & Communication Racks</u>	<u>Schneider</u>	M/s Clipsal Pakistan Pvt Ltd, 101-102, Sector 15, Korangi Industrial Area, Karachi, Ph: 5067278-9, Fax 5063369
		<u>Panduit</u>	M/s. HK Shah Enterprise (Pvt) Ltd., Suit # 409, 4 th Floor, The Regency Mall (Uni Shopping Centre), Abdullah Haroon Road, Karachi. Tel: 5671570, 5670406
		<u>Vivanco/APC</u>	M/S MM Corporation Bangalow No. A-13, Al-Hilal Society, Opp Askari Park, KDA Scheme No.7, Karachi Ph #(+92)2134923200-01-02 ; Email: sales1@mmc.biz.pk 0334-3451978
		<u>ATTOM</u>	M/SATTOM Technology Office Plot 204 A Karachi. Sindhi Muslim Cooperative Housing Society Block A Sindhi Muslim CHS (SMCHS), Karachi Email: Arsalan.ashraf@attom.com.cn Mob No.: 0341-2473072
18	<u>Active Switches</u>	<u>Cisco/Dell/Lenovo/Huwei</u>	M/S MM Corporation Bangalow No. A-13, Al-Hilal Society, Opp Askari Park, KDA Scheme No.7, Karachi Ph #(+92)2134923200-01-02 ; Email: sales1@mmc.biz.pk 0334-3451978
19	<u>Wifi Device/Access Point</u>	<u>Cisco/Dell/Lenovo/Huwei</u>	M/S MM Corporation Bangalow No. A-13, Al-Hilal Society, Opp Askari Park, KDA Scheme No.7, Karachi Ph #(+92)2134923200-01-02 ; Email: sales1@mmc.biz.pk 0334-3451978

20	<u>Computers</u>	<u>IBM</u>	M/SMMCorporationBangalowNo.A-13,Al-HilalSociety,OppAskari Park,KDASchemeNo.7,Karachi Ph #(+92)2134923200-01-02 ; Email: sales1@mmc.biz.pk 0334-3451978
		<u>Compaq</u>	
		<u>Dell</u>	
		<u>HP</u>	
21	<u>Telephone PABX System</u>	<u>Panasonic, Japan</u>	M/s. Softechms Suite # 1001 – 10th Floor, Caesars Towers (National IT Park), Main Shara-e-Faisal, Karachi, Pakistan, sales@softechms.com Tel : +92(21)37132222 Fax : +92 (21)37132222
		<u>Siemens, Germany</u>	M/s. Siemens Pakistan Ilaco House, Abdullah Haroon Road, Karachi. Tel: 5662200, Fax 5684679
		<u>Clipsal/(MOD-TAP)Molex, Australia</u>	M/s Clipsal Pakistan Pvt Ltd, 101-102, Sector 15, Korangi Industrial Area, Karachi, Ph: 5067278-9, Fax 5063369
		<u>Alcatel, France</u>	M/s Al-Futtuim Technologies Pakistan (Pvt.) Ltd., 43/2/F, Block-6, PECHS, Karachi-75400 Tel: 111-238-324, Fax: 4313586
		<u>Nortel, Canada</u>	M/s Almoayed Group, Office-121, First Floor, The Forum, Khayaban-e-Jami, Block-9, Kehkashan, Clifton, Karachi Tel: 5373031, Fax: 5373032
22	<u>UPS</u>	<u>APC Schneider</u>	M/S MM Corporation Bangalow No. A-13, Al-Hilal Society, Opp Askari Park, KDA Scheme No.7, Karachi Ph #(+92)2134923200-01-02 ; Email: sales1@mmc.biz.pk 0334-3451978
		<u>Greaves</u>	M/s. Greaves Pakistan Private Limited aneesur.rehman@gfg.com.pk , 0300-2725094, 0322-2937272
		<u>General Electric, USA</u>	M/s. Inpro Pakistan (Private) Limited, 112, 1st Floor, Business Arcade, PECHS, Karachi Tel: 021-4310847, Fax: 021-4310848
		Emerson Network Power (Liebert), UK/ Italy	ComputerMarketingCo. Pvt.Ltd , Address: 306 CliftonCentre, 3 rd Floor kehkashanCliftonKarachi.Email:marsalan@cmc.net.pk,Tel: UAN021 111357357,0335-4006998
		<u>ABB, Switzerland</u>	SI Global The Plaza, 3rd Floor, Office # 311, KDA Scheme # 5, Near II Talwar, Clifton, Karachi. 75600 Email: arsalan.ashraf@sigbl.com , ashfaq.tunia@sigbl.com 0341-2473072
23	<u>Voltage Stabilizer</u>	<u>Ortea, Italy</u>	M/s.BritliteEngineeringCompany,Shop#2,plot#18-C,4 th Sunset CommercialStreet,PhaseIV,DHA,Karachi. Tel: 021-35341732-6, Email : rizwan.mirza@britlite.net .
		<u>Watford, UK</u>	M/s. Emba Corporation Pvt. Ltd. Computer Power Center, Shahid-e-Millat Road, Karachi. Tel: 4946850-55, Fax: 4937824, 4938705.
		<u>Stabimatic, Japan</u>	
		<u>Stavol, UAE AETCO, UAE</u>	M/s. IVY Interface, 222-G, Block 2, PECHS, Karachi Tel: 4558147, Fax: 4547176
24	<u>Fire Alarm System</u>	<u>SIMPLEX, USA</u>	M/s. Haseen Habib Haseen Habib Corp. (Pvt.) Ltd. PlotNo. 40C, Suite 102, First Floor, 24 Commercial Street, PhaseIIExt, Karachi, Pakistan. Tel.: (021) 3453 8945. Fax: +92-21-34538946 UAN: 111-HASEEN (111-427-336)
		<u>Honeywell (Morley), UK</u>	M/s. Telecom Engineering Co, Suit # 101, 1 st floor, Sea Breeze Plaza, Shara-e-Faisal, Karachi. Tel: 778 7711, 778 7722, 0335-3035765
		<u>Zeta(UK), Gent by Honeywell</u>	M/s Secure Vision, office No. 17, Crown Center SB-1, Bloack 13-C, Gulshan-e-Iqbal Karachi, 0301-8502044
		<u>Notifier, USA</u>	M/s. IMS Center, 10-K PECHS, Block-6, Karachi Tel: 34313196-7
25	<u>Fire Alarm</u>	<u>Belden, USA</u>	From Fire Alarm System manufacturer / supplier

	<u>Cable</u>		C-XOR Engineering 15 A-5 P.G.E.C.H.S. Near Wapda Town Lahore Pakistan T +92 42 35446195 +92 42 35180653 F +92 42 35181114 M +92 300 8477751 aamir.kardar@cxorengineering.com
		<u>FR cables</u>	
		<u>Presmian</u>	
		<u>Cavi Cel</u>	
26	<u>Public Address System</u>	<u>Bosch, Singapore</u>	M/s.Tyco,4 th Floor,Philips MarkazM.A.JinnahRoad,Karachi Tel: 276 6362, 276 6945; Fax: 272 9006
		<u>TOA, Japan</u>	M/s Secure Vision, office No. 17, Crown Center SB-1, Bloack 13-C, Gulshan-e-Iqbal Karachi, 021-34830466
		<u>Honeywell</u>	M/s. Telecom Engineering Co, Suit # 101, 1 st floor, Sea Breeze Plaza, Shara-e-Faisal, Karachi. Tel: 778 7711, 778 7722, 0335-3035765
27	<u>CCTV System</u>	<u>IDIS(KOREA)/Dahua(China)</u>	M/s Secure Vision, office No. 17, Crown Center SB-1, Bloack 13-C, Gulshan-e-Iqbal Karachi, 021-34830466
		<u>Honywell, USA.</u>	M/s Secure Vision, office No. 17, Crown Center SB-1, Bloack 13-C, Gulshan-e-Iqbal Karachi, 0301-8502044
		<u>Bosch, USA</u>	M/s. Telecom Engineering Co, Suit # 101, 1 st floor, Sea Breeze Plaza, Shara-e-Faisal, Karachi. Tel: 778 7711, 778 7722, 0335-3035765
		<u>Pelco, USA</u>	M/s.CNS Engineering, House # 43/16-D, Block-6, PECHS Karachi. Tel: 34314899, 34313977, 03207889813
		<u>HIK Vision</u>	M/SMMCorporationBangalowNo.A-13,Al-HilalSociety.OppAskari Park,KDASchemeNo.7,Karachi Ph #(+92)2134923200-01-02; Email: sales1@mmc.biz.pk 0334-3451978
28	<u>Lighting Control system</u>	<u>C-Bus (Schneider Electric)</u>	France
		<u>KNX –Germany</u>	M/s. Clipsal Pakistan,101-102,Sector 15 Korangi Industrial Area, Karachi Tel: 35067278-9,35062085-6
		<u>S-Bus,USA</u>	USA
29	<u>Access Control System</u>	<u>Honeywell, USA</u>	M/s. Telecom Engineering Co, Suit # 101, 1st floor, Sea Breeze Plaza, Shara-e-Faisal, Karachi. Tel: 778 7711, 778 7722, 0335-3035765 email: atiq.clipsal@gmail.com , Atiq@tec.com.pk
		<u>Virdi, USA</u>	M/s Secure Vision, office No. 17, Crown Center SB-1, Bloack 13-C, Gulshan-e-Iqbal Karachi, 0301-8502044
		<u>TAC, USA</u>	M/s. IMS Center, 10-K PECHS, Block-6, Karachi Tel: 34313196-7
30	<u>Audio / Video Intercom System</u>	<u>Comelit, Italy</u>	M/s Pak Security & Safety, 20 Amber Hotel , P.E.C.H.S., Block 6, Karachi Tel: 4546818, 4528541 Fax: 4526182
		<u>Mircom, USA</u>	
		<u>Honeywell</u>	M/s. Telecom Engineering Co, Suit # 101, 1st floor, Sea Breeze Plaza, Shara-e-Faisal, Karachi. Tel: 778 7711, 778 7722, 0335-3035765
31	<u>MATV & SMATV System</u>	<u>WISL, USA</u>	M/s Pak Security & Safety, 20 Amber Hotel , P.E.C.H.S., Block 6, Karachi Tel: 4546818, 4528541 Fax: 4526182
32	<u>Hand Held & Walk through Metal Detectors</u>	<u>Control screening, USA</u>	M/s Pak Security & Safety, 20 Amber Hotel , P.E.C.H.S., Block 6, Karachi Tel: 4546818, 4528541 Fax: 4526182
		<u>Adams, UK</u>	

33	<u>Earthing & Lightning Protection System</u>	<u>DEHN</u>	<u>M/s Jubilee Corporation, Mercantile Centre, 1st Floor, Newnham Road, P.O. Box 6165, Karachi-74000 Tel: 021-32439070, 021-32439081 Fax: 021-32414589</u>
		<u>WALLIS</u>	M/s. Consumers Electric Corp (pvt) Ltd. The Forum, Suite # 115, G-20, Block 9, Khayaban-e-Jami, Clifton, Karachi-75600, Pakistan T : +92 21 3536-0916, 3536-1516, 0312-1135666 <u>Email: ceco@cyber.net.pk</u>
34	<u>Low Voltage Switchgear</u>	<u>Libra Engineering, Karachi</u>	<u>M/s. Libra Engineering, DP-25, Sector 12-D, North Karachi Industrial Area, Karachi Tel: 6905981, 6976469. Fax: 6934557.</u>
		<u>Power engineers</u>	<u>M/s. Power Engineers. Godhra Factories, Karachi. Tel: 0321-3818285</u>
		<u>Hussain & Co. Karachi</u>	<u>M/s. Hussain & Company. III, Ghafoor Chambers, Abdullah Haroon Road, Karachi. Tel: 7728529, 7729582 Fax: 7724509, 0331-2390085</u>
		<u>Unique Engineering</u>	<u>Mr. Imran, 0300-2008035. Korangi Karachi</u>
35	<u>Contactors / Relays</u>	<u>ABB, Germany</u>	<u>M/s ABB Pvt. Ltd., ST2/9 Sector 23 Near Chumera Churangi Tel: +92 21 3511 5584 - 85</u>
		<u>Telemecanique, France</u>	<u>M/s. Elektro Technik, 3-Hassan Mension, First Floor, Altaf Hussain Road, Denso Hall, Karachi. Tel: 2623724, 2634917; Fax: 2625115</u>
		<u>Finder, Italy</u>	<u>M/s Jubilee Corporation, Mercantile Centre, 1st Floor, Newnham Road, P.O. Box 6165, Karachi-74000 Tel: 021-32439070 , 021-32439081 Fax: 021-32414589</u>
		<u>National, Japan</u>	<u>M/s. Jubilee Corporation, First Floor Fakhri Trade Center, Shahra-e-Liaquat P.O. Box 677 Karachi Tel: 021-32602200-07, Fax: 92-21032602211</u>
		<u>Samwha, Korea</u>	
		<u>Emirel, Italy</u>	
36	<u>Circuit Breaker</u>	<u>Schneider Electric, France</u>	<u>M/s Sh. Wilayat Ahmed & Sons, G-1, Abid Chamber, Shahrah-e-Liaquat, Karachi-74200 Tel: 111-112-113, Fax: 2626314</u>
		<u>ABB, Germany</u>	<u>M/s ABB Pvt. Ltd., ST2/9 Sector 23 Near Chumera Churangi Tel: +92 21 3511 5584 - 85</u>
		<u>Terasaki(Japan)W</u>	<u>M/s. Jubilee Corporation, First Floor Fakhri Trade Center, Shahra-e-Liaquat P.O. Box 677 Karachi Tel: 021-32602200-07, Fax: 92-21032602211</u>

37	<u>Indicating</u>	<u>Telemecanique, France</u>	<u>M/s. Elektro Technik, 3-Hassan Mension, First Floor, Altaf</u>
----	-------------------	------------------------------	---

	<u>Lamps and Push Buttons</u>		Hussain Road, Denso Hall, Karachi. Tel: 2623724, 2634917; Fax: 2625115
		<u>Baco, France</u>	M/s Sh. Wilayat Ahmed & Sons, G-1, Abid Chamber, Shahrah-e-Liaquat, Karachi-74200 Tel: 111-112-113, Fax: 2626314
		<u>Revalco, Italy</u>	M/s Jubilee Corporation, Mercantile Centre, 1st Floor, Newnham Road, P.O. Box 6165, Karachi-74000 Tel: 021-32439070 , 021-32439081 Fax: 021-32414589
		<u>Maruyasu, Japan</u>	
		<u>Fuji, Japan</u>	M/s Sh. Wilayat Ahmed & Sons, G-1, Abid Chamber, Shahrah-e-Liaquat, Karachi-74200 Tel: 111-112-113, Fax: 2626314
38	<u>LV Current</u> <u>_____ / _____</u> <u>Potential</u> <u>Transformers</u>	<u>Revalco, Italy</u>	M/s Jubilee Corporation, Mercantile Centre, 1st Floor, Newnham Road, P.O. Box 6165, Karachi-74000 Tel: 2438449, 2439070, 2439081 Fax: 2414589
		<u>Circutor, Spain</u>	M/s Sh. Wilayat Ahmed & Sons, G-1, Abid Chamber, Shahrah-e-Liaquat, Karachi-74200 Tel: 111-112-113, Fax: 2626314
		<u>Fico, Pakistan</u>	
39	<u>Measuring Instruments, Voltmeters/ Ammeters</u>	<u>Circutor, Spain</u>	M/s Sh. Wilayat Ahmed & Sons, G-1, Abid Chamber, Shahrah-e-Liaquat, Karachi-74200 Tel: 111-112-113, Fax: 2626314
		<u>Schneider Electric, France</u>	M/s. Schneider Electric 409, Fortune Center 45-A PECHS Block-6, Karachi Tel: 4386395-6 Fax: 4386397
		<u>Hobut, UK</u>	<u>M/s Electro Technik, 3-Hassan Mension, First Floor, Altaf Hussain Road, Denson Hall, Karachi.</u> Tel: 2438449, 2439070, 2439081 Fax: 2414589
		<u>Revalco, Italy</u>	M/s Jubilee Corporation, Mercantile Centre, 1st Floor, Newnham Road, P.O. Box 6165, Karachi-74000 Tel: 2438449, 2439070, 2439081 Fax: 2414589
		<u>Lovato, Italy</u>	
		<u>Autonics, Korea</u>	
		<u>Camsco, Taiwan</u>	
40	<u>Change Over Switch (COS)</u>	<u>SOCOMEK, France</u>	<u>M/s Jubilee Corporation, Mercantile Centre, 1st Floor, Newnham Road, P.O. Box 6165, Karachi-74000</u> Tel: 2438449, 2439070, 2439081 Fax: 2414589
		Schneider Electric, France Tel: 4386395-6 Fax: 4386397	M/s. Schneider Electric 409, Fortune Center 45-A PECHS Block-6, Karachi Tel: 4386395-6 Fax: 4386397
		<u>Gave, Spain</u>	<u>M/s Jubilee Corporation, Mercantile Centre, 1st Floor, Newnham Road, P.O. Box 6165, Karachi-74000</u> Tel: 2438449, 2439070, 2439081 Fax: 2414589
		<u>Techno Electric, Italy</u>	<u>M/s Jubilee Corporation, Mercantile Centre, 1st Floor, Newnham Road, P.O. Box 6165, Karachi-74000</u> Tel: 2438449, 2439070, 2439081 Fax: 2414589
		<u>Breter, Italy</u>	M/s Sh. Wilayat Ahmed & Sons, G-1, Abid Chamber, Shahrah-e-Liaquat, Karachi-74200 Tel: 111-112-113, Fax: 2626314
		<u>K & N, New Zealand</u>	
		<u>Chint</u>	<u>China</u>

41	<u>Surge Protective</u>	<u>DEHN, Germany</u>	M/s Jubilee Corporation, Mercantile Centre, 1st Floor, Newnham Road,
----	-------------------------	----------------------	--

	<u>Devices</u>		P.O. Box 6165, Karachi-74000 Tel: 2438449, 2439070, 2439081 Fax: 2414589
42	<u>Prepaid Energy Meter</u>	<u>Conlog, South Africa Delixi, China</u>	M/s. Britlite Engineering Company, Office 29-C, Ground Floor Sunset Commercial Street, Phase 4, DHA, Karachi-75500. Tel: 583 3768, 580 1096, Fax: 539 6784.
		<u>Inhemeter, China</u>	JES Instrumentation & Controls 03423206063
		<u>CNS Engineering</u>	M/s. CNS Engineering, House # 43/16-D, Block-6, PECHS Karachi. Tel: 34314899, 34313977, 03207889813
43	<u>Post Paid Energy Meter</u>	<u>Incontrol, USA</u>	M/s. IMS Center, 10-K PECHS, Block-6, Karachi Tel: 34313196-7
44	<u>Power Factor Capacitors, controllers, relays</u>	<u>Schneider Electric, France</u>	M/s Sh. Wilayat Ahmed & Sons, G-1, Abid Chamber, Shahrah-e-Liaquat, Karachi-74200 Tel: 111-112-113, Fax: 2626314
		<u>Shizuki, Japan</u>	M/s Sh. Wilayat Ahmed & Sons, G-1, Abid Chamber, Shahrah-e-Liaquat, Karachi-74200 Tel: 111-112-113, Fax: 2626314
		<u>Nokian, Finland</u>	M/s Jubilee Corporation, Mercantile Centre, 1st Floor, Newnham Road, P.O.Box 6165, Karachi-74000 Tel: 2438449, 2439070, 2439081 Fax: 2414589
45	<u>Voice Evacuation / Public Address System</u>	<u>Bosch</u>	M/s. Telecom Engineering Co, Suit # 101, 1st floor, Sea Breeze Plaza, Shara-e-Faisal, Karachi. Tel: 778 7711, 778 7722, 0335-3035765
		<u>Honeywell</u>	M/s. Mega Plus, M44, PECHS Black-6, Shara-e-Faisal, Karachi. ali.khan@megaplus.com.pk, 0312-3361842
46	<u>Master Clock</u>	<u>NIS - Time</u>	M/s. Telecom Engineering Co, Suit # 101, 1st floor, Sea Breeze Plaza, Shara-e-Faisal, Karachi. Tel: 778 7711, 778 7722, 0335-3035765
		<u>Mobatime</u>	M/s. Telecom Engineering Co, Suit # 101, 1st floor, Sea Breeze Plaza, Shara-e-Faisal, Karachi. Tel: 778 7711, 778 7722, 0335-3035765
47	<u>Lighting Automation</u>	<u>Schneider Electric, France</u>	M/s Clipsal Pakistan Pvt. Ltd/ 101-102, Sector 15, Korangi Industrial Area, Karachi Tel: 111-081-081, 03222880038
48	<u>Diesel Generators</u>	<u>Aksa Power Generator</u>	M/S Energy solution pvt. Ltd, ESL House, DP-01, Sector 21, Korangi Industrial Area, Karachi, fawad@eslpk.com, 0302-8487961
		<u>Power Zone</u>	M/s Powerzone: 1P, 1KM, Defence off, Raiwind Road, Bhobtianchowk, Adjacent University Of Lahore Email: salik.mehmood@pzes.co Tel: 0321-2818285
		<u>Masco Energy Services</u>	M/s Masco Energy Services Address: 12/1 Sector 23, Korangi Industrial Area, Karachi-74900, Pakistan. Contact Person: Adeel Hassan 0332-2173687 adeel.hassan@mascoenergy.com
49	<u>Lifts/ Escalators</u>	<u>Kone</u>	M/s Greave Pakistan Pvt Ltd Tel: 0322-2937050
		<u>Fuggi</u>	M/s Pentatrading Pvt Ltd Tel: 0332-3075309
		<u>Shindler</u>	M/s Merin (Pvt) Ltd., 2nd Floor, Hassan Ali Centre, M.A. Jinnah Road, Karachi - 74000 Tel: 2411654, 2411988, 2444685-6 Fax: 2417836
		<u>General, China</u>	M/s Saasa Corporation (Pvt) Ltd., 8-II/G Model Town, Lahore-54700, Tel: 5843781-3 0312-5033194, Fax: 5843784
		<u>Mitsubishi, Japan</u>	

50	<u>Cable tags and stickers</u>	<u>Consumer Electric</u>	M/s. Consumers Electric Corp (pvt) Ltd. The Forum, Suite # 115, G-20, Block 9, Khayaban-e-Jami, Clifton, Karachi-75600, Pakistan T : +92 21 3536-0916, 3536-1516 <u>Email: ceco@cyber.net.pk</u>
51	<u>Anchor bolt/rawl bolt Cable Tray Support</u>	<u>Fisher (German)</u>	<u>Address: H.S Ahmed Allay(Fischer) showroom no. 8 sareena pride plot no. 14/A/1 Block-6 PECHS shara-e-faisal adjacent KFC Nursery Karachi.</u> <u>Tell:021-34548345 0300-8275108 Email:wahid@hsahmedally.com, Sghazanfar@hsahmedally.com</u>
		<u>Cembre, Italy</u>	M/s. Consumers Electric Corp (pvt) Ltd. The Forum, Suite # 115, G-20, Block 9, Khayaban-e-Jami, Clifton, Karachi-75600, Pakistan T : +92 21 3536-0916, 3536-1516, 0312-1135666 <u>Email: ceco@cyber.net.pk</u>



CONSTRUCTION OF HILTON PHARMA NANO TECHNOLOGY CENTRE (REMAINING WORKS)

AT

**NED UNIVERSITY OF ENGINEERING & TECHNOLOGY,
KARACHI**

VOLUME - III BILL OF QUANTITIES

**NED University of Engineering and Technology,
University Road,
Karachi-75270.**

**CONSTRUCTION OF HILTON PHARMA NANO TECHNOLOGY CENTRE
(REMAINING WORKS)**

S U M M A R Y O F C O S T

1. Architectural Works

a)	Schedule Items	Rs
b)	Non-Schedule Items	Rs
Total Amount		Rs

2. Structural Works

a)	Schedule Items	Rs
b)	Non-Schedule Items	Rs
Total Amount		Rs

3. Plumbing Works

a)	Schedule Items	Rs
b)	Non-Schedule Items	Rs
Total Amount		Rs

4. Electrical & Air-Conditioning Works

a)	Schedule Items	Rs
b)	Non-Schedule Items	Rs
Total Amount		Rs

5. Diesel Generator

a)	Schedule Items	Rs
b)	Non-Schedule Items	Rs
Total Amount		Rs

TOTAL COST OF WORKS (1 to 5)	Rs
-------------------------------------	-----------

***In Rupees:
(Inclusive with all taxes)***

Signature of Contractor with Seal

NED University of Engineering & Technology, Karachi
Construction of Hilton Pharma Nano Technology Centre (Remaining Works)

BILL OF QUANTITIES
B - Architectural Works (Non-Schedule Items)

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
1	<u>TERMITE PROOFING</u> Applying termite treatment by spraying solution of 0.5% dieldrin or Aldrin as per specification to the following locations complete in all respects to the entire satisfaction of the Project Architects. a. All rough wood work in entire project.	Job.	L/s		
2	<u>MASONRY IN SUB STRUCTURE</u> Provide and lay normal quality C.C. block masonry sub-structure bases, laid and jointed with 1:4 cement sand mortar using approved quality screened river sand. Masonry to be laid so as to provide even and firm base to all surfaces. All work is to be completed as per drawings, specifications and as directed by the Project Architect. The masonry base will be of 6" masonry and is 9" below NGL. 1.4.8 PCC and soling base is calculated as part of other BoQ items. All edges at building facade will be raked and finished with smooth and plumbed surfaces.				
2.1	Steps base masonry	Cft.	945		
2.2	Platform edges block masonry (6" wide)	Rft.	69		
2.3	Ramp base masonry	Cft.	126		
3	<u>PLINTH PROTECTION</u> Provide plinth protection complete with pudlo plaster (1:4 cement and sand finish) in slope, block masonry, PCC 1:3:6, complete in all respects as shown in drawings and approved by Project Architect. (All sub-structure material would be included in the cost of Plinth Protection and would not be paid separately.)				
3.1	2' wide Plinth Protection (around building)	Rft.	231		
3.2	1' wide Plinth Protection (around steps)	Rft.	189		

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
4	<u>MASONRY IN SUPER STRUCTURE</u> Provide and lay 1st quality C.C. block masonry in super structure walls, laid and jointed with 1:4 cement sand machine mixed mortar using approved quality screened river sand. Masonry to be laid in courses true to line, level and plumb, properly cured, raking done on both sides and the external surface of masonry walls to be smooth. All work is to be completed as per drawings, specifications and as directed by the Project Architect.				
4.1	8" thick hollow block masonry	Sft.	3549		
4.2	8" thick solid block masonry	Sft.	4764		
4.3	6" thick hollow block masonry	Sft.	630		
4.4	6" thick solid block masonry	Sft.	1100		
4.5	4" thick solid block masonry	Sft.	3000		
4.6	3" thick solid block masonry	Sft.	Rate only		
4.7	2" thick solid block masonry	Sft.	Rate only		
4.8	Provide and lay polystyrene beads for insulation in hollow block masonry	Cft	1575		
5	<u>PLASTER</u> Provide and lay plaster with cement sand mortar on masonry and concrete surfaces, at any height, as shown on the drawings with 8" wide G.I. Expanded metal of 18 Swg at all interfaces of structures of different materials (masonry and concrete), plaster stopper, corner beads, channels for making grooves and drip course etc. where required or as directed by the Project Architect including rounding of all edges by 1/8" hacking staging and curing etc. complete in all respects. (Note - Cost of moulds, grooves, plaster details around windows, edges, chamfers etc. as indicated in drawings and/or as approved by Project Architect is to be included in all plaster works. The same would not be paid separately). 1/2" thick kachha (rough) plaster on external specified surface with 1:4 cement sand mortar including roughening of surface.				
5.1		Sft.	10367		

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
5.2	1/2" thick kachha (rough) plaster on internal specified surface with 1:4 cement sand mortar including roughening of surface. (In Toilets)	Sft.	4200		
5.3	1/2" thick textured finish plaster in white cement of approved sample as shown on drawings and/or as directed and approved by the Project Architect.	Sft.	Rate only		
5.4	3/4" thick textured finish plaster in grey cement of approved sample as shown on drawings and/or as directed and approved by the Project Architect.	Sft.	8267		
5.5	1/2" thick fair face plaster as directed and approved by the Project Architect.	Sft.	Rate only		
5.6	Provide and lay 1:4 water proof plaster 3/4" thick with cement sand mortar on masonry and concrete surfaces, at any height, as shown on the drawings using water proofing material pudlo at 5lbs per bag of cement i/c curing etc. complete in all respects.	Sft.	1554		
5.7	Making mould on parapet wall with 1:4 cement mortar complete with drip mould as shown on drawings and approved by Project Architect. Drip mould provided of given sizes on internal edges				
5.7.1	Size 2"x1-1/2"	Rft.	525		
5.7.2	Size 2-1/2"x1-1/2"	Rft.	Rate only		
5.7.3	Size 3"x1-1/2"	Rft.	Rate only		
6	<u>FLOORING</u> All work to be completed as per drawings, details given, specifications, directions and sample approval of Project Architect. All floor finish including base is 3" thick and wherever material of floor is changed aluminum strip (1/8" width x depth of finish) would be provided.				
6.1	<u>Under Floor Finish Works</u>				
6.1.1	Earth filling with excavated earth brought from outside in layer i/c compacting at every 12" etc. complete in all respects as approved by the Project Architect.	Cft.	Rate only		
6.1.2	P/L C.C.1:3:6 – 4" thick under floors including ramming, compacting and curing, complete in all respects.	Sft.	Rate only		

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
6.1.3	P/L C.C. 1:4:8 – 4" thick under floors including ramming, compacting and curing, complete in all respects.	Sft.	Rate only		
6.1.4	Soling and P.C.C under foundations	Sft.	Rate only		
6.2	<u>Cement Concrete (CC) Flooring</u> Provide and lay 1:2:4 cement concrete floor smooth finished (laid in panels of approximately 25 sft.) with 5 mm thick, 30mm deep aluminum dividing strips including curing hacking of existing surface for bonding where necessary, with lifting, wastage etc. complete in all respects as approved by Project Architect.				
6.2.1	In Grey Cement (In Clean Room Lab)	Sft.	3780		
6.2.2	In Grey Cement with approved imported pigment	Sft.	Rate only		
6.3	<u>Cement Concrete (CC) Tile Flooring</u> Provide and lay cement concrete tile flooring over 1:4 cement sand mortar over sub-floor 1:4 cement sand mortar over C.C. 1:2:4 sub-floor with grouts (approximately 1/2") wide in white cement mixed with approved imported pigment of matching colour including rubbing and polishing complete in all respects, as approved by the Project Architect (at any elevation) as per the given sizes and variations. (Total thickness of Flooring is 3") (Manufacturer Mohammadi Tiles/Matrix Tiles as approved).				
6.3.1	Size 8"x8"x1-1/2" thick (in grey cement)	Sft.	Rate only		
6.3.2	Size 12"x12"x1-1/2" thick (in grey cement with pigment)	Sft.	Rate only		

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
6.4	<u>Porcelain Floor Tile Flooring</u> Provide and lay porcelain tile matt finish of approved sample and colour for flooring in slope fixed with dry bond with 1:4 cement sand mortar base of required thickness so as to achieve a minimum over-all finished floor thickness in 3", setting the tiles with neat cement mortar, grouting the joints with white cement mixed with approved imported pigment of matching colour including curing, cleaning etc. complete in all respects. (Manufacturer Granitto or approved equivalent) as approved by the Project Architect. (Basic cost of tile to be taken as Rs. 3500/- per Sq. M.)				
6.4.1	In 3" thick - Size 48x24	Sft.	3822		
6.4.2	In 3" thick - Size 24x24	Sft.	5566		
6.4.2	In 2" thick - Size 24x24	Sft.	Rate only		
6.5	<u>National Tiles Flooring</u> Provide and lay National tiles of approved sample and colour for flooring in slope with 1:4 cement sand mortar base of required thickness so as to achieve a minimum over-all finished floor thickness in 3", setting the tiles with neat cement mortar, grouting the joints with white cement mixed with approved imported pigment of matching colour including curing, cleaning etc. complete in all respects. (Manufacturer National tiles or approved equivalent) as approved by the Project Architect. (Basic cost of tiles is to be taken as Rs. 2500/- per Sqm.)				
6.5.1	Size16"x16" x1/2" thick	Sft.	2144		
6.5.2	Size12"x12"x1/2" thick	Sft.	630		
6.6	<u>Marble Flooring</u> Provide and lay 3/4" thick Ocean marble of approved sample and colour for flooring with 1:4 cement sand mortar base of required thickness so as to achieve a minimum overall finished floor thickness 3" setting with approved pigment etc. including bull nosing, grooving at edge cutting, grouting grinding and polishing etc. complete in all respects as directed Project Architect. (Basic cost of marble is to be taken as Rs. 1500/- per Sft.				
6.6.1	For Floor 2" in step landing of min. size 24"x24"	Sft.	263		
6.6.2	For Floor 3" of min. size 24"x24"	Sft.	Rate only		

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
6.6.3	For Main Staircase 14" wide Steps Single piece with 1.5" chamfered nosing on three sides	Rft.	113		
6.6.4	For Outer Staircase 12" wide Steps Single piece with 1.5" chamfered nosing on one side	Rft.	101		
6.6.5	For Exit Staircase 12" wide Steps Single piece with 1.5" chamfered nosing on three sides	Rft.	227		
6.6.6	For Service Balcony 11" wide Steps Single piece with 1.5" chamfered nosing on two sides	Rft.	84		
6.6.7	For Ground Floor 12" wide Entrance Steps Single piece with 1.5" chamfered nosing on three sides	Rft.	151		
6.7	<u>Ceramic Tile Flooring</u> Provide and lay ceramic tile matt finish of approved sample and colour for flooring in slope with 1:4 cement sand mortar base of required thickness so as to achieve a minimum over-all finished floor thickness in 3", setting the tiles with neat cement mortar, grouting the joints with white cement mixed with approved imported pigment of matching colour including curing, cleaning etc. complete in all respects as approved by Project Architect. (China make). In Bathroom of min size 16"x16" (Basic cost of tile is to be taken as Rs. 3500/- per Sqm)	Sft.	667		
6.8	<u>Terrazzo Tile Flooring</u> Provide and lay terrazzo tiles (of specification 40:60 i.e. 40 marble powder : 60 cement) flooring over 1:4 cement sand mortar over sub floor 1:4 cement sand mortar over C.C. 1:2:4 sub-floor with grouts in white cement mixed with approved pigment (imported) of matching colour including rubbing and polishing complete in all respects, as approved by the Project Architect (at any elevation) as per the following sizes and variations. (Manufacturer Mohammadi Tiles/Al-Noor Tiles or approved equivalent).				
6.8.1	8"x8" size 3/4" thick (in grey cement)	Sft.	Rate only		
6.8..2	8"x8" size 3/4" thick (in grey cement with pigment)	Sft.	Rate only		
6.8.3	8"x8" size 3/4" thick (in white cement)	Sft.	Rate only		
6.8.4	8"x8" size 3/4" thick (in white cement with pigment)	Sft.	Rate only		
6.8.5	12"x 12" size 1" thick (in grey cement)	Sft.	Rate only		
6.8.6	12"x 12" size 1" thick (in grey cement with pigment)	Sft.	Rate only		

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
6.8.7	12"x 12" size 1" thick (in white cement)	Sft.	Rate only		
6.8.8	12"x 12" size 1" thick (in white cement with pigment)	Sft.	Rate only		
6.9	<u>Wooden Flooring</u> Providing and laying wooden flooring inter wood design or equivalent i/c lacquer polish etc. complete as approved by the Project Architect.	Sft.	Rate only		
7.0	<u>SKIRTING AND DADO</u>				
7.1	<u>CC Skirting</u> P/Laying in situ CC skirting 4" high with ratio 1:4 on wall in grey cement with imported pigment laid in 1:4 cement mortar i/c curing etc. complete in all respects as approved by the Project Architect.	Rft.	Rate only		
7.2	<u>CC Tiles Skirting</u> Provide and lay cement concrete tile skirting over 1:4 cement sand mortar over sub-floor 1:4 cement sand mortar over C.C. 1:2:4 sub-floor with grouts 1/2' wide in white cement mixed with approved imported pigment of matching colour including rubbing and polishing complete in all respects, as approved by the Project Architect (at any elevation) as per the given sizes and variations. (Total thickness of Flooring is 3") (Manufacturer Mohammadi Tiles/Matrix Tiles as approved).	Rft.	252		

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
7.3	<u>Porcelain Tile Skirting</u> Provide and lay porcelain tile skirting of approved sample with 1:4 cement sand mortar base of required thickness, setting the tiles with neat cement mortar, grouting the joints with white cement mixed with approved pigment of matching colour including curing, cleaning etc. complete in all respects as approved by Project Architect. (Manufacturer Master or approved equivalent). (Basic cost of tile to be taken as Rs. 2200/- per Sq. M.)				
7.3.1	Size 48"x4"	Rft.	693		
7.3.2	Size 24"x4"	Rft.	987		
7.4	<u>National Tiles Skirting</u> Provide and lay National tiles of approved sample and colour for flooring in slope with 1:4 cement sand mortar base of required thickness so as to achieve a minimum over-all finished floor thickness in 3", setting the tiles with neat cement mortar, grouting the joints with white cement mixed with approved imported pigment of matching colour including curing, cleaning etc. complete in all respects. (Manufacturer National tiles or approved equivalent). (Basic cost of tiles is to be taken as Rs. 1500/- per Rm.)				
7.4.1	Size16"x4" x1/2" thick	Rft.	315		
7.4.2	Size12"x4"x1/2" thick	Rft.	Rate only		
7.5	<u>Marble Skirting</u> Provide and lay Ocean or equivalent marble skirting 3/4" thick or as per approved thickness by gluing the marble with grinding and chemical polishing, grinding etc. complete in all respects as approved by Project Architect. (Basic cost of marble to be taken as Rs. 1000/- Per Sft.)				
7.5.1	Size 48"x6" in steps riser Single piece is provided for front face of all risers	No.	50		
7.5.2	Size 24"x6" around steps Provided in angular shape as per length of stairase meeting wall. Only rft will be paid	Rft.	252		
7.5.3	Size 24"x4"around steps	Rft.	Rate only		

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
7.6	<u>Ceramic Tile Dado</u> Provide and lay ceramic tile matt finish of approved sample and colour for wall in slope with 1:4 cement sand mortar base of required thickness so as to achieve a minimum over-all finished floor thickness in 3", fixed with dry bound including grouting the joints with white cement mixed with approved pigment of matching colour including curing, cleaning etc. complete in all respects as approved by Project Architect. (Basic cost of tile is to be taken as Rs. 3500/- per Sqm.)	Sft.	3226		
7.7	<u>Terrazzo Tiles Skirting</u> Provide and lay terrazzo tile skirting (of specification 40:60 i.e. 40 marble powder : 60 cement) of approved sample with 1:4 cement sand mortar base of required thickness, setting the tiles with neat cement mortar, grouting the joints with white cement mixed with approved imported pigment of matching colour including, curing, clearing, etc. complete in all respects as (Manufacturer Mohammadi Tiles/Al-Noor Tiles or approved equivalent)				
7.7.1	Size 8"x4"x1/2" thick	Rft.	Rate only		
7.7.2	Size 12"x4"x1/2" thick	Rft.	Rate only		

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
8	<u>ALUMINIUM WORKS</u> Provide and install champagne powder coated aluminum windows with minimum 4" wide and 2.0 mm thick sections of approved sample as per details shown in drawings with (5 mm in drawings thick tinted green as approved), necessary hardware, fly-proof netting, PVC gasket seal, weather proof sealant, provision for grills, including CC 1:4 window sill, side beading and chajja with drop moulds as given in drawing complete in all respects as approved by Project Architect (Manufacturer Alcop/Pakistan Cables or approved equal). Note - All plaster edge details of windows are included in the proposed rate and will not be paid separately				
8.1	Size 4'-0"x4'-0"x32 Nos. Type W-1 External casement window with single glass	Sft.	538		
8.2	Size 4'-0"x4'-0"x05 Nos. Type W-2 Internal sliding window with single glass	Sft.	84		
8.3	Size 4'-0"x4'-0"x14 Nos. Type W-3 External fixed window with double glass and completely dust proof	Sft.	235		
8.4	Size 4'-0"x4'-0"x02 Nos. Type W-4 Internal fixed window with double glass and completely dust proof	Sft.	34		
8.5	Size 4'-0"x2'-0"x04 Nos. Type V-1 External hinged ventilator with single glass	Sft.	34		
8.6	Size 2'-0"x2'-0"x04 Nos. Type V-2 External hinged ventilator with single glass	Sft.	17		
8.7	Size 2'-0"x2'-0"x03 Nos. Type V-3 External hinged ventilator with single glass	Sft.	13		
8.8	Size 8'-0"x7'-2"-02 Nos. Type SD1 Double panel sliding door	Sft.	120		
9	<u>METAL WORK</u> Note:- All metal work is in powder coating of high quality with colour and quality as approved by Project Architect				

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
9.1	<u>Grills</u> Provide and install in position M.S. window grills consisting of 1-1/2"x3/16" thick M.S. flats horizontal vertical 1/2" dia M.S. round bar horizontal finished smooth with powder coating of approved colour and make fixed to masonry and aluminum frame with expansion bolt including all wastage, lifting etc. complete in all respects as per instructions of Project Architect.				
9.1.1	Size 4'-0"x4'-0"x46 Nos.Type W-1 and W-3	Sft.	773		
9.1.2	Size 4'-0"x2'-0"x04 Nos.Type V-1	Sft.	34		
9.1.3	Size 2'-0"x2'-0"x07 Nos.Type V-2 and V-3	Sft.	29		
9.1.4	Size 5'-0"x2'-0"x04 Nos.Type D1 and D2	Sft.	42		
9.2	<u>Metal Frames</u> Provide, fabricate and fix hollow metal frame for doors, using pressed sheet metal of 16 gauge. Frames fabricated by continuous welding, glazing beads, reinforcement for hinge, lock and closer, installation on side frames to be filled with cement sand mortar including anchoring, install door stops, finish with approved enamel paint 3 coats (ICI/Berger) over primer after installations including CC 1:4 door sill 6"x1" or 8"x1" etc. complete in all respects as approved by Project (Note- Provision of all hardware is to be made in the frames).				
9.2.1	Frame Size 2-1/2"x9"	Rft.	Rate only		
9.2.2	Frame Size 2-1/2"x6"	Rft.	Rate only		
9.2.3	Frame Size 2-1/2"x4"	Rft.	Rate only		
9.3	<u>Metal Railings</u>				
9.3.1	Provide and fix in position M.S. railing in main staircase fabricated with M.S. Square Bar 3/4" x 3/4", @ 11" centre to centre (as shown on drawing) welded to flat iron 1/8" x 1", complete with M.S. Cap 2" x 2", fixed and grouted in R.C.C. step with hold fasts and finished with powder coating as approved by Project Architect.	Rft.	63		
9.3.2	Provide and fix in position M.S. railing in lobby fabricated with brackets of M.S. Square Bar 3/4"x3/4"x9" (58 Nos.), welded to flat iron 1/8" x 1", M.S. Cap 2" x 2", fixed in wall with hold fasts and finished with powder coating as approved by Project Architect.	Rft.	68		

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
9.3.3	Provide and fix in position M.S. railing in fire exit staircase fabricated with brackets of M.S. Square Bar 3/4"x3/4"x9" (58 Nos.), welded to flat iron 1/8" x 1", M.S. Cap 2" x 2", fixed in wall with hold fasts and finished with powder coating as approved by Project Architect.	Rft.	58		
9.3.4	Provide and fix in position M.S. railing in service balcony fabricated with brackets of M.S. Square Bar 3/4"x3/4"x9" (58 Nos.), welded to flat iron 1/8" x 1", M.S. Cap 2" x 2", fixed in wall with hold fasts and finished with powder coating as approved by Project Architect.	Rft.	273		
9.3.5	Provide and fix in position stainless steel stair case railing 3'-0' high fabricated with stainless steel pipe 2" dia for hand rail 1" dia vertical two pipes on each steps and 1" square pipe horizontal at 1'-0" c/c all as per specification and approval of Project Architect.	Rft.	Rate only		
9.4	<u>Metal Hand Rail</u> Provide and fix M.S. hand rail of round bar of specified diameter including finishing with powder coating complete in all respects as approved by the Project				
9.4.1	Size 3"Ø	Rft.	Rate only		
9.4.2	Size 2"Ø	Rft.	Rate only		
10	<u>WOOD WORK</u>				
10.1	<u>Doors</u> Provide and fix in position solid core 1st class commercial veneer painted on both sides flush door levelled shutter 1½" thick with red meranti wood edging, section with 6 No. 8" long M.S. hold fast and approved quality hardware fitting and door lock (Alpha or equivalent) etc. including cost of 3 coats of matt enamel paint (ICI or equivalent as approved) over a coat of solignum, complete in all respects as per drawings, specification and approval of Project Architect. Note: Cost of Frame and Beading is not included in this item.				
10.1.1	D1-Size 5'-0"x9'-2"-01 No. Double Leaf main entrance door is polished door with teak ply 3/8" thickness on both sides in addition to door thickness	Sft.	48		
10.1.2	D2-Size 5'-0"x9'-2"-04 No. Double leaf door with glass panel at top	Sft.	192		

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
10.1.3	D3-Size 5'-0"x7'-2"-07 No. Double leaf door	Sft.	262		
10.1.4	D3a-Size 5'-0"x7'-2"-01 No. Double leaf fire door with required hardware and fire protection properties	Sft.	37		
10.1.5	D4-Size 4'-0"x7'-2"-06 No. Double leaf door	Sft.	180		
10.1.6	D4a-Size 4'-0"x7'-2"-01 No. Double leaf door for lift well at Roof	Sft.	30		
10.1.7	D5-Size 3'-4"x7'-2"-02 No. Single leaf door	Sft.	50		
10.1.8	D6-Size 3'-4"x7'-2"-05 No. Single leaf door with 6" wide aluminium strip protection on one side	Sft.	125		
10.1.9	D7-Size 2'-10"x7'-2"-06 No. Single leaf door with 6" wide aluminium strip protection on one side	Sft.	21		
10.1.10	D8-Size 2'-6"x7'-0"-10 No. Single leaf door with 6" wide aluminium strip protection on both sides	Sft.	184		
10.2	Wooden Frame Providing and fixing wooden frame of Red meranti wood fixed with hold fast and finished with enamel paint (ICI or equivalent) inclusive of beading 2"x3/4" as approved by Project Architect.				
10.2.1	Size 2"x9" - Beading on two sides	Rft.	310		
10.2.2	Size 2"x6" - Beading on one side	Rft.	215		
10.2.3	Size 2"x4" - Beading on one side	Rft.	201		
10.2.4	Size 2"x4" - No Beading	Rft.	147		
10.3	Access Panel Provide and fix in position Red meranti wood access panel with dimensions and details with meranti wood frame, louvers, rounded edging, with 4 No. 6" long M. S. hold fast and approved quality hardware, fitting etc., including cost of 3 coats of matt enamel paint ICI or equivalent complete in all respects as approved by Project Architect.	Sft	38		

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
10.4	<u>Wooden Cupboard/Cabinet</u>				
10.4.1	Base Cabinets in Pantry Provide and fabricate wooden cabinet in kitchen (low level) made with 3/4' thick Lassani wood MDF laminated with Baluchistan formica for shutter and shelves having handle catcher and locks inclding CC block wall 4" thick partition and cremic tiles on wall etc. complete with enamel paint inside in all respects as per specification and approval of Project architect. (Manufacturer for Formica is Baluchistan Laminate and manufacturer for MDF Al-Noor or equivelant)	Sft.	41		
10.4.2	Hanging Cabinets in Pantry Provide and fabricate wooden cabinet in kitchen (Hanging level) made with 3/4' thick Lassani wood MDF laminated with Baluchistan formica for shutter and shelves having handle catcher and locks etc. complete with enamel paint inside in all respects as per specification and approval of Project architect. (Manufacturer for Formica is Baluchistan Laminate and manufacturer for MDF Al-Noor or equivelant)	Sft.	27		
10.4.3	Cabinetry in Staff Bathroom Vanity and Janitor Providing and Fixing in place wooden Cupboard/cabinets in toilets having specification of being 16" deep made up of 3/4" thick wood frame and gola, 3/4" thick Lassani wood laminated with Baluchistan Formica sheet matching the colour. The shutter and top to be of laminated with approved shade farmica and 3/4" thick shelevs Lassani wood with wooden support painted with enamel paint etc complet in all respect with lock, handle and chain hinges etc. complete in all respects as approved by the Project Architect. (Manufacturer for Formica is Baluchistan Laminate and	Sft.	113		
10.5	<u>Wooden Hand Rail</u>				
	P/Fixing Red Meranti Wooden Handrail screwed to MS Flat including ICI make or equivalent polish finished as approved by the Project Architect.				
10.5.1	Size 2-1/2"x4"	Rft.	139		
10.5.2	Size 2"x3"	Rft.	59		
10.6	<u>Wooden Skirting</u>				
	Provide and lay wood skirting 4" high of solid red meranti wood with half round finished edges i/c matt polish (ICI/Berger) etc. complete as approved by the Project Architect.	Rft.	Rate only		

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
11	<u>PAINTING</u>				
11.1	<u>Plastic Emulsion</u> Provide and apply 3 coats of approved quality and shade plastic emulsion paint (ICI/Berger) including rubbing with carborandum stone, filling, primer coat (ICI/Berger) including lifting, tools, scaffolding, wastage, etc., complete as per drawings and specifications and approval of the Project Architect. (Interior Walls)	Sft.	30779		
11.2	<u>Matt Enamel</u> Provide and apply 3 coats of approved quality and shade matt enamel paint (ICI/Berger) including rubbing with carborandum stone, filling, primer coat (ICI/Berger) including lifting, tools, scaffolding, wastage, etc., complete in all respects as per drawings and specifications and approval of the Project Architect. (Wet Areas)	Sft.	315		
12	<u>WATER PROOFING & ROOF INSULATION</u> Provide and lay roof treatment as per details shown consisting of following items (For payment screed area will be measured).				
12.1	<u>Water Proofing</u> One layer of Water Proofing membrane of PVC Geomembrane 0.25 mm thick including bonding and laying as per manufacturer's specifications complete in all respects as approved by Project Architect. (Manufacturer Engro Asahi Polymer & Chemicals Ltd or equivalent).	Sft.	4620		

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
12.2	<u>Screed</u> 1:3:6 screed in required slope minimum 2" thick including making ridges, valleys, chamfered edges, khurras etc., complete in all respects as given in drawings and approved by Project Architect.	Sft.	4620		
12.3	<u>Heat Insulation</u> Provide and lay spray type heat insulation in manufacturer specified thickness (min. 02") in seamless joints and with upto 4" high on parapet wall Manufacturer: Master or approved equivalent	Sft.	3990		
12.4	<u>Heat Insulation Cover</u> 1:3:6 PCC maintaining slope minimum 2" thick including making ridges, valleys, chamfered edges, khurras etc., complete in all respects as given in drawings and approved by Project Architect. The cover is to be reinforced with reinforcement at 12" CC and gurantee of prevention of cracks is to be provided.	Sft.	3990		
12.5	<u>Floor Finish</u> P/Laying brick tiles with dry bond laid in 1:4 cement mortar etc. including grouting the joints with white cement coloured with imported pigment complete in all respects as approved by the Project Architect. (Manufacturer EQ tiles or equivalent) (Basic cost of brick tile is to be taken as Rs. 50/- per Sft.)				
12.5.1	Size 9"x9"x1-1/2"	Sft.	Rate only		
12.5.2	Size 12"x12"x1-1/2"	Sft.	3990		
12.5.3	Pea size gravel	Sft.	Rate only		
13.6	<u>Water Proofing with Bitumen</u>				
13.6.1	Providing and Laying three ply bitumen felt over a hot coat of bitumen at 30 Lbs.per 100 Sft. area with laying a mop coat of 70 Lbs. per 100 Sft. Area including cost of all material, labour, and equipment etc. complete on floor of toilets of upper floor as per drawing and specification and/or as directed by the Project Architect.	Sft.	Rate only		
13.6.2	One layer of local jute base felt of 80 lbs/100 sft. including coat of primer as per manufacture's specifications and site conditions, bonding coat of bitumen at 35 lbs/100sq. ft. and final flood coat of bitumen at 50 lbs/100 sft. Sealing of edges etc. complete in all respects.	Sft.	Rate only		

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
14	<u>MISCELLANEOUS ITEMS</u>				
14.1	<u>Cement Concrete Jali</u> Provide and lay Cement Concrete Jali in white pigmented sement of mentioned sizes and minimum thickness of 2.5" in cement sand mortar joints set together neatly with stabilizing reinforcement if required by Architect and Engineer. All CC Jali panels will be covered with netting on one side set in frame of red (Basic cost of Jali Panel is to be taken as Rs. 220/- per Sft. Manufacturer Mohammadi Tiles or approved equivalent)\				
14.1.1	Size 16"x16"x2-1/2" thick	Sft	Rate only		
14.1.2	Size 12"x12"x2-1/2" thick	Sft	907		
14.1.3	Size 8"x8"x2-1/2" thick	Sft	Rate only		
14.2	<u>Cement Concrete Coping</u> Provide and fix pre-cast cement concrete coping on walls of defferent thickness etc. complete in all respects as approved by the Project Architect				
14.2.1	Size 10"x24"x2-1/2" thick	Rft.	788		
14.2.2	Size 12"x24"x2-1/2" thick	Rft.	Rate only		
14.3	<u>Pre-cast slab for Vanity</u> P/Laying RCC Slab with drop pardi in 1:2:4 for vanity top i/c curing steel reinforcement 3/8" dia bar at 6" c/c both ways etc. complete in all respects. As approved by the Project Architect	Sft	45		
14.4	<u>Sweet Earth</u> Provide and lay sweet earth (mixed with manure) with compaction by machine at every 12" for landscape beds complete in all respects as per instructions of Project Architect.	Cft	2100		
14.5	<u>Clay Pot / Earth Filing for Sunk Slab</u> Provide and lay filling of clay pots of required maximum dimension and rammed sweet earth in compaction to fill up sunk slab spaces in toilets and cooler areas complete in all respects and as approved by the Project Architect.	Sft.	315		
14.6	<u>Gravel Finish</u> Provide and lay in place white, 1/2"-1" size crush on site after compacting and levelling existing soil, complete in all respects and as aprproved by the Project Architect.	Sft.	945		

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
14.7	<u>Landscape Pavers</u> Provide and lay on required compacted earth and sand bed 'A' quality pavers of approved colour, design, and type complete in all respects as approved by Project Architect. (Compaction of existing soil and 3" sand bed to be included in the cost and would not be paid separately). (Manufacturer Envicrete or equivalent as (Basic cost of Paver is to be taken as Rs. 90/- per sft.)	Sft.	840		
15	<u>FALSE CEILING</u>				
15.1	<u>Wooden False Ceiling</u> Providing and fixing wooden false ceiling with lassani sheet MDF fixing wooden beam (solignum treated partial wood) 2"x2" at 2'-0" C/C both way etc. complete with lighting provisions, pelmet at edge, grooves and other details approved by Project Architect.	Sft.	Rate only		
15.2	<u>Metal Ceiling</u> Provide and lay metal ceiling by Thermec in panels of size 24"x24".	Sft.	Rate only		
15.3	<u>Gypsum Board Ceiling</u> Providing and fixing of gypsum board ceiling as shown in drawing (aproximtely 4'-0"x4'-0") size with metal suspension system consisting of galvanized steel rurring channels, slices, hanger adjustment clips etc. excluding painting. The suspension shall be fixed to the slab/beam soffit with nylon anchors 1-1/2"xNO 12 round head steel screws and washersa per drwaing and as approved by the Project Architect.	Sft.	84		
Total Amount Rupees "B"		-			

NED University of Engineering & Technology, Karachi
Construction of Hilton Pharma Nano Technology Centre (Remaining Works)

BILL OF QUANTITIES
A - Architectural Works (Scheduled Items)

ITEM NO.	PWD Schedule 2012 Ref. No.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
1	Code-108 Item # 09	Providing and laying 2 inches (51 mm) thick damp proof course with cement concrete 1:2:4 cast in situ using graded screened bajri of 3/4 inch (19 mm) and down gauge including compacting, curing, form work and its removal etc. complete with applying a coat of hot bitumen (maxphalt 80/100 or equivalent) using 35 Lbs. per hundred square feet (1.71 Kg/sm) on damp proof course after complete drying and cleaning the surface	Sft.	425	85.26	36235.50
2	Code-122 Item # 04	1/2" (13 mm) thick cement plaster 1:4 on walls and columns etc. in basement, plinth, mezzanine and ground floor including making edges, corners, and curing etc., complete	Sft.	48428	43.81	2121630.68
3	Code # 122 Item # 08	3/4" (19 mm) thick cement plaster 1:4 on walls and columns etc. in basement, plinth, mezzanine and ground floor including making edges, corners, and curing etc., complete	Sft.	2100	53.35	112035.00
4	Code-127 Item # 23	Supplying and laying for sub-base, soling coat, 4" to 3" (102mm to 76 mm) gauge stone boulders to required grade and camber including packing with spawls, chips and consolidating with power roller with 10 miles lead and lift	Sft.	5775	85.77	495321.75
5	Code-117 Item # 135	Providing and laying floor of flexible polyvinyl chloride (PVC) tiles, approx. 11.8" X 11.8" X 0.099" (300 mm X 300 mm X 2-5 mm) of approved make and shade in ground floor including fixing with approved adhesive cost of sub-base concrete 1 inch (25 mm) thick 1:2:4 (one cement, two sand and 4 screened graded bajri) and its curing etc. complete as per direction of the Engineer-in-Charge	Sft.	3780	279.16	1055224.80
6	Code # 117 Item # 172	Providing and fixing wooden flooring in best quality imported teak wood planks 3/4 inch (19 mm) thick rebated including fixing with brass screws on deodar wood battens 1-1/2 inches X 2 inches (38 mm X 51 mm) placed at 12 inches (305 mm) centre to centre and filling the gap between planks and concrete base with bitumen and sand mixed in the ratio 9 lbs. (4.1 Kg) of bitumen to one cft, (0.028 cum) of sand etc. complete in any floor	Sft	801.3	2112.22	1692543.00
7	Code-118 Item # 72	Providing and laying poly vinyl chloride (PVC) skirting in pieces of required length and height 2 mm thick with approved adhesive complete in all floor	Sft	100	399.21	39921.00

ITEM NO.	PWD Schedule 2012 Ref. No.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
8	Code-122 Item # 151	<u>Ceiling</u> Distemping with vinyl distemper (ICI) Dulux Paintex of approved make and shade in two coats over and including the cost of one priming coat of lime wash including sand papering, dusting, and filling the holes, cracks and inequalities, if any, at any height in any floor	Sft.	5390	34.01	183313.90
9	Item # 162	<u>Internal Walls</u> Painting with (ICI) Dulux plastic emulsion paint VIP of approved shade two coats over and including the cost of one priming coat complete over plastered surface at any height in any floor	Sft.	10780	67.37	726248.60
10	Item # 172	<u>External paint</u> Painting three coats with weather shield paint deluxe (ICI) make of approved shade on plaster surface (External) and including the cost of cleaning the surface, sand papering etc. complete at any height in any floor	Sft.	12572	44.08	554173.76
Total Amount in Rupees						7,016,647.99
± Premium						
Net Amount in Rupees "A"						

NED University of Engineering & Technology, Karachi
**CONSTRUCTION OF HILTON PHARMA NANO TECHNOLOGY CENTRE
(REMAINING WORKS)**

BILL OF QUANTITIES STRUCTURAL WORKS

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
Note: All specifications will be provided, fabricated and applying at any height except where otherwise stated in the specific item of the Bill of Quantities including all materials, labour cost for the following items complete in all respect as per drawings, approved shop drawing, technical specifications, miscellaneous details and instructions of the Architect/Engineer					
C- SCHEDULE ITEMS					
Code-114 Item# 165	Reinforcement: Providing and laying mild steel plain reinforcement bars (having minimum yield strength of 36,000 psi) with and including the cost of straightening, cutting, bending, binding, wastage, and such overlaps as are not shown over the drawings, placing in position on cement concrete 1:2:4 precast or m.s. chairs, tying with binding wire, cost of chair and wires etc. in all kinds of RCC work in foundation, basement, plinth and ground floor of building including septic tank and underground tank and in projections for future extension.	Kg	160	250	40000.00
Code-114 Item#166	Providing and laying hard grade ribbed deformed (minimum yield point 60,000 psi) reinforcement bars with & including the cost of straightening, cutting, bending, binding, wastage, and such overlaps as are not shown in the drawings, placing in position on cement concrete 1:2:4 precast or m.s. chairs, tying with binding wire, cost of chairs and wires etc. in all kinds of RCC work in foundation, basement, plinth and ground floor of building including septic tanks and underground tanks and in projections for future extension.	Kg	16000	300	4800000.00
Total Amount "A"					4840000.00
± Premium					
Net Cost in Rupees					

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
D- NON-SCHEDULE ITEMS					
Item # 02	P/L R. C. C. ready mix (cylindrical strength of 4000 psi) for all structural work of columns and RCC walls as specified using graded screened crushed stone ¾" down gauge and approved sand including form work matching with architectural details vibrating, compacting finishing and curing etc. complete as per drawing and instruction.	CFT	350		
Item # 03	P/L R. C. C. ready mix (cylindrical strength of 3000 psi) for all structural works including foundation, plinth beams, stair case, beams, slabs, loft slabs, OHWT and slab, etc. as specified using graded screened crushed stone ¾" down gauge and approved sand including form work matching with architectural details vibrating, compacting finishing and curing etc. complete as per drawing and instruction.	CFT	4500		
Total Amount of "B"					

NED University of Engineering & Technology, Karachi
Construction of Hilton Pharma Nano Technology Centre (Remaining Works)

ENGINEER ESTIMATE
Plumbing Works

S.No.	DESCRIPTION	AMOUNT
A	TOILET FITTINGS & ACCESSORIES	Rs. -
B	INTERNAL COLD WATER SUPPLY SYSTEM	Rs. -
C	INTERNAL SOIL, WASTE, VENT & RWP WATER SYS	Rs. -
D	EXTERNAL WATER SUPPLY & SEWER SYSTEM	Rs. -
TOTAL COST		Rs. -

Date : _____

Contractor's Sign & Seal

NED University of Engineering & Technology, Karachi
Construction of Hilton Pharma Nano Technology Centre (Remaining Works)

BILL OF QUANTITIES
Plumbing Works (Non-Schedule Items)

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
A	<u>TOILET FITTINGS & ACCESSORIES</u>				
1	Providing and fixing European water closet S/P trap type with coupled flushing cistern, including all accessories and fittings, waste pipe and traps, CP flexible pipe, including double seat and cover, tee stop cock with check nut, thimble, all joints to services and drains plugging and screwing as necessary to the structure complete in all respects.	Nos.	8		
2	Providing and fixing Asian water closet orrisa type with low down flushing cistern connecting pipe complete with all accessories and fittings waste and traps, CP flexible pipe, including tee stop cock with check nuts, all joints plugging and screwing as necessary to the structure complete in all respects.	Nos.	3		
3	Providing and fixing wash basin vanity type with all accessories such as Pillar cock, tee stop cock with check nuts, CP flexible pipe, C.P. waste coupling bracket set, C.P. bottle trap, and silicon sealant, all joint to service and drain, plugging and screwing as necessary to the structure complete in all respects.	Nos.	7		
4	Providing and fixing wash pedestal type with all accessories such as Pillar cock, tee stop cock with check nuts, CP flexible pipe, C.P. waste coupling bracket set, C.P. bottle trap, and silicon sealant, all joint to service and drain, plugging and screwing as necessary to the structure complete in all respects.	Nos.	1		
5	Providing and fixing water cooler of approved make including all fittings such as tee stop cock, drain pipe dual water purification system with ultra violet sterilizer 6703 x 1, etc. complete in all respect.				
a)	50 gallons capacity.	No.	2		
6	Providing and fixing chrome plated shower rose/head with Aram and concealed stop cock for emergency shower, complete in all respects.	Nos.	1		

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
7	<u>Toilet Accessories</u> Providing and fixing bathroom/toilet accessories including fixing with Rawal plug & screws of approved quality complete in all respects, as approved by the Consultant.				
	i) Towel rail	Nos.	7		
	ii) Hand dryer	Nos.	3		
	iii) Soap Dish	Nos.	8		
	iv) Toilet paper holder	Nos.	11		
	v) Double Bib cock with Muslim Shower	Nos.	11		
	vi) Robe Hook	Nos.	11		
	vii) Mirror 4' wide (Bevelled edge type)	Rft.	34		
8	<u>Pantry Fixtures</u> Provide and lay approved pantry fixtures as per manufacturers specifications complete in all respects.				
	i) Sink Providing and fixing heavy stainless steel kitchen Sink double bowl of ATLAS 20 x 12 inches or equivalent complete fitting with mixer for hot and cold water supplies as per drawings and specifications complete in all respects.	Nos.	2		
	ii) Hob Stove Hob with minimum 03 Burners	Nos.	2		
	SUB TOTAL				-

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
B	<u>COLD WATER SUPPLY SYSTEM</u>				
a)	Galvanized iron piping (at roof or in duct)				
1	Providing, fixing, jointing testing and disinfecting G.I. Cold water pipes water supply as per BSS 1387 medium quality IIL make including specials, hanging system sockets, tees, elbows, bends, reducers, plugs and unions etc. supported on walls, or suspended from roof slab or in chase including pipe hangers supports, cutting making good the chase and holes as necessary to the structure including protective coating colour coding as per drawing and specification complete in all respects.				
	i) 1/2" dia.	Rft.	Rate only		
	ii) 3/4" dia.	Rft.	Rate only		
	iii) 1" dia.	Rft.	Rate only		
	iv) 1-1/4" dia.	Rft.	Rate only		
	v) 1-1/2" dia.	Rft.	120		
	vi) 2" dia.	Rft.	15		
	vii) 2-1/2" dia	Rft.	25		
b)	Polypropylene piping (For internal/underground)				
2	Providing & fixing, jointing, testing of Polypropylene pipe BS 5174 or DIN 8028 including special fittings such as hanging system, sockets, tees, elbow, bends, reducers, plugs and union etc. supported on walls or buried in walls/floor or suspended from roof slab as per specification complete in all respects.				
	i) 20mm dia. / 1/2" dia.	Rft.	41		
	ii) 25mm dia. / 3/4" dia.	Rft.	40		
	iii) 32mm dia. / 1" dia.	Rft.	63		
	iv) 40mm dia. / 1-1/2" dia	Rft.	8		

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
3	Providing and fixing of full way gate valves of bronze trim upto 3" (75mm) dia with threaded ends and cast iron body bronze trim flanged ends for 4" dia. (100mm) and above approved make or equivalent or similar for 125 psi together with all additional material required for complete installation as described in the specification and as shown on drawings and as approved by the Consultant.				
i)	1/2" dia.	No.	2		
ii)	3/4" dia.	No.	2		
iii)	1" dia.	Nos.	1		
iv)	1-1/2" dia.	Nos.	4		
v)	2" dia.	Nos.	3		
vi)	2-1/2" dia.	Nos.	1		
SUB TOTAL					-

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
C	<u>SOIL, WASTE, VENT & RWP SYSTEM</u>				
1	Providing and fixing in position UPVC pipes push fit type for soil, waste water & vent pipe as embedded in floor and wall or suspended from slab or clamped to wall including plugs, clamps, hanger collars, supports, specials (bens, tees, Y-tee etc). Making requisite number of holes in walls and floors where required and making good the same as necessary to the structure labelling testing to 6.5 Fl. water height complete in all respects.				
i)	2" dia.	Rft.	Rate only		
ii)	3" dia.	Rft.	270		
iii)	4" dia.	Rft.	370		
2	Providing and fixing UPVC cowl for vent pipe of the following dia. including all accessories complete in all respects.				
i)	3" dia.	Nos.	1		
ii)	4" dia.	Nos.	2		
3	Providing and fixing UPVC floor drain/Floor Gully of approved design with S.S grating including requisite number of holes in wall, plinth or floor for pipe connection and making good the same as necessary to the structure including gasket and clamp complete in all respects.				
i)	4" dia.	Nos.	19		
4	Providing and fixing UPVC clean out (floor/ceiling type) with S.S cover making requisite number of holes in walls, plinth or floor for pipe connection and making good the same as necessary to the structure including rubber gasket and clamp etc.				
i)	FCO 3" dia.	No.	Rate only		
ii)	FCO 4" dia.	Nos.	Rate only		
5	Providing and fixing UPVC domed rain water outlet/grating with requisite number of holes in roof slab same as necessary to the structure including rubber gasket and clamps/support etc. complete in all respects.				
i)	RWG 4" dia.	Nos.	5		
	SUB TOTAL				

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
D	<u>EXTERNAL WATER SUPPLY & SEWER SYSTEM</u>				
1	Providing and fixing CI cover with frame 24"x 24" for overhead water tank complete in all respects.	Nos.	5		
2	Providing and constructing RCC chamber 12" x 12" as per drawing covering all works items involved confirming to details and relevant section of specifications, including C.I. Manhole frame and cover of approved make complete in all respect as per drawings and specifications.	No.	3		
3	Providing, laying and jointing UPVC sewer pipe class "D" including excavation, backfilling, compaction bedding, lowering in trenches to correct alignment and grade, jointing, cutting pipes where necessary, finishing and testing complete as per drawing and specification.				
i)	6" dia.	Rft.	120		
4	Providing and making connection from existing water supply including the cost of valve and pipes and necessary materials required for complete in all respects.				
i)	PPR pipe 32mm dia./1-1/2" dia.	Rft.	100		
ii)	G.I pipe 1-1/2" dia.	Rft.	100		
5	Providing and making RCC square manhole 2' x 2' complete in all respects including excavation, backfilling, compaction M. I. Rings, block masonry, ½" thick puddlo plaster beuching, heavy duty manhole cover of approved make complete as per drawings and specifications.				
i)	For depth 0-5m (24" x 24")	Nos.	5		
6	Providing and fixing 4" dia. P-trap for 12" x 12" C.I. Gully trap chamber approved make with C.I. Frame and cover including R.C.C. gully trap chambers block masonry ½" thick puddlo plaster as per drawing and specification complete in all respects.	Nos.	4		
	SUB TOTAL				-
	NET AMOUNT OF PLUBMING ITEM "F"				-

NED University of Engineering & Technology, Karachi
Construction of Hilton Pharma Nano Technology Centre (Remaining Works)

BILL OF QUANTITIES
ELECTRICAL WORKS (ITEM)

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
Notes: Contractor shall prepare Shop drawings and submit sample of item to get approval from Engineer/Consultant prior to proceed with any electrical works and any kind of procurement.					
PART -1 Distribution Board					
1	<u>Distribution Board</u> Fabrication, Supply, installation, Testing and commissioning at site of following Distribution board, made of MS Sheet 14 SWG with hinged door, handle, catcher, earthing bar, neutral strip, internal wiring from MCCB, MCBs terminating on cable terminal blocks, 2 coats of antirust and powder coated paint of approved color, including cost of all necessary materials complete in all respects, MDB,DBs shall be manufactured as per specification, diagram complete in all respect up to the satisfaction of Engineer.				
1 (a)	MDB	No.	1		
1 (b)	DBLP-GF	No.	1		
1 (c)	DBLP-FF	No.	1		
1 (d)	DB-EQP-FF	No.	1		
1 (e)	DBLP-SF	No.	1		
1 (f)	DB-AC-GF	No.	1		
1 (g)	DB-AC-FF	No.	1		
1 (h)	DB-Lift	No.	1		
1 (j)	Breaker Box Include 125A TP MCCB Breaker	No.	1		
PART-2: CABLES AND CONDUITS					
2	<u>L.V. Power Cables</u> Supply at site, installation, testing and commissioning of PVC insulated unarmored copper conductor cable 600 / 1000 Volt grade manufactured by any one of the manufacturers as mentioned in approved manufacturer list in Laid direct underground, manually Excavate 03 feet depth, including /red bricks /warning tape/route marker. UPVC pipe Install under road cutting/paved area and foot path. As per routes shown on drawings including cost of all necessary connections, identification tags, cables lugs, cables glands, properly crimped at both ends for the following sizes complete in all respects. Actual length of cables to be installed & Paid. Cable shall be practically measured at site by the Contractor, duly authenticated by the employers electrical engineer before placing the order with the manufacturer.				
(a)	Single & Multi Core Copper PVC/PVC Cable				
(i)	4 core 10mm.sq.(MDB to DBLP-SF/DB-AC-GF/DB-AC-FF/DB-Lift)	Rft.	459		
(ii)	4 core 16mm.sq (MDB to DBLP-GF/DBLP-FF)	Rft.	180		
(iii)	4 core 50mm.sq (DB-EQE-FF to Breaker Box)	Rft.	40		
(iv)	1core 95mm.sq (MDB to DB-EQE-FF)	Rft.	525		

(b)	Four Core Copper PVC/PVC Cable				
(i)	04 core 240mm.sq(Existing SS to MDB)	Rft.	656		
(c)	Circuit Protective Conductor (CPC)				
(i)	1 core 10mm sq. PVC insulated color Green/Yellow	Rft.	459		
(ii)	1 core 16mm sq. PVC insulated color Green/Yellow	Rft.	180		
(iii)	1 core 25mm sq. PVC insulated color Green/Yellow	Rft.	40		
(iv)	1 core 50mm sq. PVC insulated color Green/Yellow	Rft.	525		
2.1	PVC/UPVC Conduit and Accessories				
	Supply at site of PVC/UPVC conduit to be installed on slabs, walls, floor, columns or as required as per site conditions including cost of all PVC Conduit accessories, steel pull wires, complete in all respects.				
2.1(a)	20mm (3/4") dia. PVC conduit	Rft	100		
2.1(b)	25mm (1") dia. PVC conduit	Rft	100		
2.1(c)	32mm (1 1/4") dia. PVC conduit	Rft	300		
2.1(d)	38mm (1 1/2") dia. PVC conduit	Rft	180		
2.1(e)	50mm (2") dia. UPVC conduit Class-B	Rft	50		
2.1(f)	150mm (6") dia. UPVC conduit Class-B	Rft	800		
2.2	CABLE TRAY/LADDER				
	Supply and installation of 16 SWG Hot Dip Galvanized Perforated cable tray with cover having two-compartment including bends, tees, reducers, supports, etc. of the following sizes complete with all mounting accessories as per drawings and specifications complete in all respects, to be installed on wall, floor or in ceiling or in floor screeding, run horizontal or vertical as required.				
2.2(a)	Cable Tray 300x75mm High	Rft	1		
2.2(b)	Cable Tray 150x50mm High	Rft	1		
PART-3 WIRING & CONDUITING					
3	Circuit Wiring & Conduiting				
3(a)	Supply, circuit Wiring and conduiting from DB to switch board/EM light with 2 x 2.5 sq.mm 1 core Cu/PVC insulated cable + CPC 2.5 sq.mm 1 core Cu/PVC insulated cable in 25 mm. dia PVC conduit, complete with cables, conduits and all necessary accessories such as connectors, ceiling rose, flexible wires/conduits, sheet steel boxes etc. (wherever required) as per the specifications and drawings and approval by the Engineer.				
3(b)	Same as item (a) but wiring from Adjacent switch.	Nos.	30		
3(c)	Same as item (a) but wiring from switch board to switch board.	Nos.	25		
3(d)	Wiring from switch to first light/fan point with 2 x 1.5 sq.mm 1 core Cu/PVC insulated cable + CPC 1.5 sq.mm 1 core Cu/PVC insulated cable in 25 mm dia PVC conduit, complete with cables and conduits and all necessary accessories as per the specifications and drawings and approval by the Engineer.				
		Nos.	22		

3(e)	Wiring and conduiting of light point to point with 2 x 1.5 sq.mm 1 core Cu/PVC insulated cable + CPC 1.5 sq.mm 1 core Cu/PVC insulated cable in 25 mm. dia PVC conduit, complete with cables, conduits and all necessary accessories such as connectors, ceiling rose, flexible wires/conduits, sheet steel boxes etc. (wherever required) as per the specifications and drawings and approval by the Engineer.				
3(f)	Circuit Wiring and conduiting from DB to Power socket outlet/Industrial Socket/Hand Dryer with 2 x 4 sq.mm 1 core Cu/PVC insulated cable + CPC 4 sq.mm 1 core Cu/PVC insulated cable in 25 mm dia PVC conduit complete with cables, conduits and all necessary accessories such as sheet steel back box with earth connecting point bends, junction boxes, sockets etc., as per the specifications and drawings and approval by the Engineer.	Nos.	290		
3(g)	Same as item (f) but wiring between adjacent socket outlets with 2 x 2.5 sq.mm 1 core Cu/PVC insulated cable + CPC 2.5 sq.mm 1 core Cu/PVC.	Nos.	46		
3(h)	Same as (f) but wiring from socket outlet to socket outlet with 2 x 2.5 sq.mm 1 core Cu/PVC insulated cable + CPC 2.5 sq.mm 1 core Cu/PVC.	Nos.	61		
3(j)	Circuit Wiring and conduiting from DB to Isolator/AC socket for AC/FCU/Air Curtain with 2 x 6 sq.mm 1 core Cu/PVC insulated cable + CPC 4 sq.mm 1 core Cu/PVC insulated cable in 25 mm. dia PVC conduit, complete with cables, conduits and all necessary accessories such as 20A safety breaker ,power outlet , sheet steel boxes etc. (wherever required) as per the specifications and drawings and approval by the Engineer.	Nos.	130		
3(k)	Circuit Wiring and conduiting from DB to Pump socket with 2 x 4 sq.mm 1 core Cu/PVC insulated cable + CPC 4 sq.mm 1 core Cu/PVC insulated cable in 25 mm. dia PVC conduit, complete with cables, conduits and all necessary accessories such as connectors, 20A power out let, sheet steel boxes etc. (wherever required) as per the Specifications and drawings and approval by the Engineer.	Nos.	18		
3(m)	Circuit Wiring and conduiting from DB to 32A TP industrial socket with 4 x 6 sq.mm 1 core Cu/PVC + CPC 6 sq.mm 1 core Cu/PVC insulated cable insulated cable in 32 mm dia PVC conduit complete with cables, conduits and all necessary accessories such as sheet steel back box with earth connecting point bends, junction boxes, sockets etc., as per the specifications and drawings and approval by the Engineer.	Nos.	2		
3(n)	Circuit Wiring and conduiting from DB to 63A TP industrial socket with 4C x 16 sq.mm 1 core Cu/PVC + CPC 16 sq.mm 1 core Cu/PVC insulated cable insulated cable in 38 mm dia PVC conduit complete with cables, conduits and all necessary accessories such as sheet steel back box with earth connecting point bends, junction boxes, sockets etc., as per the specifications and drawings and approval by the Engineer.	Nos.	5		
		No.	1		

PART-4: LIGHT FIXTURES, FANS, SWITCHES, OUTLETS & ACCESSORIES					
4	<u>LIGHT FIXTURES</u> Supply, Installation, testing and commissioning of following light fittings, ceiling /wall mounted or hanging arrangement with SS rod as per detail shown in drawing . Complete with , lamp holders, internal wiring, earthing terminal, complete in all respects, as per approved manufacturer, fittings shall be duly approved by Engineer.				
4(a)	Supply and installation of Circular Down Light 10Watt LED IP-20, CRI>80 with Colour Temperature 4000K Surface/Recessed type , as approved by Architect.	Nos.	25		
4(b)	Supply and installation of Circular downlight 12Watt LED IP-20, CRI>80 with Colour Temperature 4000K Surface/Recessed type ,as approved by Architect.	Nos.	70		
4(d)	Supply and installation of Smart Bright Panel 2'x2' 40 Watt 4200 Lumen, IP-20, CRI>80 Recessed with Colour Temperature 4000K .as approved by the Architect.	Nos.	100		
4(e)	Supply and installation of M2 louver 1'x4' LED 2x18 Watt 4200 Lumen, IP- 20, CRI>80 Recessed with Colour Temperature 4000K .as approved by the Architect.	Nos.	45		
4(f)	Supply and installation of Pacific LED panel 1'x4' 1X18 Watt 1900 Lumen, IP-65, CRI>80 Recessed with Colour Temperature 3000K .as approved by the Architect.	Nos.	4		
4(g)	Supply and installation of Wall Light(Bulkhead) 18 Watt LED IP-65, CRI>80 with Colour Temperature 3000K , as approved by Architect.	Nos.	4		
4(h)	Supply and installation of Wall Light(Decorative fixture) 18 Watt LED IP- 20, CRI>80 with Colour Temperature 3000K , as approved by Architect.	Nos.	10		
4(i)	Supply and installation of LED Tube Batten type 18 Watt P-20, CRI>80 with Colour Temperature 4000K as approved by Architect.	Nos.	55		
4(j)	Supply and installation of LED Mirror Light 9 Watt as approved by Architect. (IP-65)	Nos.	4		
4(k)	Supply and installation of 10 watt LED Emergency Light IP20 Non-Maintained type rechargeable with 2 hours battery backup	Nos.	17		
4(l)	Supply and installation of 4 watt LED Emergency with Exit Sign Light IP20 Maintained type rechargeable with 3 hours battery backup	Nos.	8		
4(m)	Supply and installation of 36 watt 2'x2' LED Emergency with Light IP20 Non-Maintained type rechargeable with 2 hours battery backup	Nos.	15		
4(n)	Supply and installation of Flood light 150 Watt LED , IP-65, CRI>80 Recessed with Colour Temperature 3000K .as approved by the Architect.	Nos.	1		

4.1	<u>Ceiling Fans\Bracket Fan\Exhaust Fan</u> Supply & installation of 3-blade energy efficient ceiling fans\bracket fan of following sizes, complete with capacitor, hanging rod, canopy, blades, dimmers nuts and bolts complete in all respects, fittings shall be duly approved by Engineer.				
4(a)	56" dia Ceiling Fan	Nos.	26		
4(b)	48" dia Ceiling Fan	Nos.	1		
4(c)	18" dia. Bracket Fan	Nos.	1		
4(d)	12" dia. Exhaust Fan	Nos.	8		
4(e)	Circumatic fan Fan 2'x2	Nos.	95		
4.2	<u>Switches & Fan Dimmers</u> Supply and installation of following approved manufacture type gang switches of 10 Amp rating, including 16 SWG sheet steel back box recessed in wall (with earth terminal and 2 coats of antirust paint), complete in all respect, as per specifications and drawings and approval by the Engineer. (Vivace or equivalent).				
4.2(a)	One gang - 1 Way Switch	Nos.	8		
4.2(b)	Two gang - 1 Way Switch	Nos.	13		
4.2(c)	Three gang - 1 Way Switch	Nos.	11		
4.2(d)	Four gang - 1 Way Switch	Nos.	14		
4.2(e)	Five gang - 1 Way Switch	Nos.	10		
4.2(f)	One gang - Fan Dimmer	Nos.	26		
4.3	<u>SOCKETS</u> Supply & installation of following type socket outlet including 16 SWG sheet steel back box of top quality recessed in wall (with earth terminal and 2 coats of antirust paint), complete in all respects, as per specifications and drawings, as per approved manufacturer list and approval by the Engineer (Vivace or equivalent).				
4.3(a)	13A, 3-pin Universal Switch Socket outlet(International)	Nos.	113		
4.3(b)	13A, 3-pin Flat Pin Duplex Switch Socket outlet	Nos.	26		
4.3(c)	15A 3Pin Switch Socket Outlet with neon	Nos.	30		
4.3(d)	15A 3Pin Switch Socket Outlet -IP-65	Nos.	2		
4.3(e)	16A 3Pin Schuko Socket	Nos.	60		
4.4	<u>LOAD BREAK SWITCHES</u> Supply, installation, testing & commissioning of following size Load Break switch with MS back box including all accessories complete in all respects, as per specifications and drawings and approval by the Engineer.				
4.4(i)	20 Amp SPN LBS	Nos.	3		
4.4(ii)	35 Amp TPN LBS	Nos.	1		
4.5	<u>FLOOR BOX</u> Supply and installation of Floor Boxes without face plates made of 16 SWG G.I Sheet, recessed in ground as per design drawings.	Nos.	3		
4.6	<u>PULL BOX</u> Supply and installation of Pull Boxes made of 16 SWG G.I Sheet, recessed in ground as per design drawings.	Nos.	6		

4.7	<u>INDUSTRIAL SOCKETS</u> Supply & installation of Industrial socket-outlet, including 16 SWG sheet steel back-box/enclosure, connectors etc., and all accessories, complete in all respect				
4.7(a)	16A TPN+E 3 Pin Industrial socket outlet IP44 (male & female)	Nos.	3		
4.7(b)	32A TPN+E 5 Pin Industrial socket outlet IP44 (male & female)	Nos.	5		
4.7(c)	63A TPN+E 5 Pin Industrial socket outlet IP67 (male & female)	Nos.	1		
PART-5: EARTHING SYSTEM					
5	<u>EARTH PITS</u> Supply, installation, preparation testing and commissioning of Earth Pits including copper bonded steel earth electrodes, 10 feet long and 19.07 mm nominal Dia., 25mm sq. mm hard drawn bare copper conductor as per drawing, 60ft boring, Earth pit / Inspection Chamber, Cad weld with copper conductor, Earthing low resistance Chemical compound, bentonite, charcoal etc., all materials, complete in all respects as per specification & Drawings Contractor make sure Earth resistance should be less than 1 ohm.				
5.1(a)	<u>COPPER CONDUCTOR:</u> Supply, installation and connection of copper conductor 16 mm sq. insulated 32mm UPVC conduit, from Pit to ECP, ECP to IT rack as shown in detail as per specification and entire satisfaction with approval of Engineer.	Nos.	2		
5.1(b)	<u>COPPER CONDUCTOR:</u> Supply, installation and connection of copper conductor 70 mm sq. insulated 38mm pvc conduit, from Earth pit to ECP, ECP to MDB as shown in detail and as per specification and entire satisfaction with approval of Engineer.	Rft	50		
5.2	<u>EARTH CONNECTING POINTS (ECP)</u> Supply of earth connecting points consisting of copper plate tin coated 300mm long x 50mm wide x 6mm thick to be installed as and where shown on drawings, complete with fixing arrangements SS nuts bolts, washers, Cu. lugs, 1/2" dia. holes to facilitate connections of Incoming copper strips / copper conductors and outgoing CPC.	Rft	60		
5.3	If the required resistance is not achieved with a single earth pit, two additional earth pits can be constructed and connect with the parallel to achieve the required resistance.	Nos.	2		
		Nos.	2		

PART-6: DATA/TELEPHONE SYSTEM					
6	<u>DATA NETWORK</u> Supply, installation, testing and commissioning of following items for voice and data communication system including all material, labor, tools, accessories etc. Complete in all respects. Quantities for cables shown in BOQ are estimated and taken from drawings/Schematic riser. Contractor is Advised to take measurement at site before commencement of Different colors of voice and data cables shall be used. (Selected for Simplex / Duplex Face plates is Clipsal Vivacy series or equivalent):				
6.1(a)	Simplex Face plate with 1 Gang Cat-6a RJ-45 I/O for Data, white/off white finish, complete with shuttered click-ins, labels and all including back box. recessed on wall or column as per design drawings.	Nos.	16		
6.1(b)	Simplex Face plate with 1 Gang Cat-6 RJ-45 I/O for Telephone, white/off white finish, complete with shuttered click-ins, labels and all including back box. recessed on wall or column as per design drawings.	Nos.	3		
6.2	Duplex Face plate having 2 Gang Cat-6a/Cat-6 RJ-45 I/O for Data/Telephone, white / off white finish, complete with shuttered click-ins, labels and all accessories including back box, recessed on wall or column as per design drawings.	Nos.	18		
6.3(a)	CAT-6a, UTP Cable for Data from IT Rack to each outlet in 25 mm PVC conduit / channel as per drawings including termination and tagging at both ends. Complete in all respects.	Rft	3600		
6.3(b)	CAT-6, UTP Cable for Telephone from IT /TJB to each outlet in 25 mm PVC conduit / channel as per drawings including termination and tagging at both ends. Complete in all respects.	Rft	2300		
6.4	Following CAT-6a, Patch Panel equipped with RJ 45 I/Os for Data/Telephone System including all labeling and all mounting accessories. Complete in all respects.				
(a)	24-Port CAT-6A Patch Panel	Nos.	2		
(b)	48-Port CAT-6A Patch Panel	Nos.	1		
6.5	Following CAT-6a, factory certified Patch Cords of specified color having RJ-45 connectors at both ends for Data/Telephone				
(a)	1 meter long	Nos.	25		
(b)	3 meter long	Nos.	25		
6.6	Supply installation testing and commissioning of 12U wall mounted Data racks for the fixing of 24 port rack mounted 19" CAT-6A UTP Patch Panel with cable organizer, including cost of PDU, cable management, 3kva single phase online UPS sine wave 0.9pf etc. with all accessories as per directed by the Engineer.	No.	1		
6.7	24 Port Data Cu Switch Cat 6A (For Data) including connectors and other Accessories. Complete in all respects.	Nos.	2		
6.8	Supply, Installation of access point for Wi-Fi device including patch cord with complete in all respect.	Nos.	4		

6.9	Coordination and Connection with existing PABX with building building TJB, complete in all respect.	Job	1		
6.10	Supply & installation of following type of Cat5e shielded, 0.6 mm dia, twisted pair telephone cable to be installed in PVC Conduit/Cable Tray already laid from MDF to TJB as per drawings & Specification including connection, labeling and tagging. Complete in all respects.				
(a)	1x20 Pair Cat5e	Rft	500		
6.11	Supply, installation, testing and commissioning of Telephone Junction Boxed made with 16 SWG sheet steel housing, powder coated paint of approved color, consisting of specified Distributor Blocks / Tag Blocks for incoming and outgoing PTCL lines from ONU. Item includes all interconnecting jumper wiring and termination.				
(a)	TJB(1x30 Pair wiring tag blocks)	No.	1		
6.12	Telephone Set				
(a)	Telephone with CLI (Panasonic)	Nos.	3		
(b)	Telephone without CLI (Panasonic)	Nos.	10		
6.13	Testing and commissioning of all above items termination and connectivity at both ends, including submission of detailed test report from the Principals.				
		Job	1		
PART-7: CCTV SYSTEM					
7.1	Supply & installation of 4-Pair Cat-6 UTP from Copper Switch to each camera in 25mm dia PVC conduit as per route shown on drawings. Insulated cable in 25 mm dia PVC conduit, all necessary accessories, as per the specifications and drawings and approval by the Engineer.	Rft	880		
7.2	FIXED HD BULLET IP CAMERAS WALL MOUNTED Providing, installation, testing & Commission of Color 2 Megapixel Day/Night Vision, Motion Detection HD Bullet Camera as per specifications: 2 Megapixel Resolution: 1080P(1920x1080) 2.8~12mm varifocal lens IR Illumination Range: 40m IR Night Vision True WDR 130dB, min illumination 0.01 LUX Field of View: 100° (H), IP67, micro SD card, PoE,	No.	1		
7.3	FIXED HD DOME IP CAMERAS CEILING MOUNTED Providing, installation, testing & Commission of Color 2 Megapixel Day/Night Vision, Motion Detection HD Dome Camera as per Specifications: 2 Megapixel Resolution: 1080P(1920x1080) 2.8~12mm varifocal lens IR Illumination Range: 40m IR Night Vision True WDR 130dB, min illumination 0.01 LUX Field of View: 100° (H), IP67, micro SD card, PoE	Nos.	7		

7.4	NETWORK VIDEO RECORDER Providing, installation, testing & Commission of following types of NVR complete in all respect: Simultaneous view, record with 15 days backup, playback, backup & remote monitoring Supports high definition recording with cameras up to 5MP Video Compression: H.264 / H.265 Supports internal HDDs and interface with external SAN Network Interface 10/100/1000-Base-TX, RJ-45 Dual Power Supply and RAID-5 level redundancy VGA OUT & HDMI outputs Remote access via iOS, Android, PC / Mac Integration with NOC & DOC Room Video Walls including the cost hard disk(15 days of backup) and require the provision of the spare hard disk. 08Channel NVR(Network Video Recorder)	No.	1		
7.5	Supply and installation of following types of LED Screen for monitoring purpose including all fixing accessories complete in all respect. 40" LED Color Screen	No.	1		
7.6	Testing and commissioning of all above items termination and connectivity at both ends, including submission of detailed test report from the Principals.	Job	1		
PART-8 LIGHTNING PROTECTION SYSTEM					
8.1	Roof Conductor Supply at site and installation of 50sqmm stranded bare copper conductor fixed on parapet walls or on flat surface of roof as shown on drawing or as required as per site conditions, including cost of copper saddles, copper crossing 3"x3" as shown on drawings, brass screws, all necessary fixing material / accessories, complete in all respects.	Rft	R.O		
8.2(a)	Conductor Supply at site, installation, connections of 50mm.sq. stranded bare copper conductor Cad weld with column steel rebar's at one end with roof conductor from air terminal on roof, all other required accessories, complete in all respects.	Rft	R.O		
8.2(b)	Supply at site, installation, connection of 50mm.sq. stranded bare copper conductor with test link box at one end Building Rebar and cad weld with copper earth electrode at other end as shown in drawings.	Rft	R.O		
8.3	AIR TERMINAL Supply, installation and connecting up of 1 x 16mm DIA SOUND ROUND COPPER 600mm LONG AERIAL ROD with half round head as and where complete with fixing arrangement, cost of all necessary materials / accessories, complete in all respects.	Nos.	R.O		
8.4	COPPER TEST LINK Supply at site and installation of sectionable copper test link made of 200mm x 200mm UPVC enclosure with necessary holes, all fixing accessories of the copper test link to be installed on the wall of manholes, SS nuts bolts, washers, including cost of all necessary materials, complete in all respects.	Nos.	R.O		

8.5	EARTH ROD Direct Driven Earth Station for Lightning protection system composes of 3/4" dia/ 3 meter long including Cad welded steel rebar with earth electrode Copper Bonded Earth Rod with 50sqmm bare copper conductor including 10ft boring, chemical compound etc complete in all respects, as show in detail earthing drawings & specification.	Nos.	R.O		
PART-9 FIRE ALARM SYSTEM					
9.1	Supply & Installation of Intelligent Microprocessor controlled networkable Addressable type 02 Loop Fire Alarm Control Panel .Panel should have alarm facilities, hooter, fire / fault indicators, audio video signals, battery, battery charger, central processing unit, network integrator module, power supply, independent time delay circuits for MCP actuated alarms and also for detector actuated alarms, etc., complete in all respects as per detailed specifications.	No.	1		
9.2	Supply and installation of wiring of Fire Alarm System devices with 1.5sq.mm two core shielded Fire resistance cable with drain wire and aluminum foil in 25mm PVC conduit from FACP to devise with all required accessories, complete in all respect.	Rft	750		
9.3	Supply & Installation of Addressable optical Smoke detector with base as per drawing & specifications.	Nos.	20		
9.4	Supply & Installation of Addressable optical Heat detector with base as per drawing & specifications.	Nos.	2		
9.5	Supply & Installation of Multidetector with base as per drawing & specifications.	No.	1		
9.6	Supply, Installation of Electronic Sounder as per drawing & specifications.	Nos.	5		
9.7	Supply, Installation of Manual Call Point as per drawing & specifications.	Nos.	7		
9.8	Supply and installation of Fire alarm Junction box 12" x 8" x 4" with cover plate, surface mounted fabricated from 16 SWG sheet steel, powder coated, complete with all fixing arrangements and accessories, complete in all respect.	No.	1		
9.9	Testing, Commissioning, proper tagging of FA System by authorized local representative of the manufacturer.	Job	1		
PART-10 Public Address System					
10.1	Supply, installation, testing and commissioning of following items for Public Address System as described below including all accessories. Complete with mounting brackets, wiring, adapters etc. Power Amplifier Supply & installation of following type amplifier with three outputs, 2 microphone inputs and three music input, Amplifier integrated each other and divide into zone as shown in diagram, complete in all respect and all installation accessories (a) 30W (Conference room Amplifier)	No.	1		

10.2	Supply, installation of Table top/Recessed active paging station, complete in all respect and all installation accessories.	Nos.	2		
10.3	Speakers (a) Supply, installation & commissioning of 6W ceiling mounted speaker with all accessories complete in all respects.	Nos.	2		
10.4	Wiring with 2 Core, 2.5 sq.mm PVC insulated and PVC sheathed Cable from Amplifier / controller to speaker and speaker to speaker in 25mm dia PVC conduit complete in all respects upto maximum.	Rft	80		
10.5	Supply & installation of Multimedia projector DH720P, aspect ratio 16:9, WXGA with 2 HDMI inputs (5000 LUMENS),with fixed type projector screen with all the necessary mounting accessories complete in all respect.	No.	1		
10.6	Training, testing & commissioning of Public Address system by Authorized representative of the manufacturer/Supplier.	Job	1		
PART -11 Miscellaneous Work					
11.2	Manholes/Handholes Construction of water tight block masonry handhole / cable chamber with medium duty RCC cover with lifting hooks and these words "ELECTRICAL CABLES" written with paint on cover. Complete in all respect as per drawing and specification. Sizes of Manhole are as under: (i) 2' x 2' x 2' deep Handholes (ii) 1'6" x 1'6" x 2' deep Handholes	Nos. No.	8 1		
11.3	Excavation and Back filling (a) Excavation of every type of trench in any type of soil within the project area for laying of LV cables, (dimensions shall be 3 ft wide x 2 ft deep 900 ft length), complete in all respects and to the approval of the Engineer. (cost of pipe shall not be included)	Cuft	3200		
(b)	Backfilling of any type of trench already excavated as per item 11.3(a), after laying 150mm dia UPVC pipe class B including Warning tape above pipe excavated earth compacted to 95% in layers of not exceeding 9" thickness, site cleaning etc, as per drawings, complete in all respects and to the approval of the Engineer.	Cuft	3200		
(c)	Supply and installation of LV cable markers every 50m distance as per specifications, drawings complete in all respects and to the approval of the Engineer.	Nos.	5		
(d)	Construction of concrete LV road crossing duct with 50mm dia. two pipes in parallel of total carriage way length, work include excavation in all type of soil, back filling , compaction, concrete protection layer up to 200mm etc. to the approval of the Engineer. (cost of pipe shall not be included).	Rft	100		

(e) (f)	Prepare and submit 2 sets of hard copies of As-built electrical drawings on A2 sheet size with one CD soft copy in CAD format for the record of project to the client complete in all respect.	Job	1		
	Addition of 300A TP MCCB Circuit Breaker in existing LT panel of substation with all necessary support, tagging etc. complete in all respect.	Job	1		
PART -12 Air Condition System					
12	Supply and installation of Split type inverter A/C unit having loading capacity 24000 BTU/HR (2 Tons). Flammable gases are not allowed such as (R-32) . Single phase, complete in all respect, copper tubing as per site, insulation , internal wiring , angle bracket (heavy duty) including making cuts, holes in wall and floor etc. and making good the same as required . Sealing the holes with sealant etc. complete in all respect wall/ roof mounted with proper drainage system with UPVC pipe 3/4" all controls. Make: Hitachi/ Mitsubishi/ Haier Brand.	Nos.	18		
TOTAL AMOUNT IN RUPEES		-			

NED University of Engineering & Technology, Karachi
Construction of Hilton Pharma Nano Technology Centre (Remaining Works)

BILL OF QUANTITIES
DIESEL GENERATOR WORKS (ITEM)

ITEM NO.	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
1.1	<u>Diesel Generator Set</u> Design, manufacture, supply at site, storing, handling, installation, testing and commissioning of DG sets in sound proof Canopy enclosure as per specification & drawings complete in all respect 415Volts, 3 phase, 50 Hz, 1500 RPM AC alternator coupled to diesel engine complete with all accessories as per specifications tool kits, service manual, self-starting device, fly wheel, coupling with guard, V belt, radiator cooling system, instrument panel, common bed plateform (block masonry with neru plaster), anti-vibration isolation pads, grouting bolts, PVC/PVC unarmored cables and terminal box as per specification, adopter box, glands, nuts etc. first filling of Engine oil, Gear oil, high speed diesel oil, 24 volts chargeable battery set (Minimum 180 AH capacity) complete with batteries, battery charger etc.				
(a)	48 KVA	No.	1		
1.2	L.V. Power Cables Supply at site, installation, testing and commissioning of PVC insulated unarmored copper conductor cable 600 / 1000 Volt grade manufactured by any one of the manufacturers as mentioned in approved manufacturer list in prelaidd conduits/ trench / Cable Tray to be installed as per routes shown on drawings including cost of all necessary materials, connections, identification tags, cables lugs, cables glands, properly crimped at both ends for the following sizes complete in all respects. Actual length of cables to be installed & Paid Cable shall be practically measured at site by the Contractor, duly authenticated by the employers electrical engineer before placing the order with the manufacturer.				
(b)	04 Core copper PVC/PVC Cable				
(i)	04 core 16mm.sq PVC/PVC cable (MDB to Generator)	Rft	459		
1.3	PVC/UPVC Conduit and Accessories Supply at site of UPVC conduit to be installed on slabs, walls, floor, columns or as required as per site conditions including cost of all UPVC conduit accessories, steel pull wires, complete in all respects.				
(a)	150mm (3") dia. UPVC conduit Class-B	Rft	100		

EARTHING SYSTEM					
1.4	Earth Pits Supply, installation, testing and commissioning of Earth Pits including copper bonded steel earth electrodes, 10 feet long and 19.07 mm nominal dia, bare copper conductor as per drawing, 60ft boring, Earth pit / Inspection Chamber, Cad weld with copper conductor, Earthing low resistance Chemical compound, bentonite etc., all necessary materials, complete in all respects as per specification & Drawings Contractor make sure Earth resistance should less than 1 ohm.	Nos.	2		
1.5	Copper Conductor (a) Supply, installation and connection of copper conductor 70 mm sq. cable in 38mm UPVC conduit, from Earth pit to ECP, ECP to MDB/Generator body/Generator neutral as shown in detail and as per specification and entire satisfaction with approval of Engineer.	Rft	60		
1.6	Earth Connecting Points (ECP) Supply of earth connecting points consisting of copper plate 300mm long x 50mm wide x 6mm thick to be installed as and where shown on drawings, complete with fixing arrangement, brass nuts bolts, ashers, Cu. lugs, connections of Incoming copper strips / copper conductors and outgoing CPC.	No.	1		
1.7	Manholes/Handholes Construction of water tight block masonry hand hole / cable chamber with medium duty RCC cover with lifting hooks and these words "ELECTRICAL CABLES" written with paint on cover. Complete in all respect as per drawing and as per approval of the Engineer. Sizes of Manhole are as under: (i) 1'6" x 1'6" x 2' deep Handholes	Nos.	2		
1.8	Excavation and Back filling (a) Excavation of every type of trench in any type of soil within the project area for laying of LV cables, (dimensions shall be 2 ft wide x 3 ft deep 900 ft length), complete in all respects as per approval of the Engineer. (cost of pipe shall not be included)	Cu.ft	460		
(b)	Backfilling of any type of trench already excavated as per item 11.3(a), after laying 150mm dia. UPVC pipe class B including red bricks and Warning tape above pipe excavated earth compacted to 95% in layers of not exceeding 9" thickness, site cleaning etc, as per drawings, complete in all respect Engineer and as per approval of the Engineer.	Cu.ft	460		
TOTAL AMOUNT IN RUPEES		-			

CONSTRUCTION OF HILTON PHARMA NANO TECHNOLOGY CENTRE

(Remaining Works)

NED University of Engineering and Technology, Karachi

MARCH – 2024

DRAWINGS

VOLUME - IV

13/01/2024
MD

13/01/24
MD
Convenor

13/01/24
MD

13/01/24
MD

CONSTRUCTION OF HILTON PHARMA NANOTECHNOLOGY CENTRE (REMAINING WORKS)
AT NED UNIVERSITY OF ENGINEERING & TECHNOLOGY KARACHI

TABLE OF CONTENTS

S. NO.	DRAWING NO.	TITLE OF DRAWING
01	--	LIST OF ARCHITECTURAL DRAWINGS
02	B-01	Site Plan
03	B-02	Ground Floor Plan
04	B-03	First Floor Plan
05	B-04	Second Floor Plan
06	B-05	Roof Plan
07	B-06	Elevation 01
08	B-07	Elevation 02
09	B-08	Elevation 03
10	B-09	Elevation 04
11	B-10	Section AA
12	B-11	Section BB
13	B-12	Section CC
14	--	LIST OF STRUCTURAL DRAWINGS
15	S-01	Foundation Plan Detail & Schedule
16	S-05	R.C.C. Framing Plan (Roof) at EL. + 38'-0"
17	S-06	Overhead Water Tank, Stair Tower & Details
18	--	LIST OF ELECTRICAL DRAWINGS
19	GR-01	Electrical List of Drawings
20	GR-02	Master Legends
21	GR-03	General Notes
22	GR-04	General Electrical Details
23	GR-05	Master Legends
24	EL-10	Ground Lighting Layout
25	EL-11	First Floor Lighting Layout
26	EL-12	Second Floor Lighting Layout
27	EL-13	Roof Lighting Layout
28	EL-14	Ground Floor Small Power Layout
29	EL-15	First Floor Small Power Layout
30	EL-16	Second Floor Small Power Layout
31	EL-17	Roof Small Power Layout
32	EL-18	Ground Floor Telephone and Data Layout
33	EL-19	First Floor Telephone and Data Layout
34	EL-20	Second Floor Telephone and Data Layout

S. NO.	DRAWING NO.	TITLE OF DRAWING
35	EL-21	Ground Floor Fire Alarm, CCTV & Public Addresses System Layout
36	EL-22	First Floor Fire Alarm & CCTV System Layout
37	EL-23	Second Floor Fire Alarm & CCTV System Layout
38	EL-24	Roof Fire Alarm System Layout
39	EL-25	Ground Floor Emergency Lighting and A.C Layout
40	EL-26	First Floor Emergency Lighting and A.C Layout
41	EL-27	Second Floor Emergency Lighting and A.C Layout
42	EL-28	Roof Emergency Lighting and A.C Layout
43	EL-29	Ground Floor Earthing Layout
44	EL-30	Roof Lighting Protection
45	EL-31	Single Line Diagram
46	EL-32	D.B. Schedules (Sheet 01 of 03)
47	EL-33	D.B. Schedules (Sheet 02 of 03)
48	EL-34	D.B. Schedules (Sheet 03 of 03)
49	EL-35	Telephone, Data, CCTV & Fire Alarm System Risers Diagrams
50	--	LIST OF PLUMBING DRAWINGS
51	PL-01	Ground Floor Plumbing and Sewerage Layout
52	PL-02	First Floor Plumbing and Sewerage Layout
53	PL-03	Second Floor Plumbing and Sewerage Layout
54	PL-04	Roof Plan Plumbing and Sewerage Layout
55	PL-05	Ground Floor Water Supply Layout Plan
56	PL-06	First Floor Water Supply Layout Plan
57	PL-07	Second Floor Water Supply Layout Plan
58	PL-08	Roof Water Supply Layout Plan
59	PL-09	Detail A Sewerage and Drainage Layout
60	PL-10	Detail A Water Supply Layout
61	PL-11	Detail B Sewerage and Drainage Layout
62	PL-12	Detail B Water Supply Layout
63	PL-13	Detail C Sewerage and Drainage Layout
64	PL-14	Detail C Water Supply Layout
65	PL-15	Detail D Sewerage and Drainage Layout
66	PL-16	Detail D Water Supply Layout
67	PL-17	Detail E Water Supply Layout

ARCHITECTURAL TENDER DRAWINGS

CONSTRUCTION OF HILTON PHARMA NANO TECHNOLOGY CENTRE (Remaining Works)

NED University of Engineering and Technology, Karachi

MARCH – 2024

Architectural Consultant
Fariha A. Ubaid

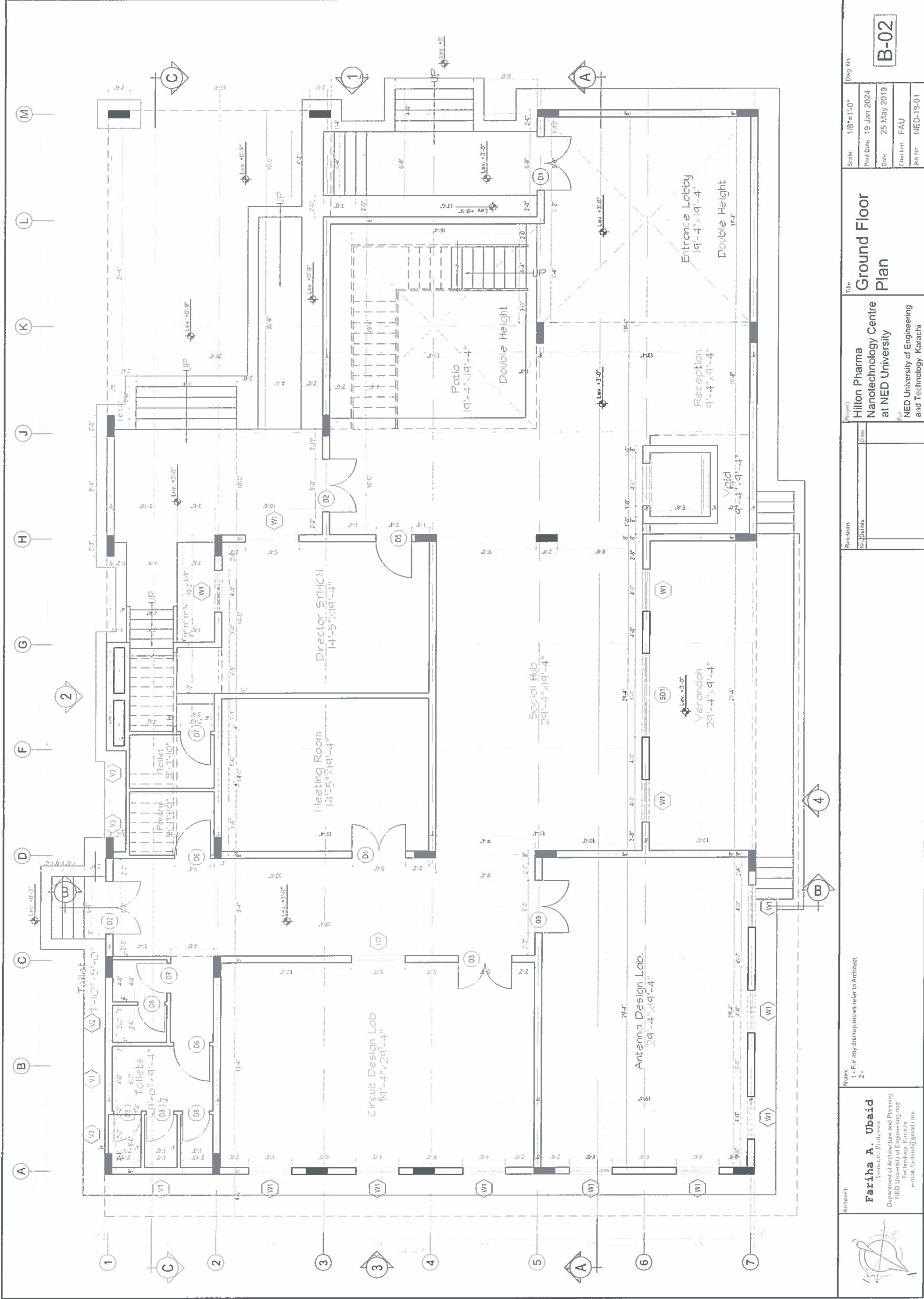
Associate Professor

Department of Architecture and Planning
NED University of Engineering and Technology

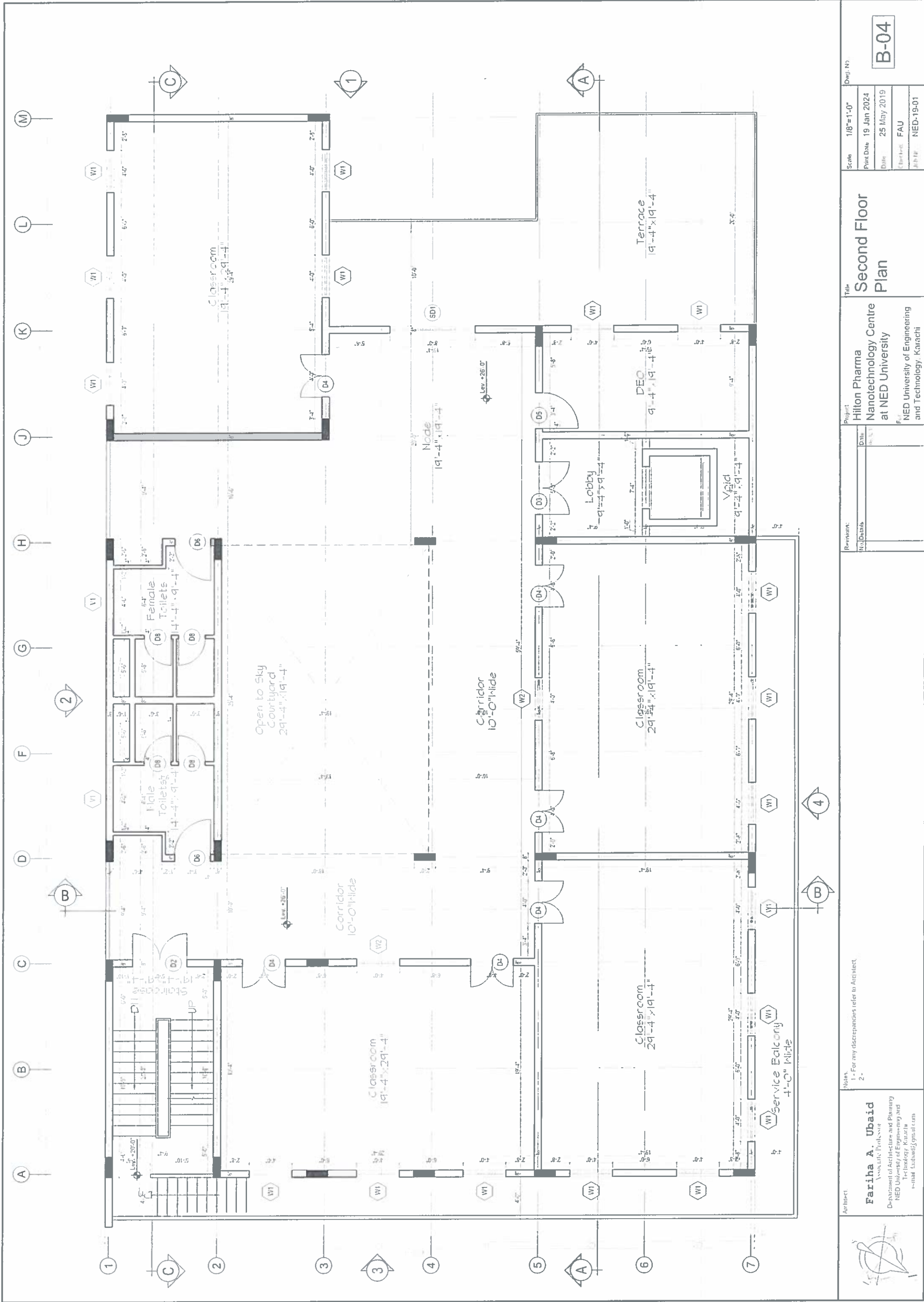
Email: ufariha@neduet.edu.pk

List of Architectural Working Drawings

No	Dwg.No.	Title
1	B-01	Site Plan
2	B-02	Ground Floor Plan
3	B-03	First Floor Plan
4	B-04	Second Floor Plan
5	B-05	Roof Plan
6	B-06	Elevation 01
7	B-07	Elevation 02
8	B-08	Elevation 03
9	B-09	Elevation 04
10	B-10	Section AA
11	B-11	Section BB
12	B-12	Section CC

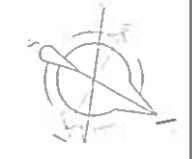


	Fariha A. Ubaid Associate Professor Department of Architecture and Planning NED University of Engineering and Technology, Karachi e-mail: farihaa@gmail.com	Architect	Notes: 1 - For any discrepancies refer to Architect 2 -					
Revisions		Client		Date		Job No.		
No. Details		Hilton Pharma		19 Jan 2024		NED-19-01		
		Nanotechnology Centre		25 May 2019		FAU		
		at NED University						



Notes:
1. For any discrepancies refer to Architect.
2.

Architect
Fariha A. Ubaid
Associate Professor
Department of Architecture and Planning
NED University of Engineering and
Technology Karachi
f-ubaid@nedup.edu.com



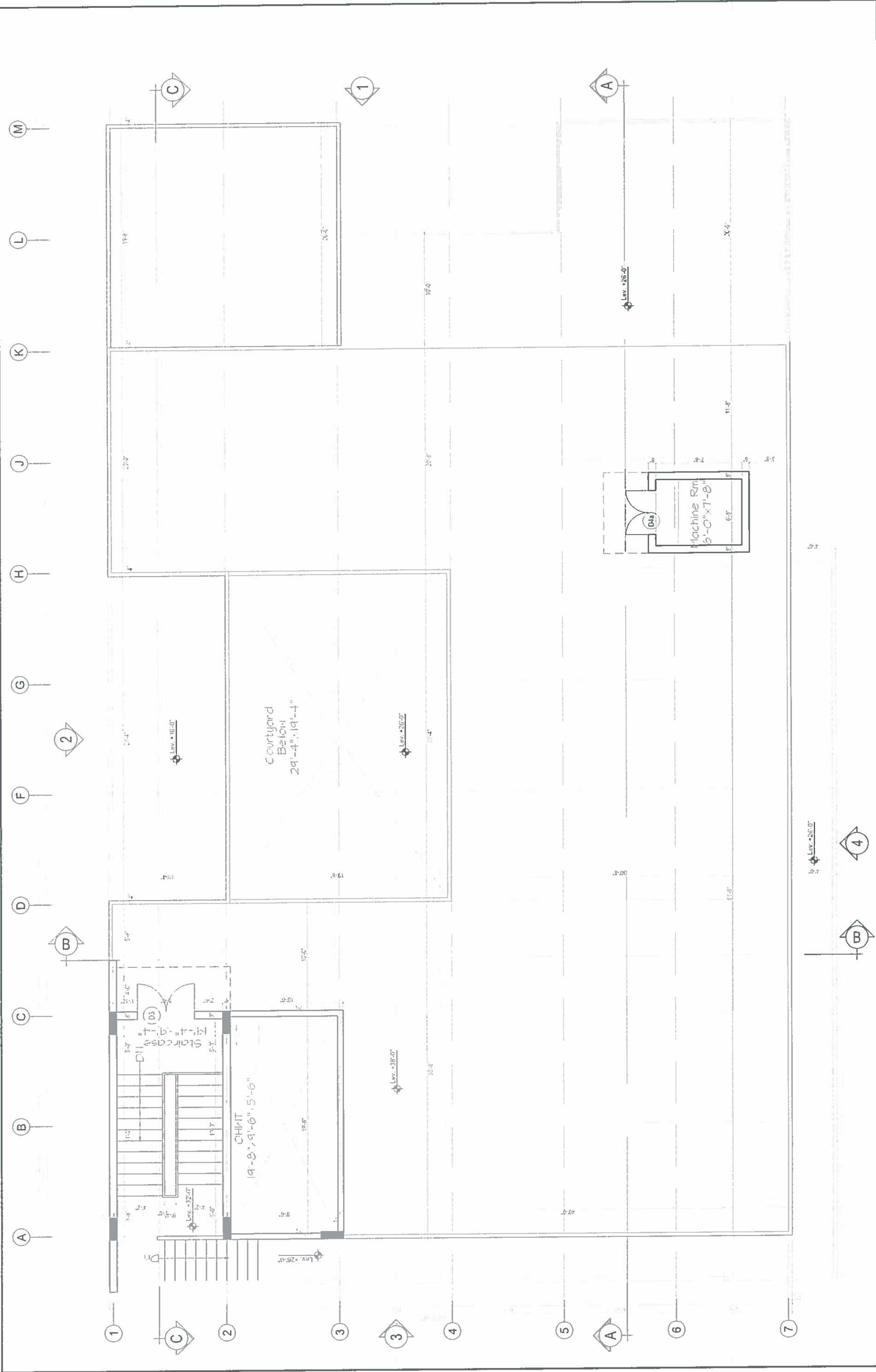
Project
**Hilton Pharma
Nanotechnology Centre
at NED University**
F.O. NED University of Engineering
and Technology Karachi


Revision:	No.	Details	Date
	1		19/01/2024

Title
**Second Floor
Plan**

Scale
1/8"=1'-0"
Print Date
19 Jan 2024
Date
25 May 2019
Checked
FAU
Job No.
NED-19-01

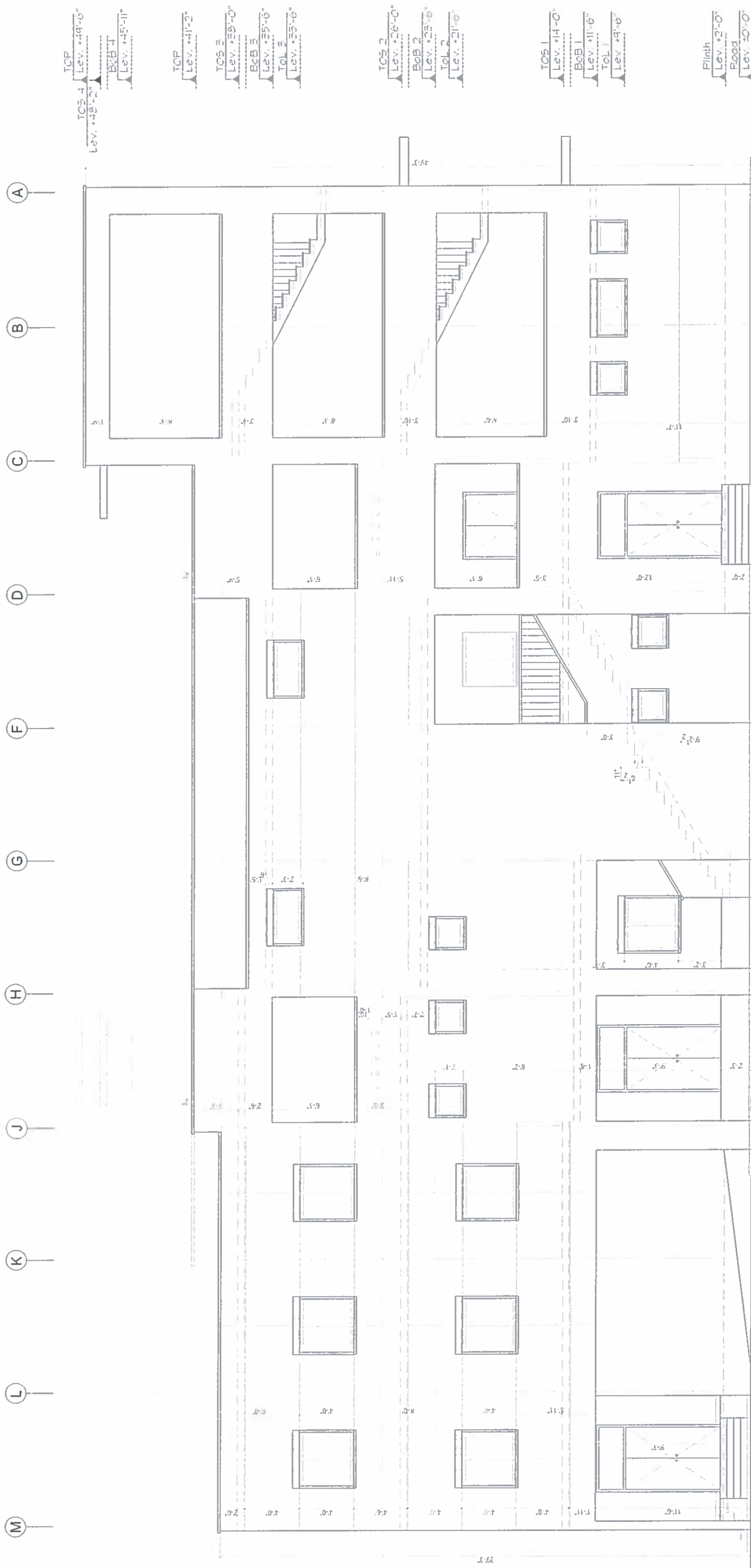
B-04



	Architect: Fariha A. Ubaid Associate Architect Department of Architecture and Planning NED University of Engineering and Technology, Karachi e-mail: fahima@nec.edu.pk	Floors: 1 - For any discrepancies refer to Architect 2 -	Rev. work		Project: Hilton Pharma Nanotechnology Centre at NED University For: NED University of Engineering and Technology, Karachi	Title: Roof Plan		Scale: 1/8"=1'-0"		Dwg. No. B-05								
			N	Details														
			Print Date: 19 Jan 2024		Date: 25 May 2019		Checked: FAU		Job No.: NED-19-01									

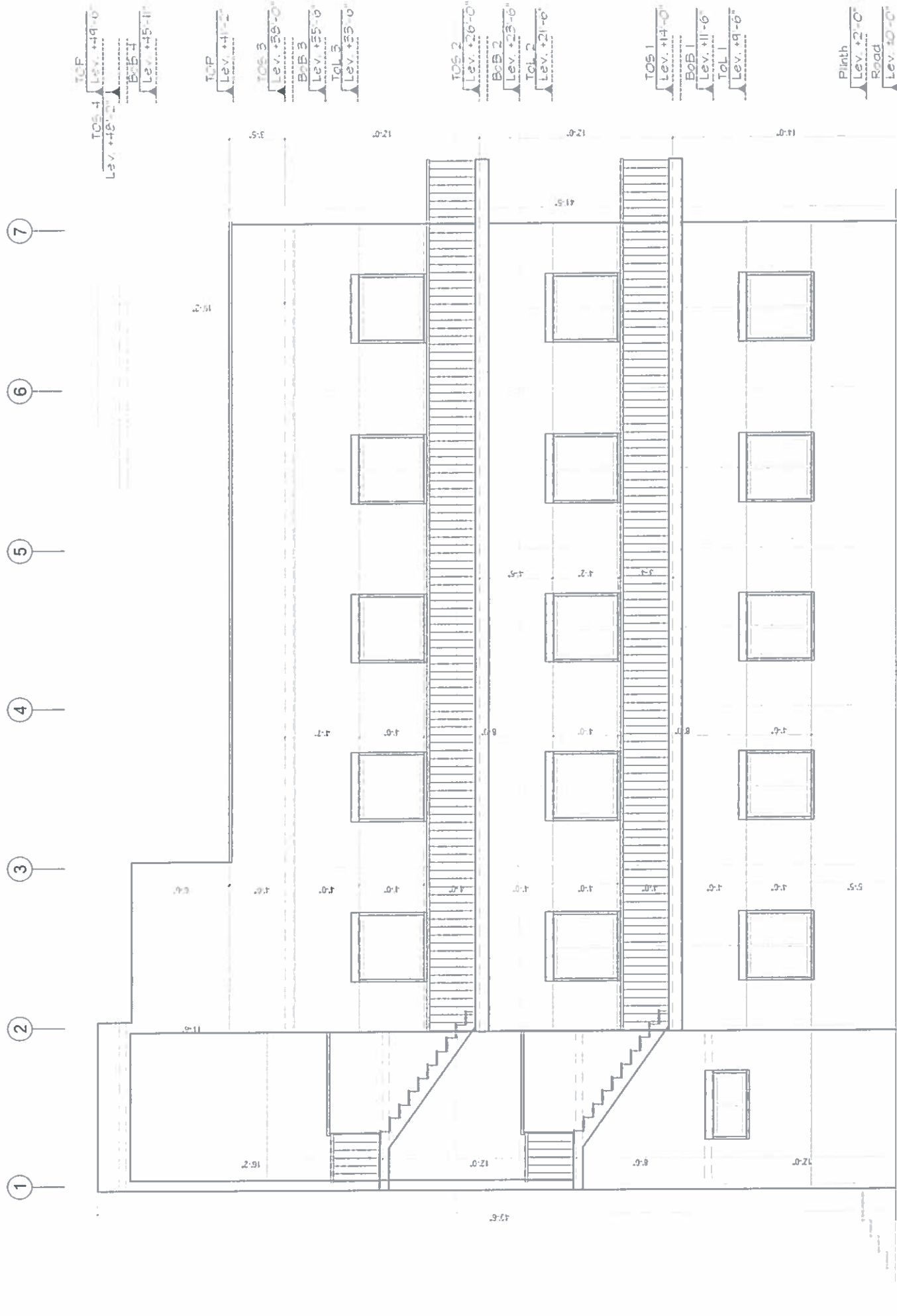


B-06



Elevation 02

Architect	Fariha A. Ubaid Associate Professor Department of Architecture and Planning HED University of Engineering and Technology Karachi f.ubaid@huetd.edu.pk	Notes: 1 - For any discrepancies refer to Architect. 2 -	Revisions	Project		Title	Scale	1/8"=1'-0"	Dwg. No.
				N. Details					
				Date					
				Hilton Pharma Nanotechnology Centre at NED University		Elevation 02		B-07	
				For		NED University of Engineering and Technology Karachi		Job No: NED-19-01	
						FAU			



Elevation 03

Architect	Fariha A. Ubaid Associate Professor Department of Architecture and Planning NED University of Engineering and Technology, Karachi e-mail: f.ubaid@neduet.edu.pk	Notes 1 - For any discrepancies refer to Architect 2 -	Revisions	Project Hilton Pharma Nanotechnology Centre at NED University	Title Elevation 03	Scale 1/8"=1'-0"	Dwg. No. B-08
						Print Date 19 Jan 2024	
						Date 25 May 2019	
						Checked FAU	
						Job No NED-19-01	

1

2

3

4

5

6

7

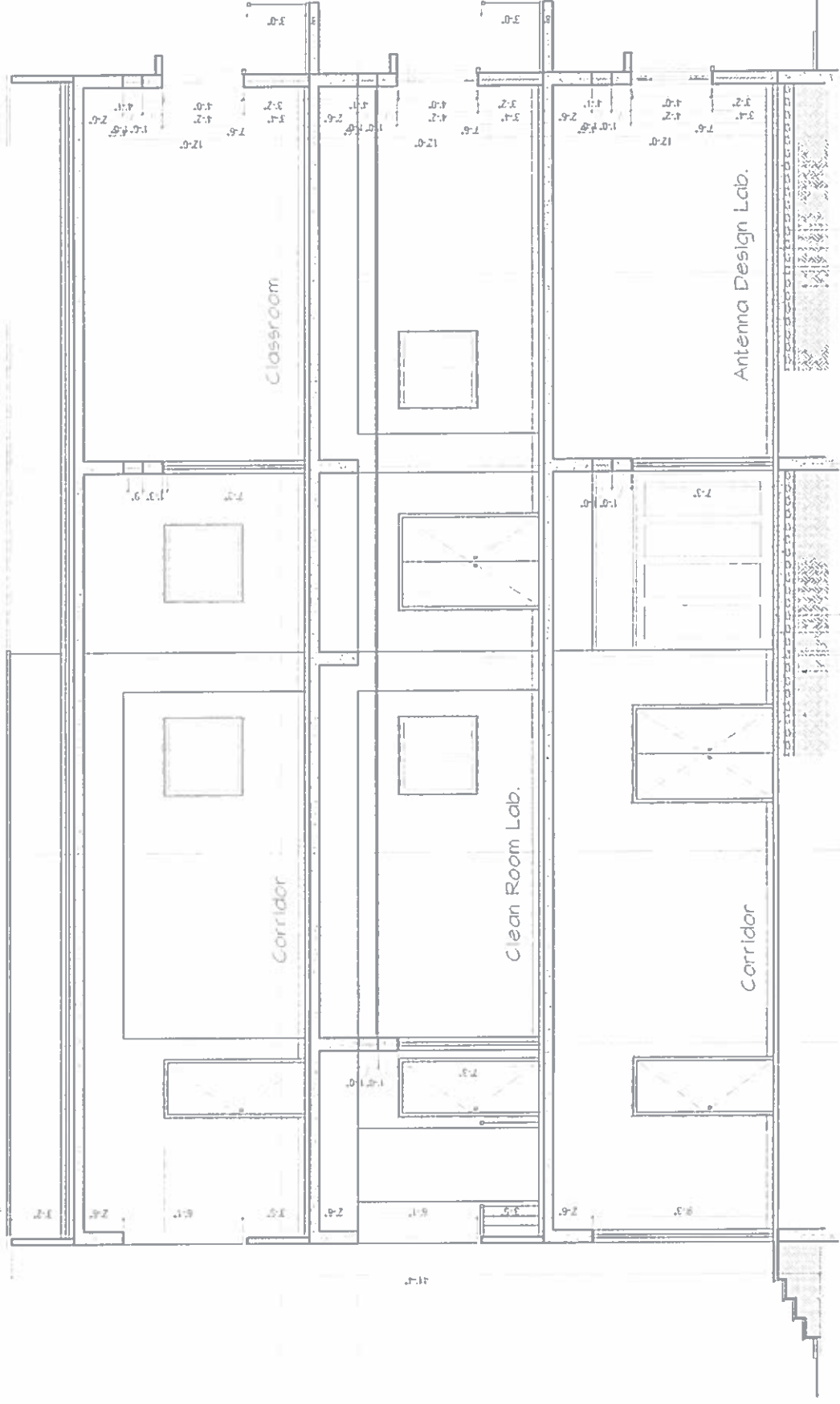
ICF
TOS 4
Lev. +19'-0"
BcB 1
Lev. +15'-11"

TCP
Lev. +11'-2"
TOS 3
Lev. +9'-0"
BcB 3
Lev. +35'-6"
Tol 3
Lev. +33'-6"

TOS 2
Lev. +26'-0"
BoB 2
Lev. +23'-6"
Tol 2
Lev. +21'-6"

TOS 1
Lev. +14'-0"
BoB 1
Lev. +11'-6"
Tol 1
Lev. +9'-6"

Plinth
Lev. +2'-0"
Road
Lev. +0'-0"



5" Th. Floor Finish
4" Th. 1:3:6
6" Th. Stone Siding
Compacted Earth Filling

Section BB

Fariha A. Ubaid
Associate Professor
Department of Architecture and Planning
NED University of Engineering and
Technology Karachi
fariha.ubaid@ned.edu.pk

Notes:
1. For any discrepancies refer to Architect.
2.

Revision	Date
1	

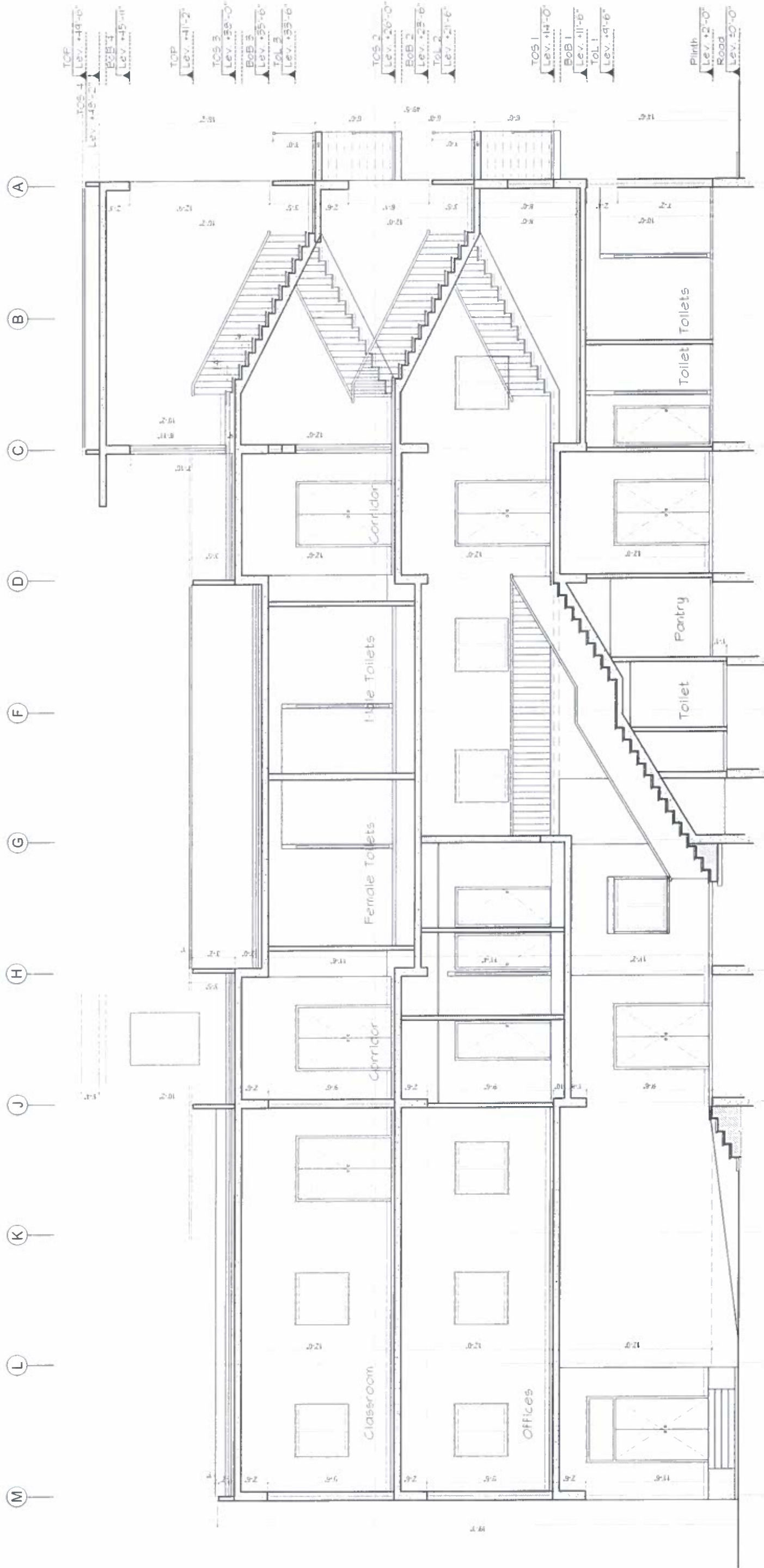
Project:
Hilton Pharma
Nanotechnology Centre
at NED University
For:
NED University of Engineering
and Technology Karachi

Title:
Section BB

Scale: 1/8"=1'-0"
Print Date: 19 Jan 2024
Date: 25 May 2019
Checked: FAU
Job No: NED-19-01

Dwg. No.

B-11



Section CC

Architect Fariha A. Ubaid <small>Associate Professor</small> Department of Architecture and Planning NED University of Engineering and Technology Karachi <small>e-mail: fahid@neda.com</small>	Notes 1 - For any discrepancies refer to Architect; 2 -	Revisions		Project Hilton Pharma Nanotechnology Centre at NED University	Title Section CC	Scale 1/8"=1'-0"	Dwg. No. <div>B-12</div>
		No.	Details				
		Date					
				For NED University of Engineering and Technology Karachi			

STRUCTURAL TENDER DRAWINGS

CONSTRUCTION OF HILTON PHARMA NANO TECHNOLOGY CENTRE (Remaining Works)

NED University of Engineering and Technology, Karachi

MARCH – 2024

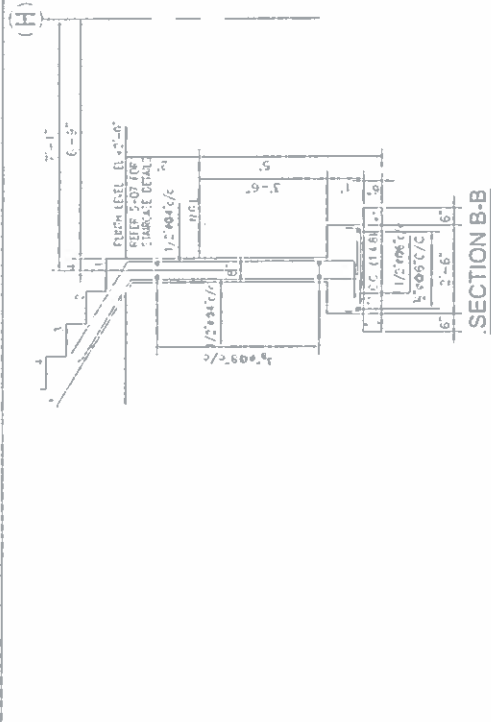
Structural Consultant
Dr. Abdul Jabbar Sangi

Professor
Department of Civil Engineering
NED University of Engineering and Technology
e-mail: ajsangi@neduet.edu.pk

CONSTRUCTION OF HILTON PHARMA NANO TECHNOLOGY CENTRE
(REMAINING WORKS)
AT NED UNIVERSITY OF ENGINEERING & TECHNOLOGY KARACHI

LIST OF STRUCTURAL DRAWINGS

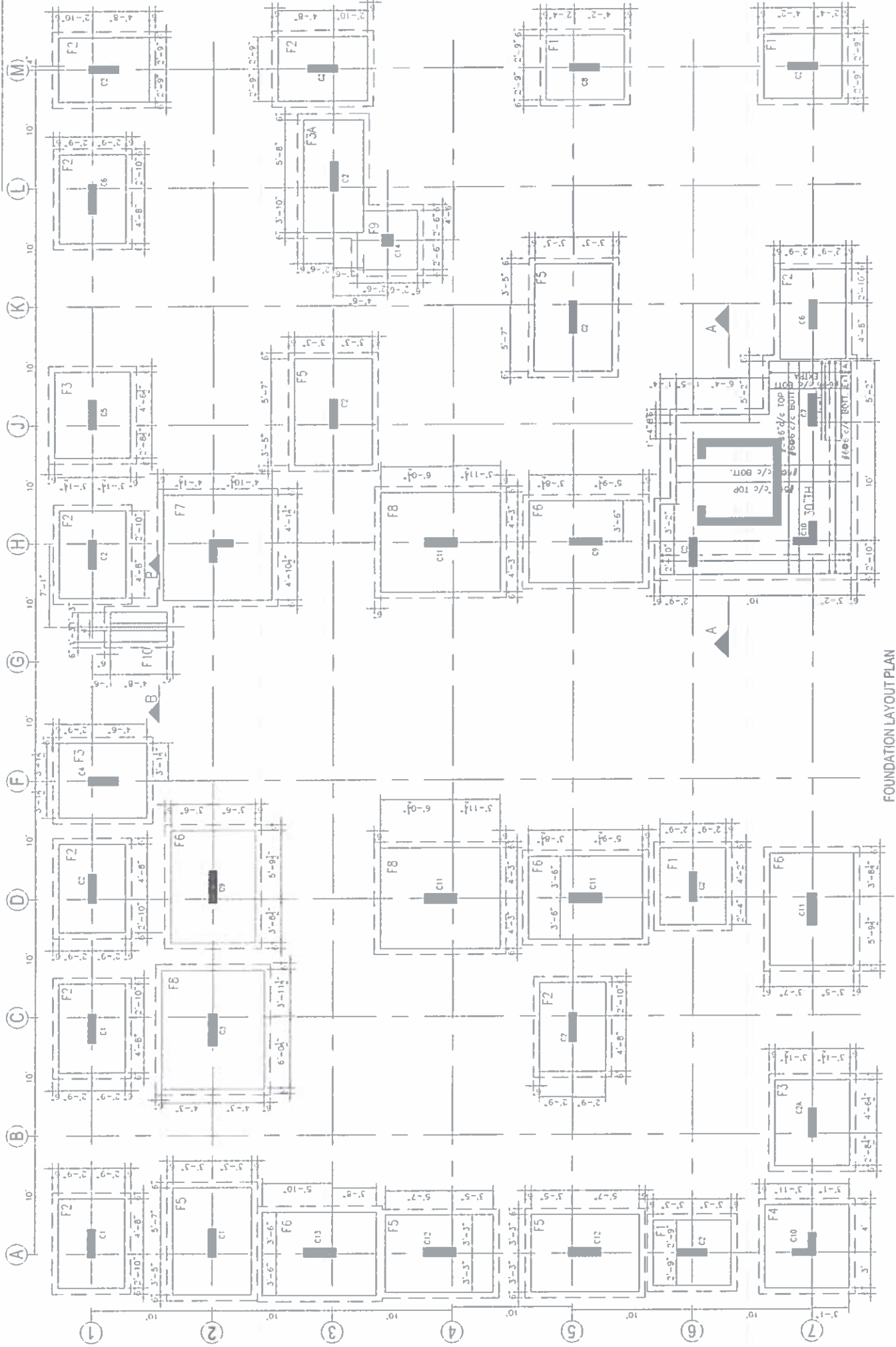
S. NO.	DRAWING NO.	TITLE OF DRAWING
01	S-01	Foundation Plan Detail & Schedule
02	S-05	R.C.C. Framing Plan (Roof) at EL. + 38'-0"
03	S-06	Overhead Water Tank, Stair Tower & Details



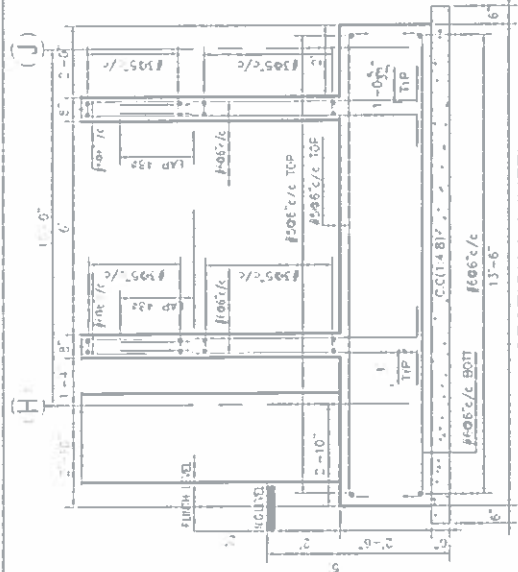
SECTION B-B

SCHEDULE OF FOOTINGS		
ID	SIZE	SHORTER
F1	5'-0" x 6'-0"	21"
F2	5'-0" x 6'-0"	21"
F3	5'-0" x 6'-0"	21"
F4	5'-0" x 6'-0"	21"
F5	5'-0" x 6'-0"	21"
F6	5'-0" x 6'-0"	21"
F7	5'-0" x 6'-0"	21"
F8	5'-0" x 6'-0"	21"
F9	5'-0" x 6'-0"	21"
F10	5'-0" x 6'-0"	21"

TYP. SECTION OF FOOTING



FOUNDATION LAYOUT PLAN



SECTION A-A (LIFT)

SCHEDULE OF COLUMNS				
ID	SIZE	FOOTING	PLINTH	ROOF
C1	8" x 30"	8" x 30"	8" x 30"	8" x 30"
C2	8" x 30"	8" x 30"	8" x 30"	8" x 30"
C3	8" x 30"	8" x 30"	8" x 30"	8" x 30"
C4	8" x 30"	8" x 30"	8" x 30"	8" x 30"
C5	8" x 30"	8" x 30"	8" x 30"	8" x 30"
C6	8" x 30"	8" x 30"	8" x 30"	8" x 30"
C7	8" x 30"	8" x 30"	8" x 30"	8" x 30"
C8	8" x 30"	8" x 30"	8" x 30"	8" x 30"
C9	8" x 30"	8" x 30"	8" x 30"	8" x 30"
C10	8" x 30"	8" x 30"	8" x 30"	8" x 30"
C11	8" x 30"	8" x 30"	8" x 30"	8" x 30"
C12	8" x 30"	8" x 30"	8" x 30"	8" x 30"
C13	8" x 30"	8" x 30"	8" x 30"	8" x 30"

Engineer:

Revisions:

Project:

Title:

Dwg No.:



Dr. Abdul Jabbar Sangi
Professor
Department of Civil Engineering
NED University of Engineering and Technology, Karachi
e-mail: ajsangi@neduet.edu.pk

Notes:
1 - For any discrepancies refer to Architect.
2 - For General Notes Refer GN-1
3 - For C-14 refer S-07.

No.	Details	Date
01	Issued for Approval	18.10.19
02	Issued for Re-tendering	31.01.24

Hilton Pharma
Nano Technology

For:
NED University of Engineering and Technology, Karachi

FOUNDATION PLAN, DETAILS & SCHEDULE

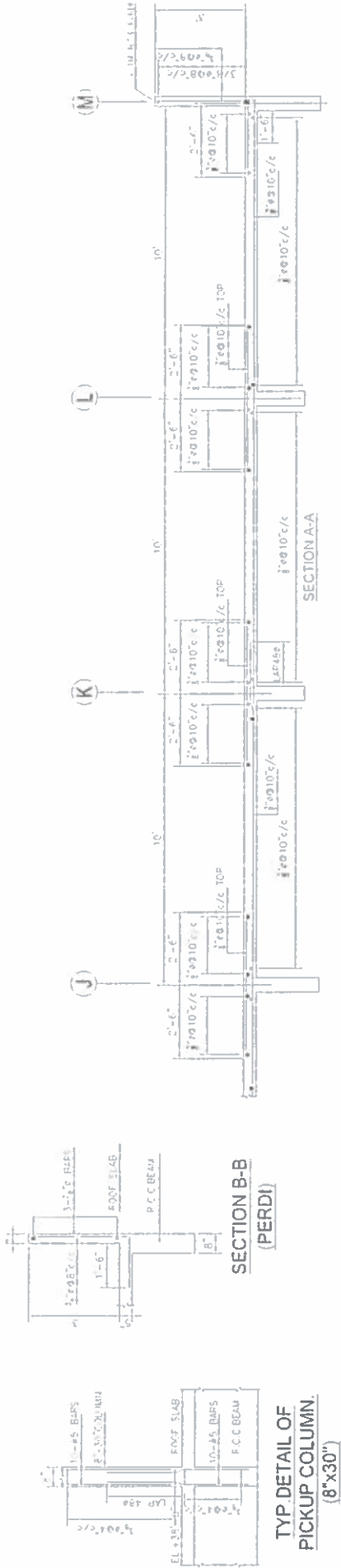
Print Date: 31 JAN 2024

Date: 31 JAN 2024

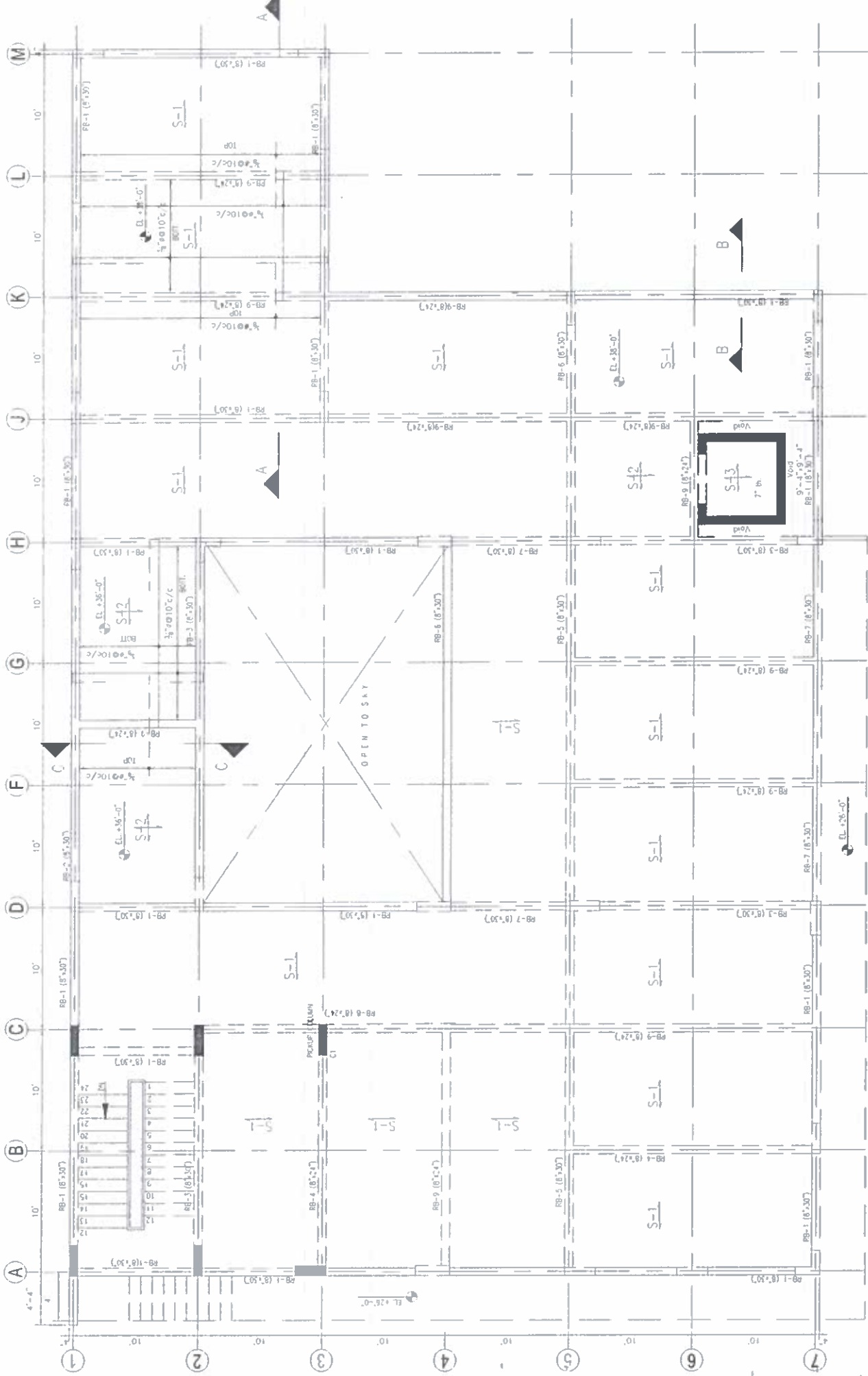
Checked: AJS

Job No.: NED-19-15

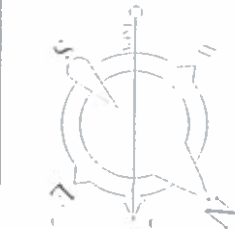
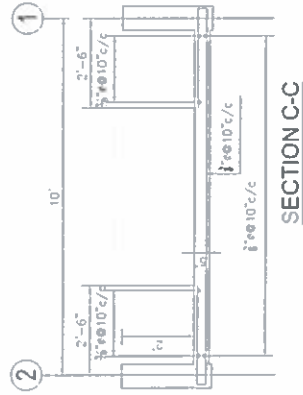
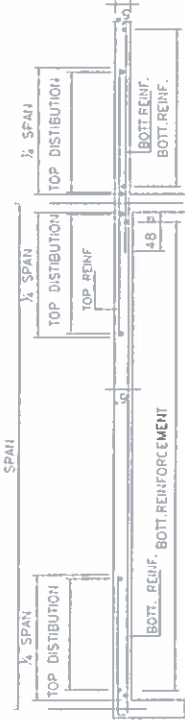
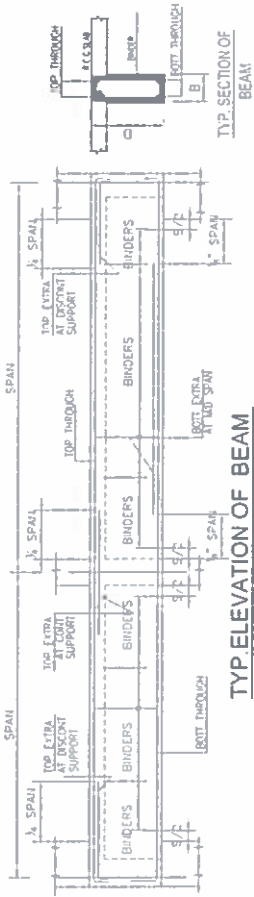
S-01



BEAM ID	CROSS SECTION	BOTTOM REINFORCEMENT		TOP REINFORCEMENT		ENDS
		BEIT THROUGH AT MID SPAN	BEIT EXTRA AT TOP	TOP EXTRA AT CONT. SUPPORT	TOP EXTRA AT NEAR SUPT. AT MID SPAN	
RB-1	8"x30"	3-#5	1-#5	1-#5	1-#5	3/8"x10"/c
RB-2	8"x30"	3-#5	1-#5	1-#5	1-#5	3/8"x10"/c
RB-3	8"x30"	3-#5	1-#5	1-#5	1-#5	3/8"x10"/c
RB-4	8"x30"	3-#5	1-#5	1-#5	1-#5	3/8"x10"/c
RB-5	8"x30"	3-#5	1-#5	1-#5	1-#5	3/8"x10"/c
RB-6	8"x30"	3-#5	1-#5	1-#5	1-#5	3/8"x10"/c
RB-7	8"x30"	3-#5	1-#5	1-#5	1-#5	3/8"x10"/c
RB-8	8"x30"	3-#5	1-#5	1-#5	1-#5	3/8"x10"/c
RB-9	8"x30"	3-#5	1-#5	1-#5	1-#5	3/8"x10"/c



ROOF SLAB REINFORCEMENT SCHEDULE				
SLAB ID	THICK	BOTTOM REINFORCEMENT		LONG WAY
		SHORT WAY	LONG WAY	
S-1	5"	3/8"x10"/c	3/8"x10"/c	3/8"x10"/c
S-2	5"	3/8"x10"/c	3/8"x10"/c	3/8"x10"/c
S-3	7"	3/8"x10"/c	3/8"x10"/c	3/8"x10"/c



Engineer:

Dr. Abdul Jabbar Sangi

Professor
Department of Civil Engineering and
NED University of Engineering and
Technology, Karachi
e-mail: ajsangi@neduet.edu.pk

- 1 - For any discrepancies refer to Architect.
2 - For General Notes Refer GN-1

No.	Details	Date
01	Issued for Approval	18.10.19
02	Issued for Re-tendering	31.01.24

Hilton Pharma Nano
Technology Centre

For:
NED University of Engineering
and Technology, Karachi

R.C.C. FRAMING PLAN (ROOF) AT EL.+38'-0"

Dwg. No.:

Scale: 3/16"=1'-0" & 3/8"=1'-0"

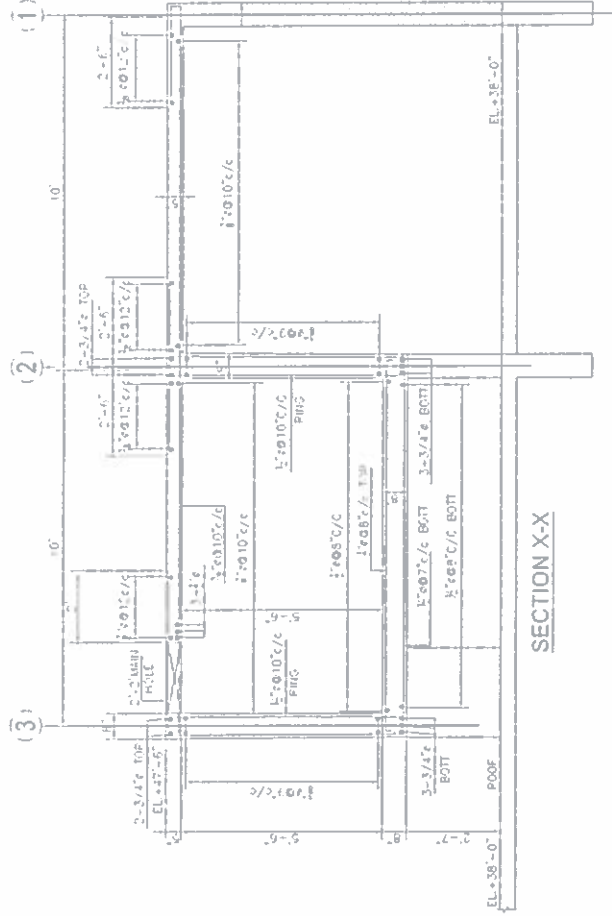
Print Date: 31 Jan 2024

Date: 31 Jan 2024

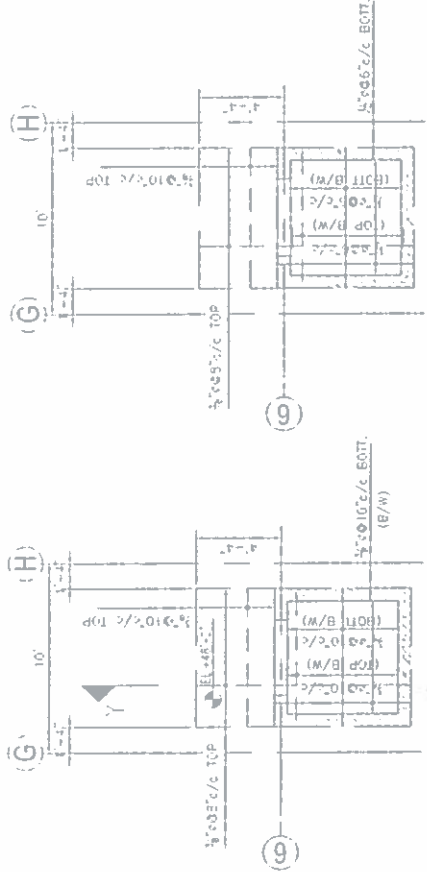
Checked: AJS

Job No.: NED-19-15

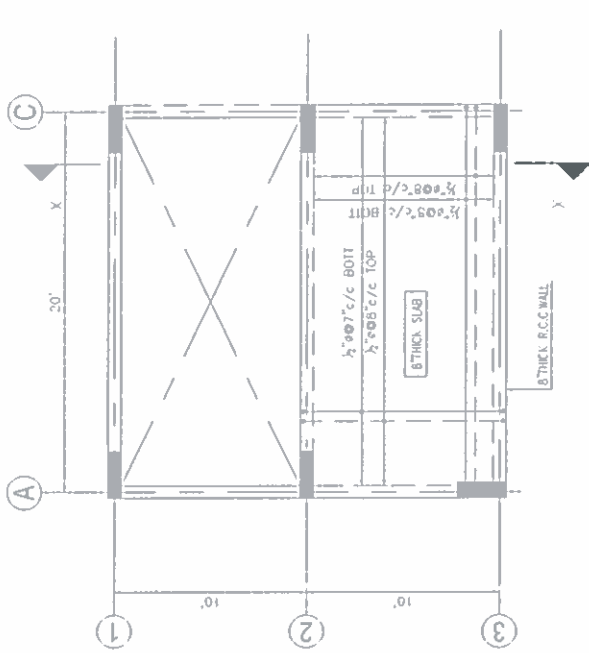
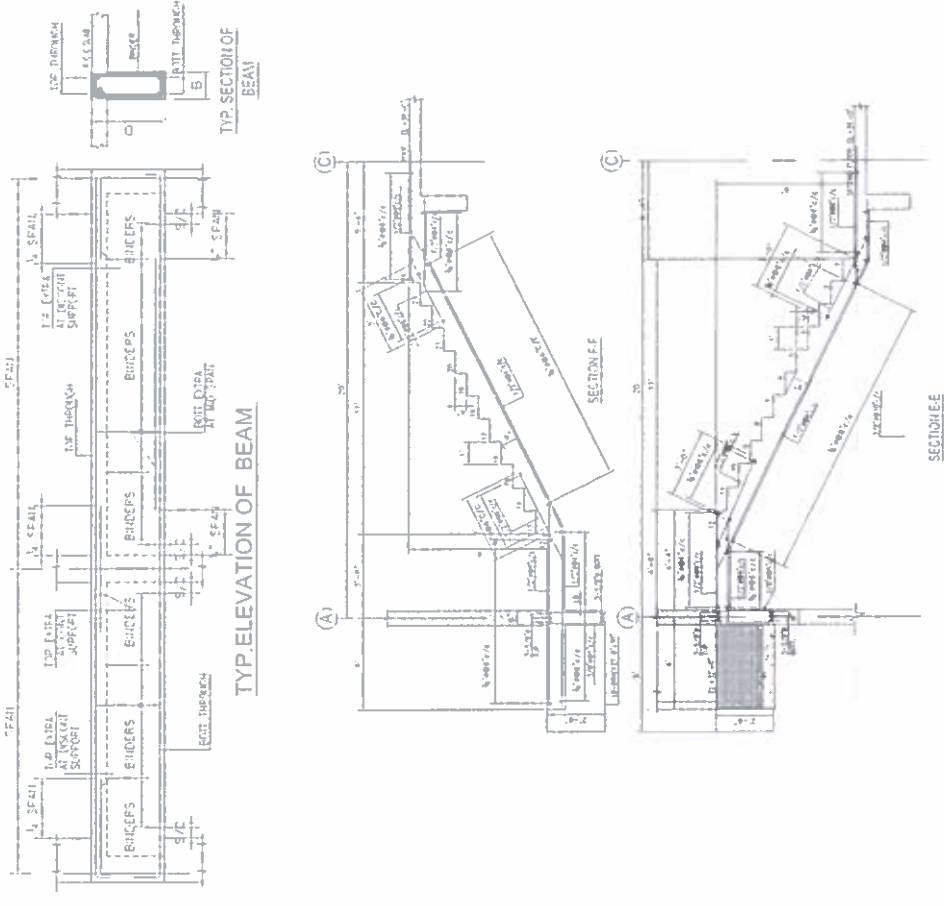
S-05



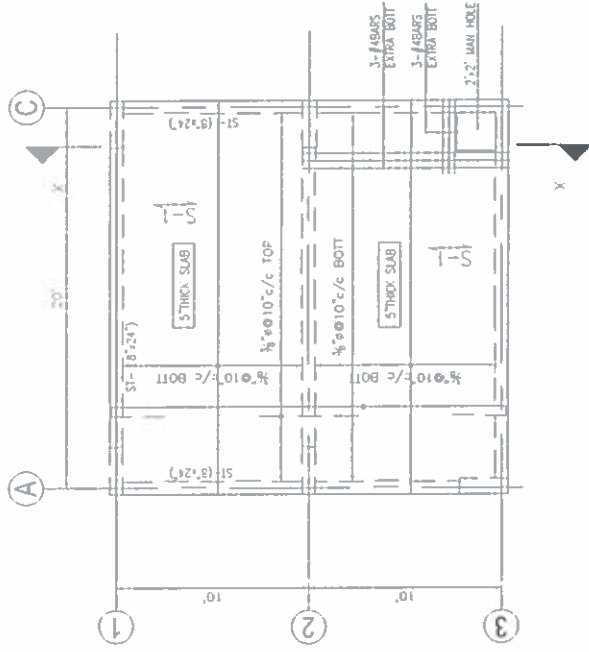
R.C.C. FRAMING PLAN (TOP PLAN)
LIFT ROOM



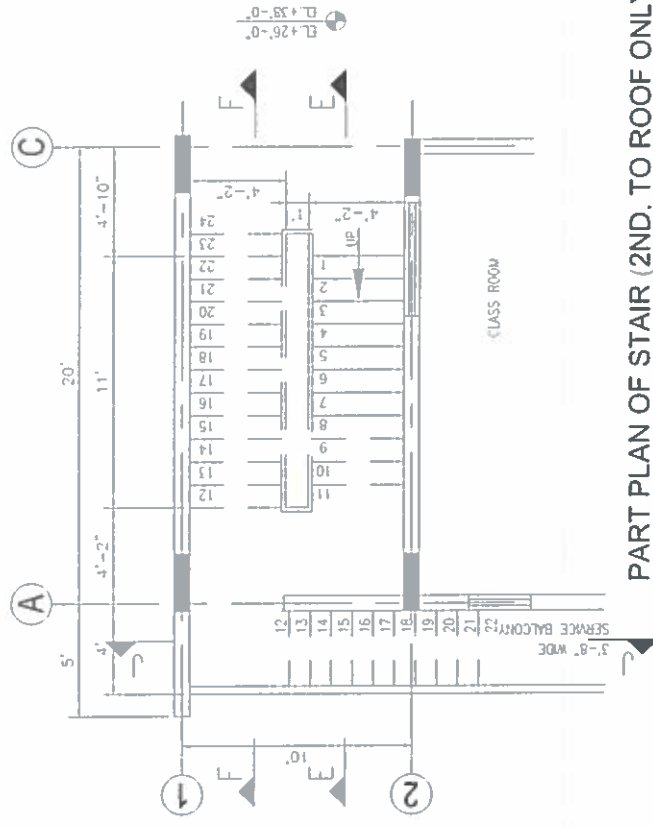
R.C.C. FRAMING PLAN (BOTT. PLAN)
LIFT ROOM



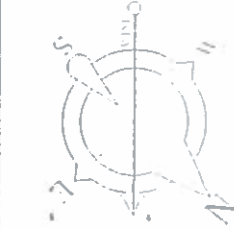
R.C.C. FRAMING PLAN (BOTT. REINFORCEMENT)
OVER HEAD WATER TANK



R.C.C. FRAMING PLAN (TOP REINFORCEMENT)
OVER HEAD WATER TANK & STAIR TOWER



PART PLAN OF STAIR (2ND. TO ROOF ONLY)
EL. +26'-0" TO 38'-0"



Engineer:

Dr. Abdul Jabbar Sangi
Professor
Department of Civil Engineering
NED University of Engineering and
Technology, Karachi
e-mail: ajsangi@neduet.edu.pk

1 - For any discrepancies refer to Architect.
2 - For General Notes Refer GN-1

No.	Details	Date
01	Issued for Approval	18.10.19
02	Issued for Re-tendering	31.01.24

Hilton Pharma Nano
Technology Centre
For:
NED University of Engineering
and Technology, Karachi

Scale: 3/16"=1'-0" & 3/8"=1'-0"

Print Date: 31 Jan 2024

Date: 31 JAN 2024

Checked: AJS

Job No.: NED-19-15

Dwg. No.:

OVER HEAD H/
WATER TANK,
STAIR TOWER
& DETAILS

S-06

ELECTRICAL TENDER DRAWINGS

CONSTRUCTION OF HILTON PHARMA NANO TECHNOLOGY CENTRE (Remaining Works)

NED University of Engineering and Technology, Karachi

MARCH – 2024

Electrical Consultant
Dr. Muhammad Mohsin Aman

Associate Professor
Department of Electrical Engineering
NED University of Engineering and Technology
e-mail: mohsinaman@neduet.edu.pk or mohsinaman@gmail.com

LIST OF DRAWINGS ELECTRICAL WORKS			
SNO	Dwgs. NO	DRAWING TITLE	REMARKS
1. GENERAL DRAWINGS			
1	NC-GR-001	ELECTRICAL LIST OF DRAWINGS	
2	NC-GR-002	MASTER LEGENDS	
3	NC-GR-003	GENERAL NOTES	
4	NC-GR-004	GENERAL ELECTRICAL DETAILS	
5	NC-GR-005	EARTHING AND LIGHTNING PROTECTION DETAILS	
LIGHTING			
6	NC-EL-010	GROUND FLOOR LIGHTING LAYOUT	
7	NC-EL-011	FIRST FLOOR LIGHTING LAYOUT	
8	NC-EL-012	SECOND FLOOR LIGHTING LAYOUT	
9	NC-EL-013	ROOF LIGHTING LAYOUT	
SMALL POWER			
10	NC-EL-14	GROUND FLOOR SMALL POWER LAYOUT	
11	NC-EL-15	FIRST FLOOR SMALL POWER LAYOUT	
12	NC-EL-16	SECOND FLOOR SMALL POWER LAYOUT	
13	NC-EL-17	ROOF SMALL POWER LAYOUT	
TELEPHONE & DATA			
14	NC-EL-18	GROUND FLOOR TELEPHONE & DATA LAYOUT	
15	NC-EL-19	FIRST FLOOR TELEPHONE & DATA LAYOUT	
16	NC-EL-20	SECOND FLOOR TELEPHONE & DATA LAYOUT	
FIRE ALARM & CCTV			
17	NC-EL-21	GROUND FLOOR FIRE ALARM, CCTV & PUBLIC ADDRESS SYSTEM LAYOUT	
18	NC-EL-22	FIRST FLOOR FIRE ALARM & CCTV SYSTEM LAYOUT	
19	NC-EL-23	SECOND FLOOR FIRE ALARM & CCTV SYSTEM LAYOUT	
20	NC-EL-24	ROOF FIRE ALARM SYSTEM LAYOUT	
EMERGENCY LIGHTING, EARTHING, LIGHTNING PROTECTION & AC			
21	NC-EL-25	GROUND FLOOR EMERGENCY LIGHTING & A C LAYOUT	
22	NC-EL-26	FIRST FLOOR EMERGENCY LIGHTING & A C LAYOUT	
23	NC-EL-27	SECOND FLOOR EMERGENCY LIGHTING & A C LAYOUT	
24	NC-EL-28	ROOF EMERGENCY LIGHTING & A C LAYOUT	
25	NC-EL-29	GROUND FLOOR EARTHING LAYOUT	
26	NC-EL-30	ROOF LIGHTNING PROTECTION	
SINGLE LINE, DB SCHEDULE & RISERS			
27	NC-EL-31	SINGLE LINE DIAGRAM	
28	NC-EL-32	DB SCHEDULES (SHEETS 1 OF 3)	
29	NC-EL-33	DB SCHEDULES (SHEETS 2 OF 3)	
30	NC-EL-34	DB SCHEDULES (SHEETS 3 OF 3)	
31	NC-EL-35	TELEPHONE, DATA, CCTV, & FIRE ALARM SYSTEM RISERS DIAGRAMS	



Dr. Muhammad Mohsin Aman
Department of Electrical Engineering
NED University of Engineering and Technology, Karachi
e-mail: mohsinaman@gmail.com

Notes:

Revisions:

No	Details	Date
01	Issued to Tender	17 Feb 24
02	Issued to Ref Tender	14 Feb 24

Project: **Hilton Pharma Nanotechnology Centre at NED University**
For: **NED University of Engineering and Technology, Karachi**

Title: **ELECTRICAL LIST OF DRAWINGS**

Scale:	NTS
Print Date:	14 Feb 2024
Date:	14 Feb 2024
Checked:	K.A
Job No	NED-19-01

Dwg. No

GR-01

LEGEND

SYSTEM	SYMBOL	DESCRIPTION	TYPE	MOUNTING
INDOOR LIGHTING		PHILIPS OR EQUIVALENT LED 40 WATT COLOR 4000	LED	FALSE CEILING
		PHILIPS TYPE OR EQUIVALENT TCS 398 WITH 2 x 18 WATT LED LAMPS W2 LOWER COLOR 4000 LED FIXTURE	LED	SURFACED AND SUSPENDED
		PHILIPS OR EQUIVALENT BATTEN TUBE LIGHT 18WATT LED FIXTURE	LED	SURFACED
		PHILIPS TYPE OR EQUIVALENT PACIFIC WITH 1 x 18 WATT (P 65) LED LAMP COLOR 3000	LED	FALSE CEILING
		PHILIPS OR EQUIVALENT CIRCULAR DOWNLIGHT 18 WATT IP-20	LED	SURFACED / FALSE CEILING
		PHILIPS OR EQUIVALENT CIRCULAR DOWNLIGHT 10 WATT	LED	SURFACED / FALSE CEILING
		PHILIPS OR EQUIVALENT CIRCULAR DOWNLIGHT 12 WATT IP-20	LED	SURFACED
		PHILIPS OR EQUIVALENT BULK HEAD LIGHT FIXTURE 18 WATT IP-65	LED	WALL MOUNTED
		PHILIPS OR EQUIVALENT DECORATIVE LIGHT FIXTURE 18 WATT IP-20	LED	WALL MOUNTED
		PHILIPS OR EQUIVALENT MIRROR LIGHT 9 WATT IP-65	LED	WALL MOUNTED
		ORNAMENTIC FAN 65 WATT 24"x24"	SEE SPECS	FALSE CEILING
		56" CEILING FAN 80 WATT	SEE SPECS	CEILING SLAB
		LIGHT SWITCH (10 AMPS) ONE WAY LIGHT SWITCH (10 AMPS) / FAN DIMMER.	SEE SPECS	1200mm AFL
		10 AMPS 2 PIN SWITCH SOCKET OUTLET WITH SHUTTER.	SEE SPECS	450mm AFL
SWITCHES & SOCKETS		16 AMPS SCHUKO SOCKET OUTLET.	SEE SPECS	450mm AFL
		13 AMPS 3 PIN UNIVERSAL SWITCH SOCKET OUTLET WITH SHUTTER.	SEE SPECS	450mm AFL
		13 AMPS 3 PIN FLAT DUPLEX SWITCH SOCKET OUTLET WITH SHUTTER.	SEE SPECS	450mm AFL
		15 AMPS 3 PIN SWITCH SOCKET OUTLET.	SEE SPECS	450mm AFL
		32A 1PN+E 5 PIN INDUSTRIAL SOCKET OUTLET.	SEE SPECS	AS PER I.D. LAYOUT
		16A 1PN+E 3 PIN INDUSTRIAL SOCKET OUTLET IP-67	SEE SPECS	AS PER I.D. LAYOUT
		20 AMPS 3 PIN SWITCH SOCKET OUTLET.	SEE SPECS	2100mm AFL
		BARKER BOX	SEE SPECS	AS PER I.D. LAYOUT
		HAND DRYER.	SEE SPECS	1340mm AFL
		"A" TYPE FLOOR OUTLET BOX 1No.-13A 3PIN FLAT DUPLEX SWITCH SOCKET OUTLET WITH SHUTTER. 1No.-13 AMPS 3PIN UNIVERSAL INTERNATIONAL SWITCH SOCKET OUTLET WITH SHUTTER. 1No. DUPLEX RJ-45 DATA/VOICE OUTLET WITH SHUTTER.	SEE SPECS	AS PER FURNITURE
		PULL BOX 1000WATT CIRCUIT PROVISION 01 NO DATA CABLE PROVISION	SEE SPECS	AS PER I.D. LAYOUT

LEGEND

SYSTEM	SYMBOL	DESCRIPTION	TYPE	MOUNTING
FIRE ALARM SYSTEM PA SYSTEM CCTV & MATV		PA AMPLIFIER RACK.	SEE SPECS	AS PER I.D. LAYOUT
		6 WATTS CEILING SPEAKER.	SEE SPECS	FALSE CEILING / CEILING
		10W WALL MOUNTED SPEAKER.	SEE SPECS	WALL MOUNTED 2430mm AFL
		CCTV CAMERA.	SEE SPECS	WALL MOUNTED
		CCTV CAMERA (DOME TYPE).	SEE SPECS	FALSE CEILING / CEILING
		NETWORK VIDEO RECORDER (NVR).	SEE SPECS	AS PER I.D. LAYOUT
		FIRE ALARM SMOKE SENSOR.	SEE SPECS	FALSE CEILING / CEILING
		FIRE ALARM HEAT SENSOR.	SEE SPECS	FALSE CEILING / CEILING
		FIRE ALARM SOUNDER.	SEE SPECS	2400mm AFL
		FIRE ALARM MANUAL CALL STATION.	SEE SPECS	1400mm AFL
		FIRE ALARM SOUNDER WITH FLASHER.	SEE SPECS	2400mm AFL
		LOOP ISOLATOR.	SEE SPECS	ABOVE FALSE CEILING
		FIRE ALARM PANEL.	SEE SPECS	1400mm AFL
		ILLUMA EMULUX DUO E3N/D.	1x4W LED LAMP	PENDENT
BATTERY OPERATED EMERGENCY LIGHTING		ILLUMA EMULUX MAXI E2N/D.	1x4W LED LAMP	PENDENT
		ILLUMA EMULUX MINI E1N.	1x4W LED LAMP	CEILING / WALL
		NON-MAINTAINED TYPE 36WATT LED EMERGENCY LIGHT WITH 2 HOUR BATTERY PACK.	LED	RECESSED TYPE
		NON-MAINTAINED TYPE 8WATT LED EMERGENCY LIGHT WITH 2 HOUR BATTERY PACK.	LED	WALL MOUNTED TYPE
SWITCHES & SOCKETS		TELEPHONE SIMPLEX SOCKET OUTLET RJ-45 WITH SHUTTER.	SEE SPECS	450mm AFL
		DATA SIMPLEX SOCKET OUTLET RJ-45 WITH SHUTTER.	SEE SPECS	450mm AFL
		TELEPHONE & DATA DUPLEX SOCKET OUTLET RJ-45 WITH SHUTTER.	SEE SPECS	450mm AFL
		DATA DUPLEX SOCKET OUTLET RJ-45 WITH SHUTTER.	SEE SPECS	450mm AFL
		TELEPHONE JUNCTION BOX	SEE SPECS	FLOOR MOUNT
		WiFi POINT.	SEE SPECS	2430mm AFL

LEGEND

SYSTEM	SYMBOL	DESCRIPTION	TYPE	MOUNTING
SWITCHGEAR		(MCCB) MOULDED CASE CIRCUIT BREAKER	SEE SPECS	
		(MCB) MINIATURE CIRCUIT BREAKER	SEE SPECS	
		(RCB) EARTH LEAKAGE CIRCUIT BREAKER	SEE SPECS	
		MULTIFUNCTION INSTRUMENT / ENERGY ANALYZER A,VA,W,KVA,KVAR,MD,PF	SEE SPECS	
		ENERGY METER + MDI (AS PER WAPDA/ESCO REQUIREMENT)	SEE SPECS	
		PHASE INDICATION LAMPS	SEE SPECS	
		CONTROL FUSE	SEE SPECS	
		CONTACTOR	SEE SPECS	
		HAND AUTO SWITCH	SEE SPECS	
		EARTHING	SEE SPECS	
		SELECTOR SWITCH	SEE SPECS	
		AMMETER / VOLTMETER	SEE SPECS	
		OVERCURRENT & EARTH FAULT RELAY	SEE SPECS	
		TRANSFORMER	SEE SPECS	
WIRING RACEWAY		GENERATOR	SEE SPECS	
		MAIN DISTRIBUTION BOARD	SEE SPECS	1200mm BOTTOM FROM FTL
		DISTRIBUTION BOARD	SEE SPECS	
		HAND HOLE.	SEE SPECS	F.F.L
		CIRCUIT WIRING CRT R1 OF DB-GA.	SEE SPECS	
		LIGHTING WIRE.	SEE SPECS	CEILING
		POWER WIRE.	SEE SPECS	FLOOR
		TELEPHONE WIRE	SEE SPECS	FLOOR
		DATA WIRE.	SEE SPECS	FLOOR
		SMOKE DETECTOR WIRE.	SEE SPECS	CEILING
		CAMERA WIRE.	SEE SPECS	CEILING



Electrical Consultants

Dr. Muhammad Mohsin Aman
Department of Electrical Engineering
NED University of Engineering and Technology, Karachi
e-mail: mohsinaman@gmail.com

Notes:

Revisions:

Rev	Details	Date
01	Issued to Tender	14.02.24
02	Issued to Ref Tender	14.02.24

Project: **Hilton Pharma Nanotechnology Centre at NED University**
For: **NED University of Engineering and Technology, Karachi**

Title: **MASTER LEGENDS**

Scale: **N.T.S**

Print Date: **14 Feb 2024**

Date: **14 Feb 2024**

Checked: **K.A**

Job No: **NED-19-01**

Dwg. No.

GR-02

GENERAL NOTES ON INTERNAL & EXTERNAL SERVICES

1	ALL ELECTRICAL WORKS CARRIED OUT SHALL COMPLY WITH THE LATEST STANDARD.
2	THE ELECTRICAL CONTRACTOR SHALL BE RESPONSIBLE TO UNSEAL WITH ELECTRIC INSULATOR FOR ALL CLEARANCE, CABLE JOINTING, TESTING AND ELECTRICAL WIRING FOR THE INSTALLATION.
3	THE ELECTRICAL CONTRACTOR SHALL BE RESPONSIBLE FOR SEALING OF ALL CABLE PENETRATION OPENINGS BETWEEN FLOOR SLAB AND WALLS ETC. WITH APPROVED FIRE RATING MATERIAL/CONSULTING ENGINEER'S APPROVAL.
4	ELECTRICAL CONTRACTOR SHALL BE RESPONSIBLE FOR SEALING OF ALL CABLE PENETRATION OPENINGS THROUGH ROOF WALL WITH APPROVED WATER-PROOF MATERIALS AFTER THE INSTALLATION OF CABLES.
5	THE ELECTRICAL CONTRACTOR SHALL BROADCAST WITH SAND THE MANHOLES AND DRAUGHTS TO COMPLY TO TECHNICAL SPECIFICATIONS.
6	ALL CABLES TO BE LAID IN HD PVC PIPES ENCASED IN CONCRETE WHEN LAID ACROSS THE DRIVEWAY.
7	FIRE RATED CABLE SHALL BE USED FOR ALL FIRE SYSTEM CIRCUIT WIRING.
8	ALL UNDERGROUND WIRING SHALL BE OF PVC/PVC CABLE (IN HD PVC PIPE FOR HARD GROUND/PAVEMENT).
9	ALL WIRING TO LIGHTING LUMINAIRES SHALL COMPLY OF APPROVED CEILING ROSE FOR INDOOR INSTALLATION AND WEATHERPROOF JUNCTION BOX FOR OUTDOOR INSTALLATION. CONNECTION TO LIGHT FIXTURE SHALL BE BY MEANS OF CUP/PIECE CABLE FOR NORMAL SUPPLY.
10	OUTDOOR INSTALLATION SHALL BE IN HEAVY DUTY UPVC PIPES.
11	ALL LOCATIONS OF EQUIPMENT AND CABLE ROUTES SHOWN ON THE DRAWING ARE APPROXIMATE. THE EXACT LOCATIONS MUST BE CO-ORDINATED ON SITE BEFORE INSTALLATION. FULLY CO-ORDINATED SHOP DRAWINGS MUST BE SUBMITTED TO THE ARCHITECT FOR APPROVAL BEFORE COMMENCEMENT OF WORK.
12	ALL CONDUITS SHALL COMPLY WITH THE LATEST STANDARD. AND LUMINAIR SIZE SHALL NOT BE LESS THAN 25mm. ALL THEORIES IN CONDUITS SHALL BE TREATED WITH ALUMINUM PAINT OR SIMILAR ANTI-RUST PAINT TO PREVENT CORROSION AT JOINTS AND TERMINATIONS. CONNECTION SHALL BE BY MEANS OF BUSH & COUPLER.
13	PHASE SELECTION SHALL COMPLY WITH THE LATEST REQUIREMENTS OF THE IEEE WIRING REGULATIONS. SEPARATE CONDUITS SHALL BE USED FOR CABLES OF DIFFERENT CIRCUIT CATEGORIES. FOR 3 PHASE FINAL CIRCUITS, SEPARATE CONDUITS SHALL BE USED FOR DIFFERENT CIRCUITS.
14	EACH CIRCUIT SHALL BE TESTED FOR GROUNDS AND SHORTS BY MEANS OF A MEGGER INSULATION RESISTANCE TESTING INSTRUMENT APPLYING A VOLTAGE OF NOT LESS THAN 500V D.C. UPON CIRCUIT UNDER TEST.
15	CABLES FOR ESSENTIAL CIRCUITS SUCH AS EMERGENCY LIGHTING CIRCUITS AND FIRE FIGHTING EQUIPMENT CIRCUITS ETC. SHALL NOT BE DRAWN INTO THE SAME CONDUIT, DUCT OR TRUNKING INTENDED FOR NORMAL CIRCUITS AS PER IEEE WIRING REGULATION. CABLES FOR EXTRA LOW VOLTAGES CIRCUITS SUCH AS TELEPHONE/DATA, FIRE ALARM SYSTEM CIRCUITS SHALL NOT SHARE THE SAME CONDUIT, DUCT OR TRUNKING WITH NORMAL CIRCUITS AS PER THE LATEST IEEE WIRING REGULATION.
16	FOR SINGLE PHASE SUPPLY, CIRCUITS OF DIFFERENT PHASES SHALL NOT SHARE THE SAME CONDUIT, DUCT OR TRUNKING. ALL LIGHTING POINTS SHALL BE PROVIDED WITH CIRCUIT PROTECTIVE CONDUCTIONS AND ALL METAL PARTS SHALL BE CONTINUOUSLY EARTHED THROUGHOUT.
17	EARTHING INSTALLATION SYSTEM SHALL COMPLY WITH THE LATEST STANDARD. ALL WIRING SHALL BE IN CONCEALED CONDUIT/TRUNKING UNLESS NOTED OTHERWISE OR APPROVED BY CONSULTING ENGINEERS.
18	THE OVERALL RESISTANCE FOR THE EARTHING SYSTEM (ELECTRICAL) SHALL BE LESS THAN 1 OHM AND IN ANY CASE SHALL COMPLY WITH LATEST REQUIREMENTS.
19	ELECTRICAL CONTRACTOR SHALL BE RESPONSIBLE FOR THE EQUIPOTENTIAL EARTHING BONDING TO ALL METAL PARTS COMPLETED BY THE OTHER TRADES TO THE NEARBY ELECTRICAL PANEL IN ACCORDANCE WITH STANDARD.
20	ALL EARTH TESTS SHALL BE CARRIED OUT WITH A 100V MEGGER TEST INSTRUMENT AND IN ACCORDANCE WITH THE LATEST REQUIREMENTS OF THE IEEE WIRING REGULATIONS CONTRACTOR SHALL SUBMIT TEST REPORT OF MEGGER TESTING. THE LIGHTNING PROTECTION SYSTEM SHALL COMPLY WITH THE REQUIREMENTS OF THE LATEST STANDARD AND INSTALLED TO THE SATISFACTION OF THE ARCHITECT.
21	EQUIPOTENTIAL BONDING SHALL BE PROVIDED IN ALL TOILETS.
22	THE POSITIONING OF ALL LIGHTING LUMINAIRES, SWITCH SOCKET OUTLETS, DISTRIBUTION BOARDS ETC. AS SHOWN IN THE DRAWINGS ARE APPROXIMATE ONLY. THE EXACT POSITIONS SHALL BE DETERMINED ON SITE.
23	ALL LED LAMP FIXTURES TO HAVE CONTROL GEAR RATED 230 VOLTS, 50HZ & PF = 0.9
24	COLOR OF INDOOR LIGHT FIXTURES SHALL BE AS PER PHILIPS OR EQUIVALENT COLOR CODE WITH : 80
25	ALL LIGHTING POLE SPECIFIED SHALL COMPRISE OF RAIL MOUNTED 10A MCB IN THE COMPARTMENT.
26	THE ELECTRICAL CONTRACTOR SHALL SUPPLY AND INSTALL ALL LIGHT LUMINAIRES AS SHOWN ON THE DRAWINGS. EACH FITTING SHALL HAVE ITS OWN INDEPENDENT SUPPORT REGARDLESS OF SURFACE, RECESSED OR SUSPENDED MOUNTING.
27	THE MOUNTING HEIGHT OF ALL 1X/15W SWITCHED SOCKET OUTLET SHALL BE AT 450mm FROM FINISHED FLOOR EXCEPT IN NET AREAS SHALL BE 1500mm FROM FINISHED FLOOR OR UNLESS OTHERWISE STATED.
28	ALL POWER OUTLET, LIGHTING, TELEPHONE, ETC. LOCATIONS SHOWN ARE APPROXIMATE ONLY.
29	ALL TRUNKINGS & CABLE TRAYS THROUGH PROTECTED LOBBIES & STAIRCASES SHALL BE FIRE RATING PAINTED FOR IN TWO-HOUR FIRE-RATED ENCLOSURE WHETHER IT IS SHOWN ON THE DRAWINGS OR NOT.
30	THE ELECTRICAL CONTRACTOR SHALL BE RESPONSIBLE FOR THE ELECTRICAL LOAD BALANCING AND LABELING OF ALL EQUIPMENT AND SWITCHBOARDS THROUGHOUT THE INSTALLATION.
31	IT IS THE CONTRACTOR'S RESPONSIBILITY TO PROVIDE EARTH FAULT AND OVERCURRENT TRIPPING DISCREMINATION BETWEEN THE SWITCHBOARD WITH SELF GENERATION INCLUDING FEEDER TO COMPLY WITH THE CONSULTANTS REQUIREMENT.
32	THE ELECTRICAL CONTRACTOR SHALL FURNISH ALL NECESSARY LABOUR, MATERIALS AND EQUIPMENTS FOR SATISFACTORY COMPLETION OF THE ENTIRE ELECTRICAL INSTALLATION AS GENERALLY DESCRIBED IN THE SPECIFICATION AND/OR SHOWN ON DRAWINGS.
33	ELECTRICAL CONTRACTOR SHALL PROVIDE ENCLOSURES FOR ELECTRICAL INTERCOM AND TELEPHONE RESEV SERVICES AS WHEN AND WHERE TO ARCHITECTS/CONSULTING ENGINEER'S APPROVAL.
34	UNLESS OTHERWISE STATED, ALL ELECTRICAL INSTALLATION IS SHOWN IN THE DRAWING ARE TO BE CARRIED OUT BY THE ELECTRICAL CONTRACTOR.

LUMINAIRES

1	ALL LIGHTING SWITCHES SHALL COMPLY WITH BS. AND SHALL BE OF APPROVED TYPE.
2	LED LAMP TUBES USED AT PUBLIC AREAS SHALL BE OF COLOR AS WHEN WHITE AND INSTANT START UNLESS OTHERWISE STATED AND OF LOW LOSS ENERGY SAVING TYPE.
3	LED LAMP TUBES USED AT OFFICES AND KITCHEN SHALL BE OF COLOUR 84 WHITE UNLESS OTHERWISE STATED AND OF LOW LOSS ENERGY SAVING TYPE.
4	ALL EXIT LIGHTINGS SHALL BE POSITIONED NOT MORE THAN 2.4m ABOVE FTL TO CENTRE OF FITTING.

MINIMUM PVC CONDUIT CAPACITY FOR SINGLE CORE PVC INSULATION CABLES SHALL BE AS FOLLOWS:

CABLES(mm ²)	1.5	2.5	4.0	6.0	10	16	25
CONDUIT							
20mm DIA	8	6	4	3	2	-	-
25mm DIA	18	11	8	6	4	3	2
32mm DIA	26	17	13	10	6	4	3

ELECTRICAL BOARDS AND COMPONENTS

1	ALL MCB'S INSTALLED SHALL COMPLETE WITH ADJUSTABLE THERMAL AND MAGNETIC SETTING OF APPROPRIATE RANGE.
2	ALL MCB'S USED FOR PROTECTION OF INDUCTION LOADS SHALL BE OF TYPE 'C' CHARACTERISTIC AND MOTOR LOAD SHALL BE OF TYPE 'D' CHARACTERISTIC.
3	MCB'S/MCB'S IN THE MAIN SWITCHBOARDS, SUB-SWITCHBOARDS, DISTRIBUTION BOARDS SHOWN HEREIN AND OTHER DEVICES PROTECTING MOTOR CIRCUITS FOR PUMPS, FANS, ETC. SHALL BE OF THE TYPE SUITABLE FOR MOTOR PROTECTION INCORPORATING OVERLOAD AND SHORT CIRCUIT PROTECTIVE DEVICES (ALSO EARTH FAULT PROTECTION WHERE SHOWN IN THE DRAWINGS) AND THEY SHALL BE SO SELECTED THAT THEY ARE ABLE TO COORDINATE WITH BOTH THE UPSTREAM AND DOWNSTREAM PROTECTION DEVICES.
4	ALL PROTECTION CDS SHALL BE OF CLASS 50/10 50A OR BETTER.
5	ALL WIRING CDS SHALL BE OF CLASS 10 50A OR BETTER.
6	BUSBAR MOUNTINGS, ARRANGEMENTS, CONNECTIONS AND GRADE OF COPPER SHALL COMPLY AS APPROPRIATE WITH BS:159, 1133 AND 1917.
7	ALL ELECTRICAL BOARDS BUSBARS SHALL BE OF HARD DRAWN TINED COPPER AND SHALL HAVE A CURRENT DENSITY OF NOT LESS THAN 1.5A/CM ² WHEN MORE THAN ONE SET OF BUSBARS ARE USED PER PHASE, APPROPRIATE DERATING FACTOR SHALL APPLY.
8	ALL BUSBAR TRUNKINGS SHALL BE OF FULL SIZE NEUTRAL WITH CONTINUOUS INTEGRAL EARTHING BAR.
9	ALL NON-CURRENT CARRYING METALLIC PARTS OF THE DISTRIBUTION BOARDS SHALL BE BONDED TO SYSTEM EARTH THERE SHALL BE A CONDUIT EARTH BAR IN EACH DISTRIBUTION BOARD.
10	THE NEUTRAL LINES AND EARTH BARS IN THE DISTRIBUTION BOARDS SHALL BE LOCATED AT AN EASILY ACCESSIBLE POSITION AND SHALL BE KEPT CLEAR OF ANY OBSTRUCTIONS.
11	NEUTRAL AND EARTH BARS SHALL HAVE SUFFICIENT NUMBER OF WAYS TO MATCH THE NUMBER OF SUB-CIRCUITS WITH SPACES.
12	THE MINIMUM CLEARANCE AROUND THE NEUTRAL LINES SHALL BE 50mm.
13	THE SUB-CONTRACTOR IS REQUIRED TO CARRY OUT HIS OWN FAULT LEVEL CALCULATIONS BASED ON THE CHARACTERISTICS OF THE EQUIPMENT OFFERED AND THE ACTUAL AGREED RATING (SUBJECT TO THE ARCHITECT'S APPROVAL) OF THE CABLES AND THEREAFTER SELECT THE MOST APPROPRIATE RATING CAPACITY OF SUB-SWITCHBOARDS, BUSBAR TRUNKING AND DISTRIBUTION BOARDS TO MEET THE PROSPECTIVE FAULT LEVELS. ALL COSTS IN CONNECTION HEREWITH SHALL BE DEEMED TO BE INCLUDED IN THE SUB-CONTRACT SUM.
14	CONTRACTOR SHALL SUBMIT DETAILED CALCULATION & SELECTION FOR ARCHITECT'S APPROVAL.
15	ALL ELECTRICAL EQUIPMENT AND ACCESSORIES THAT ARE EXPOSED TO WEATHER SHALL BE OF WEATHERPROOF TYPE TO PREVENT UNNECESSARY DAMAGE.
16	ALL PRIVATE OR IN-HOUSE METERS PARTICULARLY 1PH AND 10 METERS SHALL BE PROPERLY CALIBRATED ON SITE BY ACCEPTABLE LABORATORY TEST EQUIPMENT. ALL COSTS CONNECTED HEREWITH SHALL BE DEEMED TO BE INCLUDED IN THE SUB-CONTRACT SUM.
17	EMUL OVERCURRENT AND EARTH FAULT RELAYS SPECIFIED SHALL BE COMPLETE WITH HIGH SET ELEMENT. FOR HV INSTALLATION FEEDER PROTECTION, THE HIGH SET ELEMENT FOR EMUL OVERCURRENT RELAY SHALL BE OMITTED.
18	ALL OVERCURRENT, EARTH FAULT RELAYS AND EARTH LEAKAGE RELAYS SHALL BE TESTED ON SITE BY KEYS LOCKED TESTER AND ALL COSTS CONNECTED THEREWITH SHALL BE DEEMED TO BE INCLUDED IN THE SUB-CONTRACT SUM.
19	HRC DISSES FOR TWO-OUT TYPES (WHERE APPLICABLE) MUST BE IN ACCORDANCE WITH BRITISH STANDARD AND OF THE TYPE READILY AVAILABLE LOCALLY. HRC DISSES TO OTHER STANDARD WILL NOT BE ACCEPTED.
20	THE 4 POLE AUTOMATIC TRANSFER SWITCHES SHALL NOT HAVE A NEUTRAL POSITION OR HAVE BOTH THE NORMAL AND EMERGENCY CONTACTS CLOSED AT THE SAME TIME.
21	TERMINATION OF BUSBARS TO THE GENERATOR TERMINALS SHALL BE CARRIED OUT BY MEANS OF PROPRIETARY MAKE FLEXIBLE CONNECTION OF EQUAL RATING TO THE BUSBARS.
22	THE SUB-CONTRACTOR IS REQUIRED TO SUBMIT DETAILS OF FINAL ARRANGEMENT AND DIMENSIONAL LAYOUT OF ALL THE ITEMS OF EQUIPMENT IN RESPECTIVE ROOMS TO SUIT SITE CONDITIONS, ETC. FOR REVIEW BY THE ARCHITECT BEFORE COMMENCEMENT OF INSTALLATION.
23	UNLESS OTHERWISE INDICATED, THE MCB'S/MCB'S INSTALLED FOR ANY MAIN SWITCHBOARDS, SUB-BOARDS AND DISTRIBUTION BOARDS SHALL HAVE THE FOLLOWING MINIMUM BREAKING CAPACITY:
24	MAIN SWITCHBOARD : 35KA RMS, 3 SEC.
25	SUB BOARD : 25KA RMS, 3 SEC.
26	DISTRIBUTION BOARDS : 10KA RMS.
27	MCB'S RATED < 100A. PROTECTING CABLES SUPPLYING LOADS WITH HIGH SWITCH-ON CURRENT (E.G. MOTORS, HD LAMPS, ETC.) SHALL HAVE TYPE 'C' MAGNETIC CURVE RATING UNLESS OTHERWISE INDICATED IN THE OR SCHEDULE.
28	UNLESS OTHERWISE STATED, ALL BUSBAR ARE OF 40 COPPER AND SHALL BE RATED AT A CURRENT DENSITY OF NO MORE THAN 1000A/645 sq. mm.
29	ALL SWITCHBOARDS AND DISTRIBUTION BOARDS SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE LATEST STANDARD AND TO THE APPROVAL OF CONSULTANT. THEY SHALL BE PAINTED WITH A COAT OF ANTI-RUST PAINT AND TWO COATS OF SEMI-GLOSS TEAL PAINT OF BEST QUALITY TO THE APPROVAL OF THE ARCHITECT.
30	HEIGHT OF CEILING FANS SHOULD NOT EXCEED 10 FEET FROM THE FLOOR IN ANY ROOM.
31	CEILING LIGHTS SHOULD BE ADJUSED WITH CEILING FANS HEIGHTS.
32	ALL DBS SHALL BE FLUSH TYPE AND ALL OUTDOOR DBS WILL BE RATED P-50.

CABLES AND ANCILLARY PRODUCTS

1	ALL PVC CABLES FOR FINAL SUB-CIRCUITS SHALL BE MULTI-STRAND COPPER CONDUCTORS & INSULATION COLOR OF THE CABLES SHALL BE AS FOLLOWS :-
2	LIVE WIRES :- RED OR YELLOW OR BLUE FOR SINGLE-PHASE CIRCUIT.
3	(TO CORRESPOND TO THE PHASE OF THE SUPPLY)
4	NEUTRAL WIRE :- BLACK
5	EARTH WIRE :- GREEN & YELLOW
6	SEPARATE CONDUIT/MULTI-GANG SWITCH BOX SHALL BE PROVIDED FOR FINAL SUB-CIRCUIT OF DIFFERENT PHASES. ALSO A SIGN SHALL BE PROVIDED TO INDICATE THE VOLTAGE BETWEEN THEM IN ACCORDANCE WITH BS 7671 CODE OF PRACTICE FOR WIRING OF ELECTRICAL EQUIPMENT OF BUILDINGS.
7	ALL EXTERNAL/LANDSCAPE LIGHTING POINTS SHALL BE PROVIDED WITH CABLES WITH ADDITIONAL LENGTH OF 5m.
8	SPACE FACTOR OF CONDUIT & TRUNKING SHALL COMPLY WITH BS 7671 CODE OF PRACTICE FOR WIRING OF ELECTRICAL EQUIPMENT OF BUILDINGS.
9	ALL SUB-WIRING CIRCUITS TO BE COMPLETE WITH CIRCUIT PROTECTIVE CONDUCTOR(CPC) COMPLYING TO BS 7671 CODE OF PRACTICES.
10	NEUTRAL & EARTH CABLES FOR EACH DIFFERENT CIRCUIT SHALL BE BROUGHT BACK TO THE SOURCE PANEL AND SHALL NOT BE LOFTED TOGETHER OUTSIDE THE PANEL.
11	ALL ELECTRICAL CONDUITS AND CONDUIT BOXES TO EXIST WITHIN R.C. SLAB AT NET AREAS (eg. BATHROOM, WC, KITCHEN, BALCONY & ETC.) MUST HAVE TIGHTLY SEALED AND WATERPROOF JOINTS.
12	ALL UNDERGROUND JUNCTION BOXES SHALL BE OF CL TYPE. KNOCK OUT BOXES SHALL NOT BE USED AS UNDERFLOOR JUNCTION BOXES.
13	THE SIZES OF CABLE TRAY/TRUNKING/CONDUIT AS SHOWN IN DRAWINGS ARE APPROXIMATE ONLY. ELECTRICAL SUB-CONTRACTOR IS REQUIRED TO HAVE ALLOWED IN HIS TENDER PRICE FOR ALL NECESSARY ADJUSTMENT TO ACCOMMODATE THE CABLES AND SHALL SUBMIT DETAILED CO-ORDINATED CABLE CONDUIT/ TRUNKING / TRAY LAUNDER ROUTE PLANS AND SECTION DRAWINGS TO THE ARCHITECT FOR CLEARANCE PRIOR TO STARTING WORK ON SITE.

POWER OUTLETS

1	ALL POWER OUTLETS, VOICE & DATA OUTLETS SHALL BE OF SWITCH TYPE.
2	SWITCH SOCKET OUTLETS AND SWITCHES MOUNTED SURFACE AT PLANTROOMS, SIMILAR LICENSE AREAS SHALL BE OF METAL CLAD TYPE UNLESS OTHERWISE STATED.
3	ALL ELECTRICAL EQUIPMENT & ACCESSORIES THAT ARE EXPOSED OR LESS THAN 2.0m AWAY FROM SWG SHALL BE OF WATERPROOF TYPE.
4	COLOR FOR ALL SWITCHES, SWITCH SOCKET OUTLETS SHALL BE AS PER ARCHITECTS/ INTERIOR DESIGNERS SELECTION.
5	UNLESS OTHERWISE INDICATED, THE MOUNTING HEIGHTS FROM FINISHED FLOOR LEVEL FOR VARIOUS ITEMS OF ELECTRICAL WIRING ACCESSORIES/EQUIPMENT SHALL BE AS FOLLOWS :-
6	LIGHTING SWITCHES :- 1200mm TO CENTRELINE
7	SWITCH SOCKET OUTLETS :- 450mm TO CENTRELINE
8	DISTRIBUTION BOARDS :- GENERALLY 1500mm TO CENTRELINE
9	WALL/COLUMN LIGHTS :- 2100mm TO CENTRELINE
10	THE ELECTRICAL SUB-CONTRACTOR SHALL NOTE THAT THE POSITIONS OF ELECTRICAL POINTS, LUMINAIRES, LIGHTING SWITCHES, SWITCH SOCKET OUTLETS ETC. ARE INDICATIVE AND APPROXIMATE AS SHOWN ON DRAWINGS. THE ACTUAL POSITIONS SHALL BE BASED ON THE ARCHITECT'S OR INTERIOR DESIGNER'S DRAWING. THE SUB-CONTRACTOR IS REQUIRED TO HAVE ALLOWED IN HIS TENDER PRICE FOR ALL NECESSARY SITE ADJUSTMENT TO SUIT THE FINAL POSITIONS.
11	LOCATIONS FOR ELECTRICAL DISTRIBUTION BOARDS AND BUSBAR RISERS SHOWN IN THE PLANS ARE INDICATIVE ONLY. ELECTRICAL SUB-CONTRACTOR SHALL VERIFY ON SITE AND PROPOSE THEIR ACTUAL LOCATIONS ON THE SHOP DRAWINGS FOR CLEARANCE.
12	ELECTRICAL DISTRIBUTION BOARD SHALL NOT BE MOUNTED MORE THAN 1800mm ABOVE FTL.
13	(MEASURED FROM FFL TO TOP OF DISTRIBUTION BOARD).
14	ALL ISOLATOR SUPPLIED FROM EMERGENCY BOARD SHALL BE PAB-LOCKABLE.
15	ALL SWITCH SOCKET OUTLETS FOR KITCHEN EQUIPMENT SHALL BE MOUNTED STRICTLY TO THE MOUNTING HEIGHT SHOWN IN THE KITCHEN EQUIPMENT POWER LAYOUT PLAN.
16	ELECTRICAL SUB-CONTRACTOR SHALL USE WITH KITCHEN CONSULTANT AND KITCHEN SUB-CONTRACTOR ON THE EXACT LOCATIONS & MOUNTING HEIGHTS OF THE KITCHEN SOCKET OUTLETS / ISOLATORS / DISTRIBUTION BOARDS & KITCHEN SETTING UP DIMENSIONS.
17	ELECTRICAL SUB-CONTRACTOR SHALL USE WITH INTERIOR DESIGNER/ARCHITECT ON THE EXACT LOCATIONS & MOUNTING HEIGHTS (IF APPLICABLE) OF SWITCH SOCKET OUTLETS, SWITCHES, DISTRIBUTION BOARDS BEFORE LAYING THE CONDUITS.
18	ELECTRICAL SUB-CONTRACTOR SHALL USE WITH ADINT SUB-CONTRACTOR & KITCHEN SUB-CONTRACTOR FOR THE EXACT POSITIONS OF THE KITCHEN LIGHT FITTINGS AND ALL CONTROL PANELS OF ASSOCIATED SERVICES.

CO-ORDINATION AND INSTALLATION

1	THE ELECTRICAL SUB-CONTRACTOR SHALL OBTAIN APPROVAL FROM STRUCTURAL ENGINEERS FOR PENETRATION THROUGH R.C. BEAMS AND FLOOR SLABS PRIOR TO CONSTRUCTION.
2	ALL CONDUITS LAYOUT AND INSTALLATION METHODS SHALL BE IDENTICAL IN RESIDENTIAL UNIT OF THE SAME TYPE.
3	THE ELECTRICAL SUB-CONTRACTOR SHALL USE WITH THE COMMUNICATION AND SECURITY SUB-CONTRACTOR AND THE WEATHER DESIGNER ON THE CIRCUITING OF INTERNAL LIGHTING AND POWER LAYOUT.
4	ALL MATERIALS/ CABLES USED AND INSTALLATION METHOD SHALL COMPLY WITH THE TECHNICAL SPECIFICATION, STANDARDS, CODE OF PRACTICE AND AUTHORITY REQUIREMENT.
5	ALL CABLES/ UNDERGROUND PIPE ROUTES SHOWN ON THE DRAWINGS ARE INDICATIVE ONLY. ELECTRICAL SUB-CONTRACTOR SHALL CHECK AND VERIFY THEM ON SITE.
6	THE SUB-CONTRACTOR IS REQUIRED TO SUBMIT DETAILS OF FINAL ARRANGEMENT AND DIMENSIONAL LAYOUT OF ALL ITEMS OF EQUIPMENT IN RESPECTIVE ROOMS TO SUIT SITE CONDITIONS, ETC. FOR REVIEW BY THE ARCHITECT BEFORE COMMENCEMENT OF INSTALLATION.
7	THE TENDERER IS REQUIRED TO CHECK AND HIGHLIGHT IN THEIR TENDER SUBMISSION IF ANY OF THE SUBSTATIONS, SWITCHBOARDS, ELECTRICAL RESEV ROOMS, ETC. AS PROVIDED ON THE SPECIFICATION DRAWINGS ARE NOT ADEQUATE TO ACCOMMODATE ALL THE EQUIPMENT TO BE SUPPLIED UNDER THIS CONTRACT.
8	THE ELECTRICAL SUB-CONTRACTOR SHALL ENSURE THAT NO MAINS & SUB-MAINS CABLES, BUSBARS SHALL INTERDUCE AND DEMARCATED TENANT SPACES UNLESS OTHERWISE APPROVED BY THE ARCHITECTS.

LIST OF ABBREVIATIONS FOR GENERAL ITEMS

BS	= BASEMENT	CR	= CONFERENCE ROOM
GF	= GROUND FLOOR	MR	= MEETING ROOM
FF	= FIRST FLOOR	WA	= MAIN AUDITORIUM
SF	= SECOND FLOOR	MP	= MULTI PURPOSE
RF	= ROOF		

LIST OF ABBREVIATIONS FOR ELECTRICAL ITEMS

P	= POWER	ACB	= AIR CIRCUIT BREAKER	WATV	= MASTER ANTENNA TV
L	= LIGHTING	MCB	= MOLDED CASE CIRCUIT BREAKER	OPC	= CIRCUIT PROTECTIVE CONDUCTOR
EL	= EMERGENCY LIGHT	WCB	= UNITARY CIRCUIT BREAKER	DN	= DOWN
LP	= LIGHTING & POWER	ELOB	= EARTH LEAKAGE CIRCUIT BREAKER	ERC	= ELECTRIC WATER COOLER
ELV	= EXTRA LOW VOLTAGE	RCBO	= RESIDUAL CURRENT CIRCUIT BREAKER	EM	= EMERGENCY
PA	= PUBLIC ADDRESS	MDF	= MAIN DISTRIBUTION FRAME	HVAC	= HEATING VENTILATION/ AIR CONDITIONING
FA	= FIRE ALARM	VDR	= VOLTAGE DATA RACK	LTC	= LIGHTING
CCTV	= CLOSE CIRCUIT TV	ONU	= OPTICAL NETWORK UNIT	HH	= HAND HOLE
BGM	= BACKGROUND MUSIC	JB	= JUNCTION BOX	WH	= MAIN HOLE
CBS	= CENTRAL BATTERY SYSTEM	PB	= PULL BOX	N	= NEUTRAL
UPS	= UNINTERRUPTIBLE POWER SUPPLY	CR	= CIRCUIT	NC	= NORMALLY CLOSED
MCC	= MOTOR CONTROL CENTER	R	= RED PHASE	MC	= NOT IN CONTRACT
MDB	= MAIN DISTRIBUTION BOARD	Y	= YELLOW PHASE	CH	= OVER HEAD
SMDB	= SUB-MAIN DISTRIBUTION BOARD	B	= BLUE PHASE	T	= THERMOSTAT
DB	= DISTRIBUTION BOARD	BA	= BOOSTER AMPLIFIER	TP	= TYPICAL
CL	= CONNECTED LOAD	FDB	= FLOOR DISTRIBUTION BOX	UG	= UNDERGROUND
DL	= DEMAND LOAD	AV	= AUDIO VISUAL	WP	= WEATHER PROOF
D.F.	= DEMAND FACTOR	BMS	= BUILDING MANAGEMENT SYSTEM	TR	= TRANSFORMER
EOT	= EQUIPMENT	A/AMP	= AMPERES		
SP	= SINGLE POLE	AFEL	= ABOVE FINISHED FLOOR LEVEL		
DP	= DOUBLE POLE	AFEL	= ABOVE FINISHED GROUND LEVEL		
TP	= THREE POLE/PHASE	C	= CONDUIT		
FP	= FOUR POLE	W	= WEATHER PROOF		



Electrical Consultants.

Dr. Muhammad Mohsin Aman
Department of Electrical Engineering
NED University of Engineering and Technology, Karachi
e-mail: mohsinaman@gmail.com

Revisions.
No Details
01 Issued to Tender
02 Issued to Ref Tender

Project: **Hilton Pharma Nanotechnology Centre at NED University**

Title: **GENERAL NOTES**

Scale: **N.T.S**

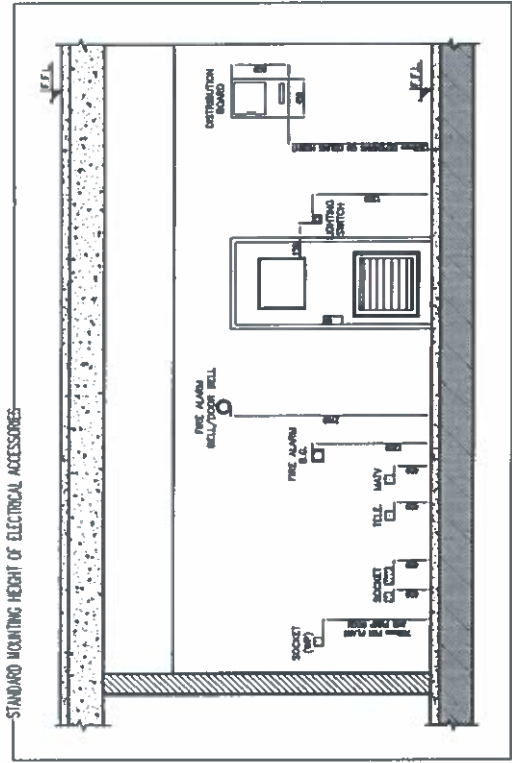
Print Date: **14 Feb 2024**

Date: **14 Feb 2024**

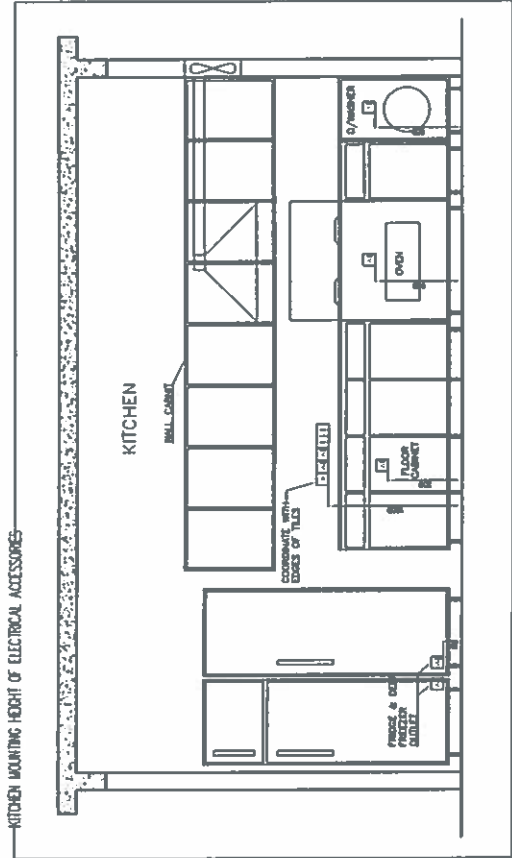
Checked: **K.A**

Job No: **NED-19-01**

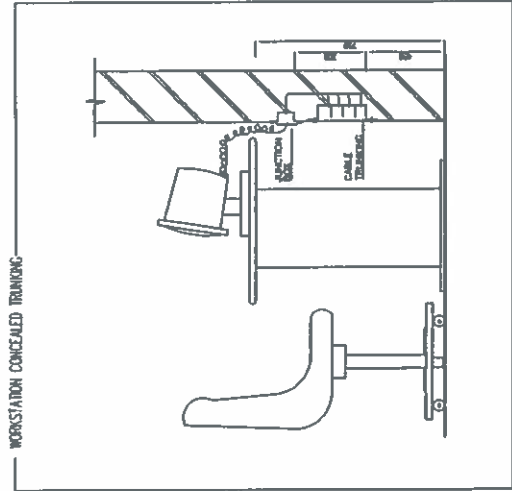
STANDARD MOUNTING HEIGHT OF ELECTRICAL ACCESSORIES



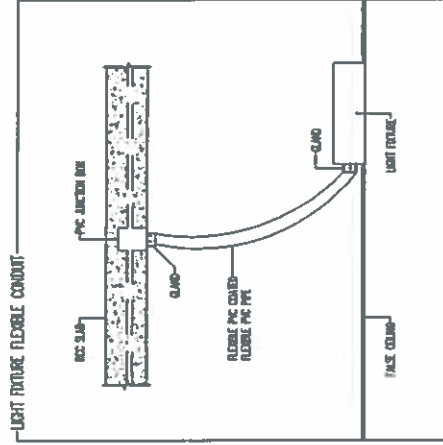
KITCHEN MOUNTING HEIGHT OF ELECTRICAL ACCESSORIES



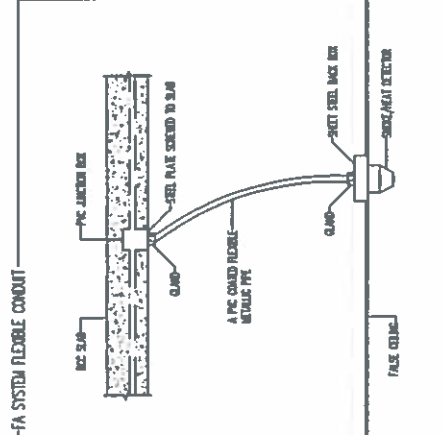
WORKSTATION CONCEALED TRUNKING



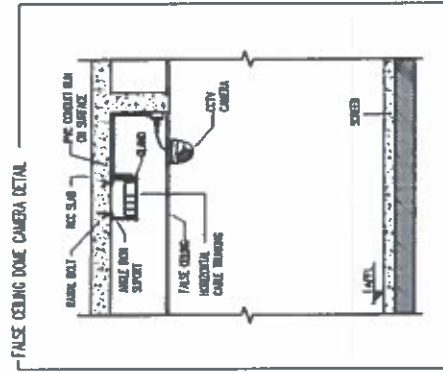
LIGHT FIXTURE FLEXIBLE CONDUIT



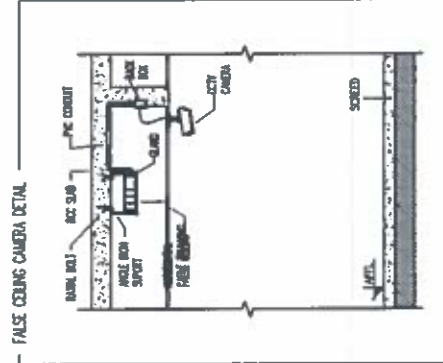
FA SYSTEM FLEXIBLE CONDUIT



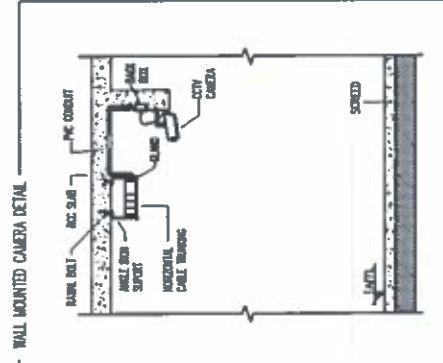
FALSE CEILING VOICE CAMERA DETAIL



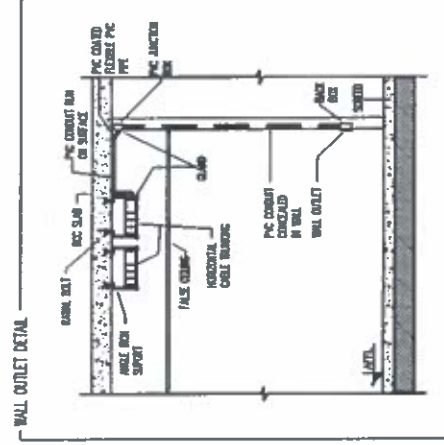
FALSE CEILING CAMERA DETAIL



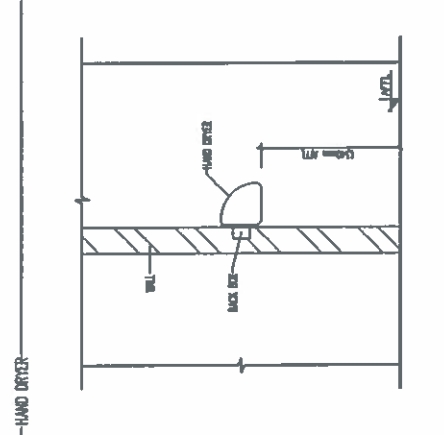
WALL MOUNTED CAMERA DETAIL



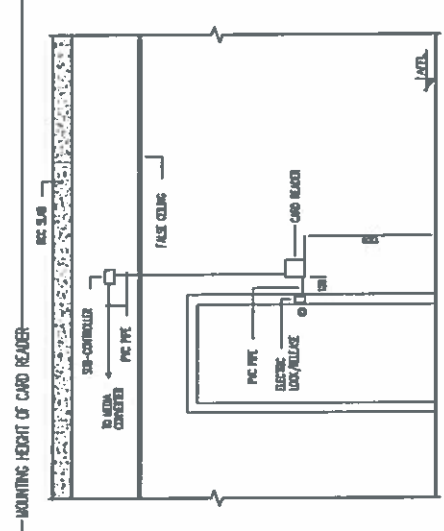
WALL OUTLET DETAIL



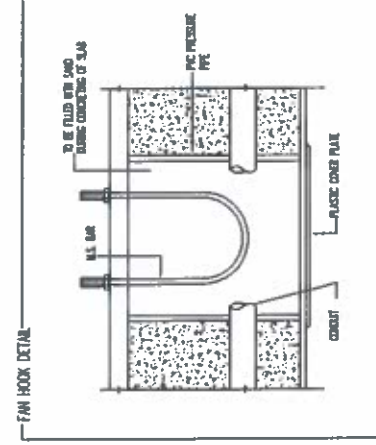
HAND DRIVER



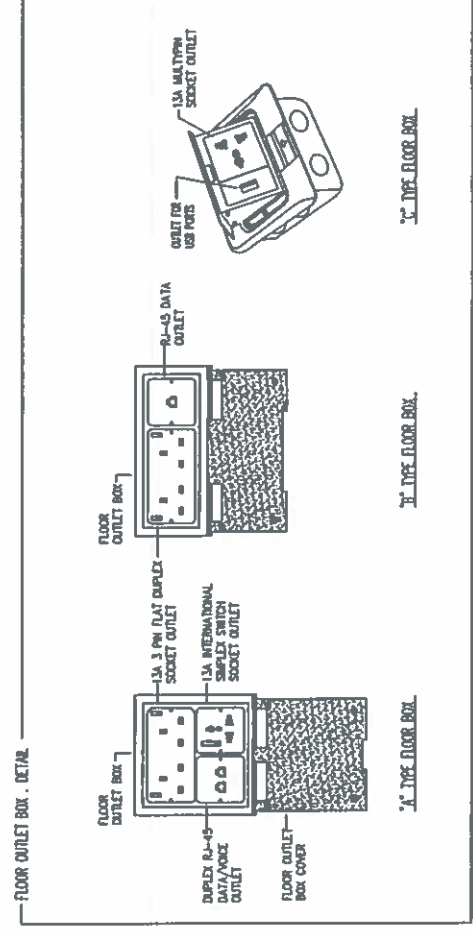
MOUNTING HEIGHT OF CARD READER



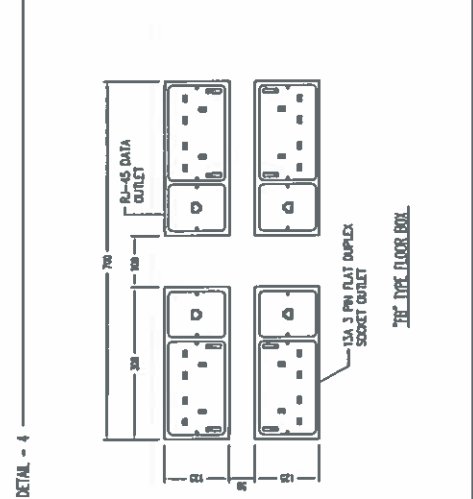
FIN HOOK DETAIL



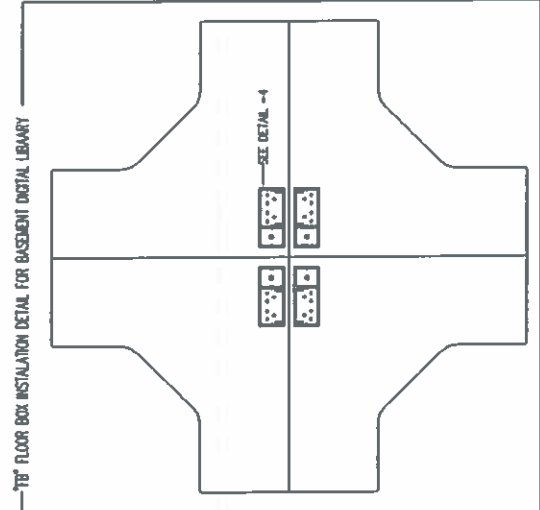
FLOOR OUTLET BOX - DETAIL



DETAIL - 4



78" FLOOR BOX INSTALLATION DETAIL FOR BASEMENT DIGITAL LIBRARY



Electrical Consultants

Dr. Muhammad Mohsin Aman
Department of Electrical Engineering
NED University of Engineering and Technology, Karachi
e-mail: mohsinaman@gmail.com

Notes:

Revisions:

Rev	Description	Date
01	Issued to Tender	14 Feb 2024
02	Issued to Client	14 Feb 2024

Project:

Hilton Pharma
Nanotechnology Centre
at NED University
For
NED University of Engineering
and Technology, Karachi

Title:

GENERAL
ELECTRICAL DETAILS

Scale:

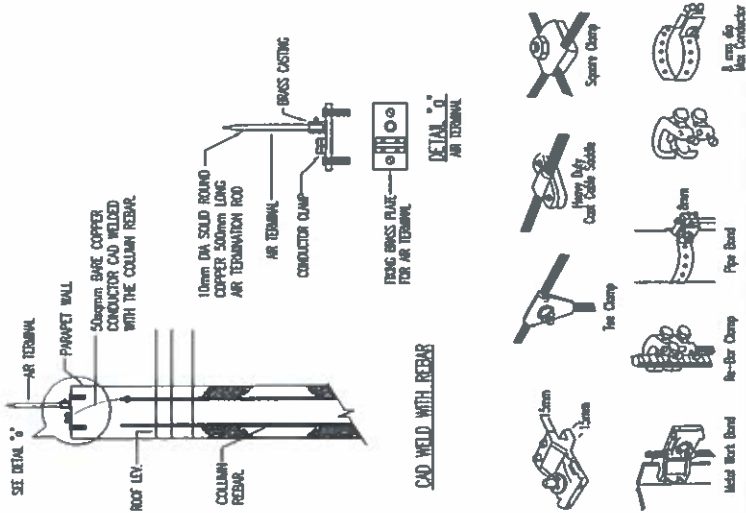
N.T.S

Dwg. No.

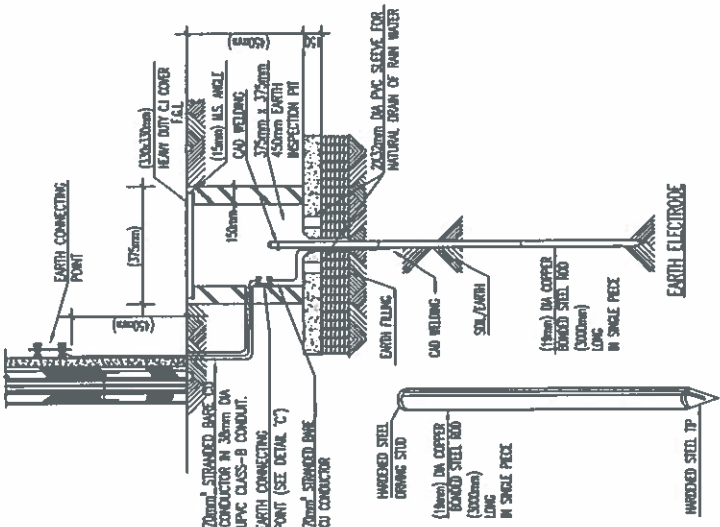
GR-04

EARTHING & LIGHTNING PROTECTION SYSTEM DETAILS

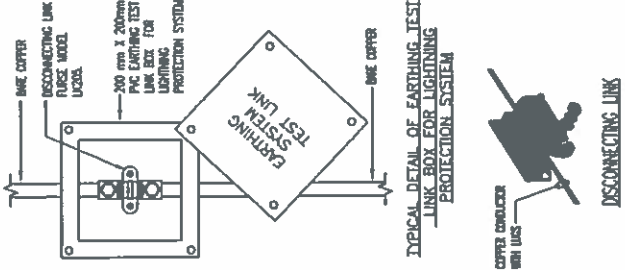
DETAIL : ROOF CONDUCTOR FOR LPS



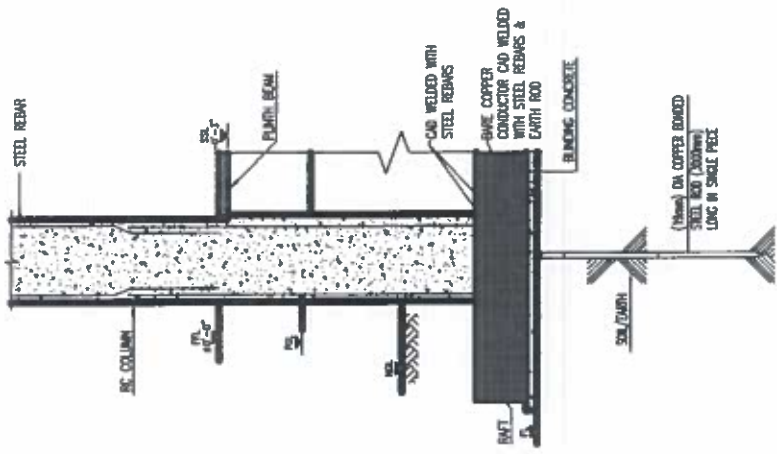
DETAIL-1 : EARTH PIT (FOR POWER SYSTEM)



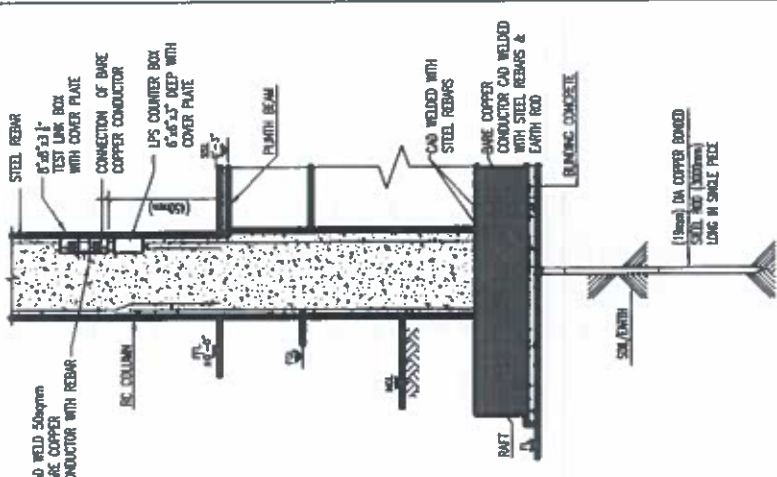
TYPICAL DETAIL OF EARTHING TEST LINK BOX



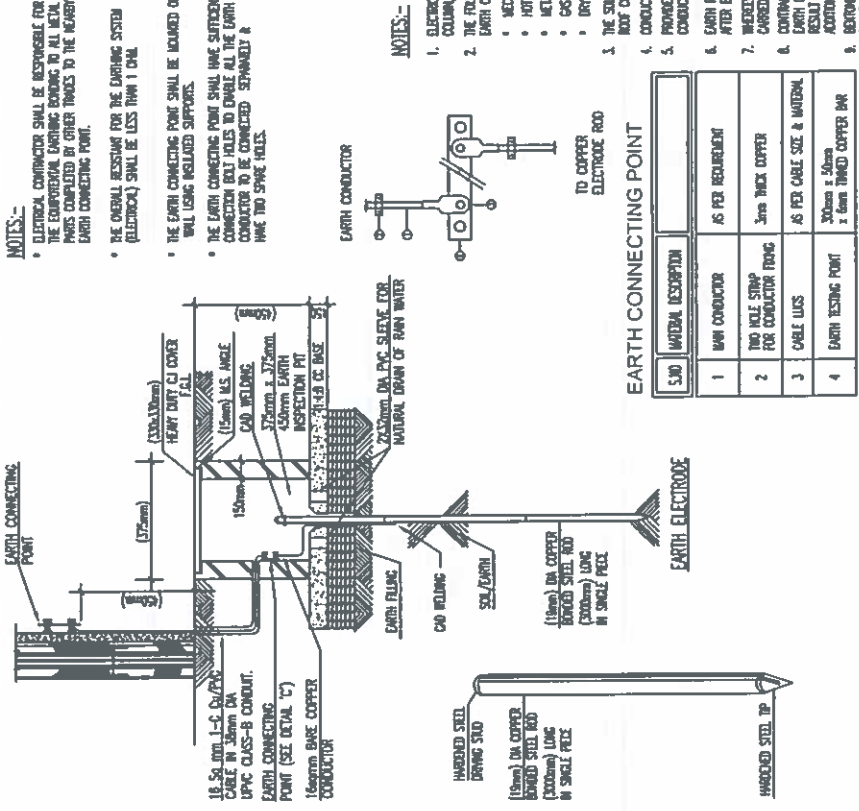
DETAIL-A : LPS WITHOUT TEST LINK BOX



DETAIL-B : LPS WITH TEST LINK BOX



DETAIL-2 : EARTH PIT (FOR COMMUNICATIONS SYSTEM)



- NOTES:-
- ELECTRICAL CONTRACTOR SHALL BE RESPONSIBLE FOR THE EARTHING SYSTEM. THE EARTHING SYSTEM SHALL BE COMPLETED BY OTHER TRADES TO THE NEAREST EARTH CONNECTING POINT.
 - THE ORIGINAL RESISTANCE FOR THE EARTHING SYSTEM (ELECTRODE) SHALL BE LESS THAN 1 OHM.
 - THE EARTH CONNECTING POINT SHALL BE MAINTAINED ON WALL USING WELDED SUPPORTS.
 - THE EARTH CONNECTING POINT SHALL HAVE SUFFICIENT CONNECTION BOLT HOLES TO ENABLE ALL THE EARTH CONDUCTORS TO BE CONNECTED SEAMLESSLY & HAVE TWO SPARE HOLES.

- NOTES:-
- ELECTRICAL CONTINUITY TO BE MAINTAINED AT ALL VERTICAL COLUMNS, BEING USED AS DOWN CONDUCTORS.
 - THE FOLLOWING EXTREMELY CORROSIVE POINTS TO BE COATED WITH LOCAL EARTH CONNECTING POINT THROUGH STANDED COPPER CONDUIT.
 - METALLURGICAL, PPE WORK
 - HOT & COLD WATER SYSTEM
 - METALLIC SINKS & SINK SERVICE
 - GAS INDOOR SERVICE
 - DRY RISER, MISTMIST & OTHER FIRE PROTECTION PIPE WORK
 - THE SOLID SYSTEM SHALL BE BOND TO LIGHTNING PROTECTION ROOF CONDUCTOR THROUGH STANDED COPPER CONDUIT.
 - CONDUCTOR USED FOR EARTHING SHALL HAVE A GREEN/YELLOW SHEATH.
 - PRIVATE BIRDS SHALL BE STABLY FASTENED VERTICALLY, INDIVIDUALLY CONDUCTORS AT 1000mm INTERVAL.
 - EARTH RODS TO BE MAINTAINED IN THE GROUND OR TO BE INSTALLED AFTER EARTHING WHEN IN FEASIBLE.
 - WELDED JOINTS OF COPPER CONDUCTOR SHALL BE CARVED OUT BY EXHAUSTIVE MEANS (CUT WELD).
 - CONDUCTOR MUST INSURE THAT THE RESISTANCE TO EARTH OF ANY EARTH CONNECTION SHALL NOT BE MORE THAN ONE (1) OHM. IF THIS RESULT IS NOT ACHIEVED THEN THE CONTRACTOR HAS TO INSTALL ADDITIONAL COPPER RODS TO GET THE REQUIRED RESULT.
 - BETTER WETTER RESISTANCE REDUCING CLAY TO BE USED AS AN EARTH ELECTRODE. SPECIAL TO REDUCE SOIL RESISTANCE ON LOW RESISTANCE COMPOUND CAN ALSO BE USED.

EARTH CONNECTING POINT

S.NO	MATERIAL DESCRIPTION
1	DOWN CONDUCTOR AS PER REQUIREMENT
2	TWO HOLE STAMP FOR CONDUCTOR RING 3mm THICK COPPER
3	CABLE LUGS AS PER CABLE SIZE & MATERIAL
4	EARTH TESTING POINT 200mm x 50mm x 5mm THICK COPPER BAR

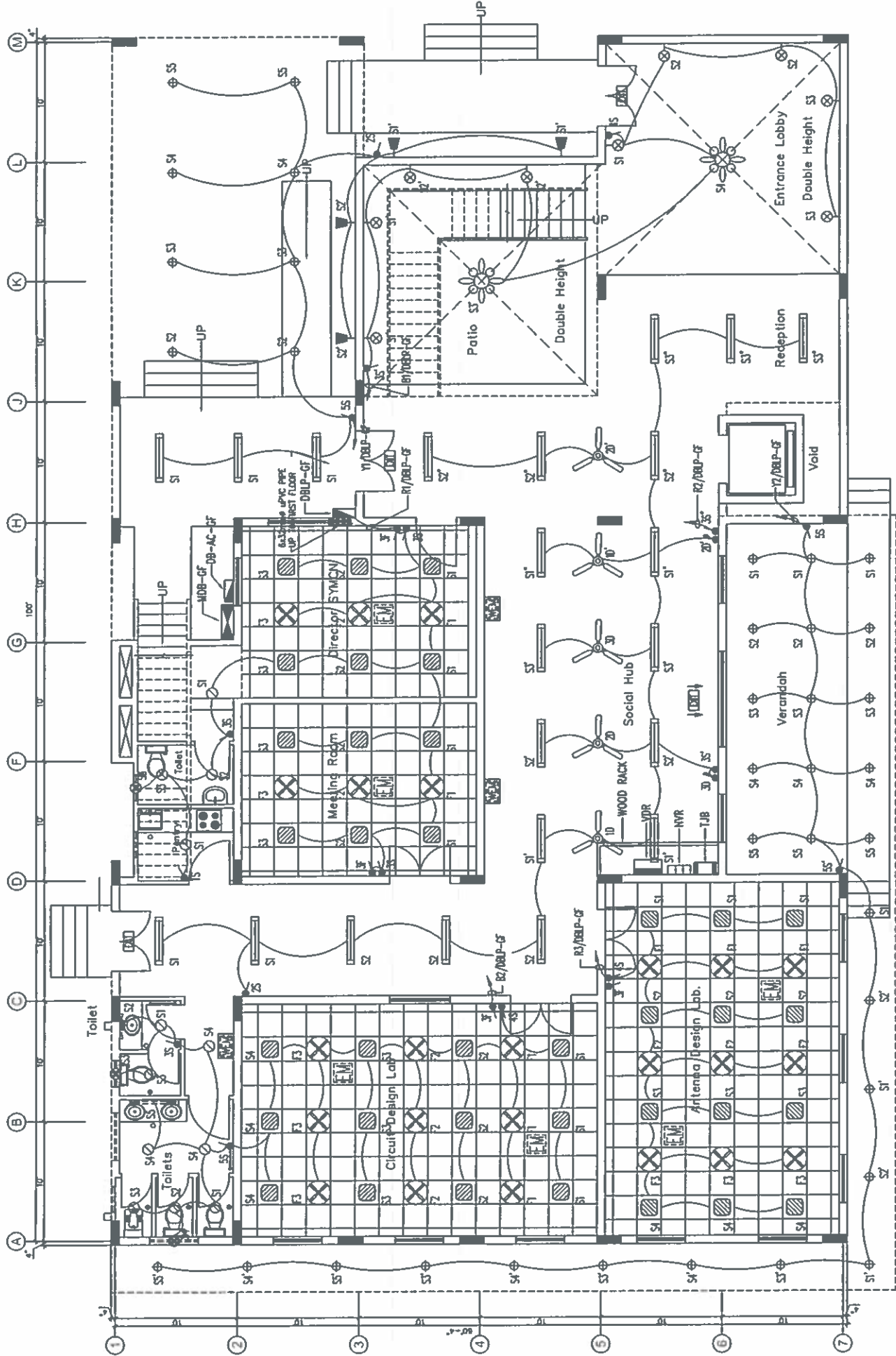


Electrical Consultants:
Dr. Muhammad Mohsin Aman
Department of Electrical Engineering
NED University of Engineering and Technology, Karachi
e-mail: mohsinaman@gmail.com

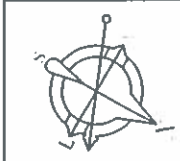
Project: **Hilton Pharma Nanotechnology Centre at NED University**
For: **NED University of Engineering and Technology, Karachi**

Scale: **N.T.S**
Print Date: **14 Feb 2024**
Date: **14 Feb 2024**
Checked: **K.A**
Job No: **NED-19-01**

Dwg. No.
GR-05



GROUND FLOOR



Electrical Consultant:
Dr. Muhammad Mohsin Anan
Department of Electrical Engineering
NED University of Engineering and Technology, Karachi
e-mail: mohsinan@neda.edu.pk

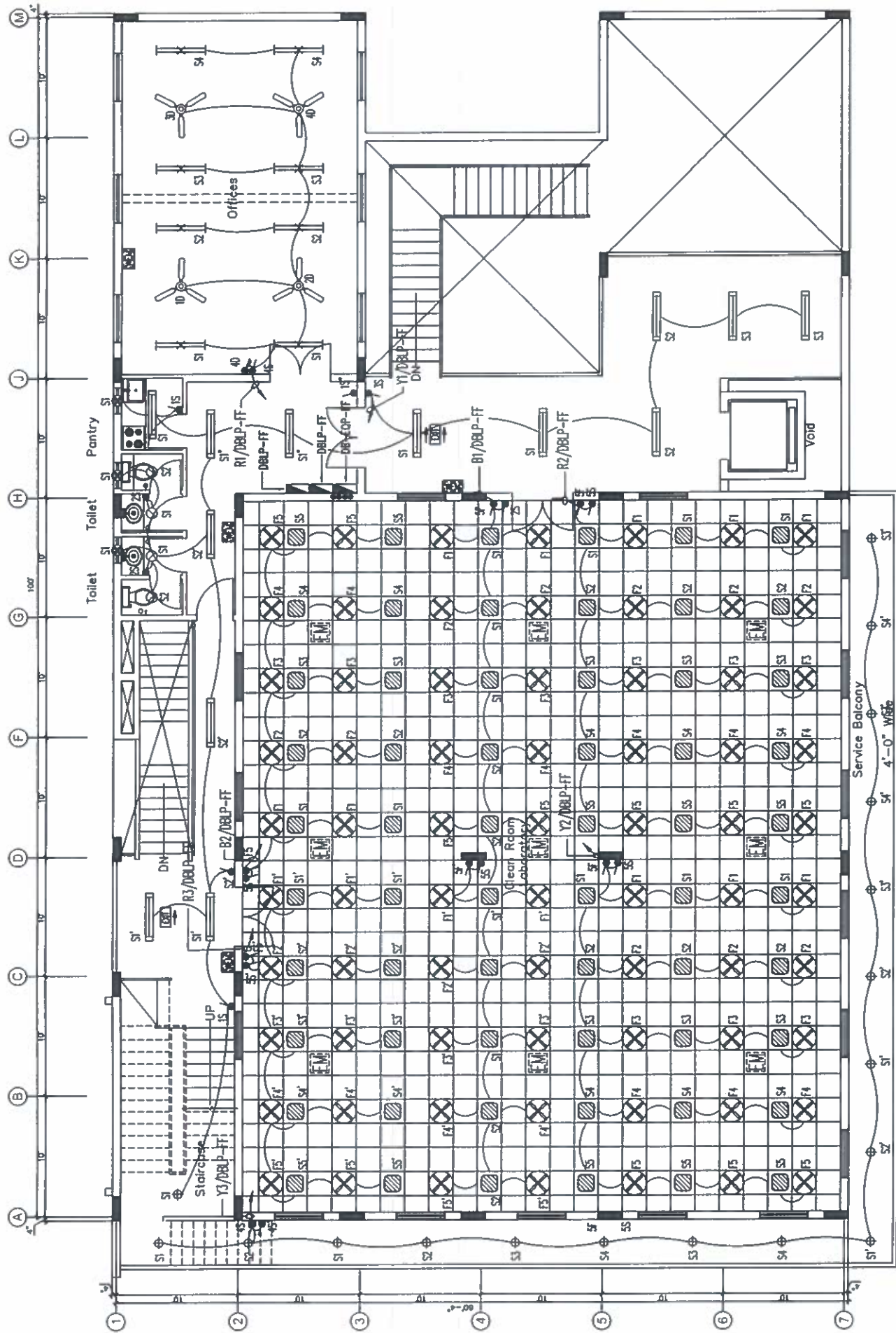
Revisions:

No	Details	Date
01	Issued for Tender	07-10-23
02	Issued to R.C.T order	14-02-24

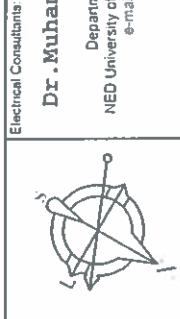
Project:
**Hilton Pharma
Nanotechnology Centre
at NED University**
For:
NED University of Engineering
and Technology, Karachi

Title:
**GROUND FLOOR
LIGHTING LAYOUT**

Scale:	1/8"=1'-0"	Dwg No:	EL-10
Print Date:	14 Feb 2024		
Date:	14 Feb 2024		
Checked:	KA		
Auto File:	NED-19-01		



FIRST FLOOR



Electrical Consultants
Dr. Muhammad Mohsin Aman
Department of Electrical Engineering
NED University of Engineering and Technology, Karachi
e-mail: mohsinaman@gmail.com

Notes:

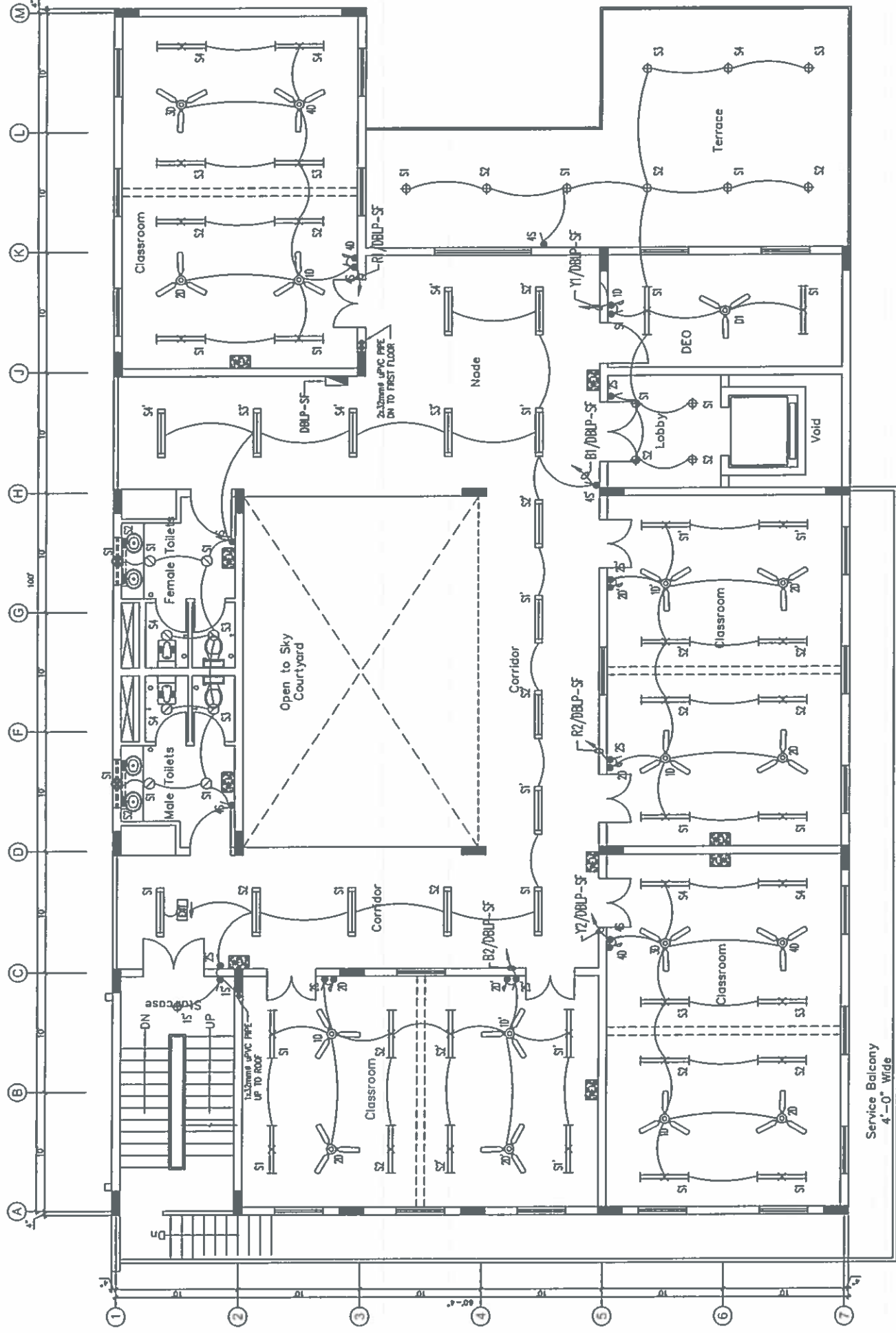
Revisions	
No	Details
01	Issued to Tender
02	Issued to R.F. order

Project
**Hilton Pharma
Nanotechnology Centre
at NED University**
For
NED University of Engineering
and Technology, Karachi

Title
**FIRST FLOOR
LIGHTING LAYOUT**

Scale	1/8"=1'-0"
Print Date	14 Feb 2024
Date	14 Feb 2024
Checked	KA
Job No	NED-19-01

Dwg No
EL-11



SECOND FLOOR



Electrical Consultants

Dr. Muhammad Mohsin Aman
Department of Electrical Engineering
NED University of Engineering and Technology, Karachi
e-mail: mohsinaman@gmail.com

Notes:

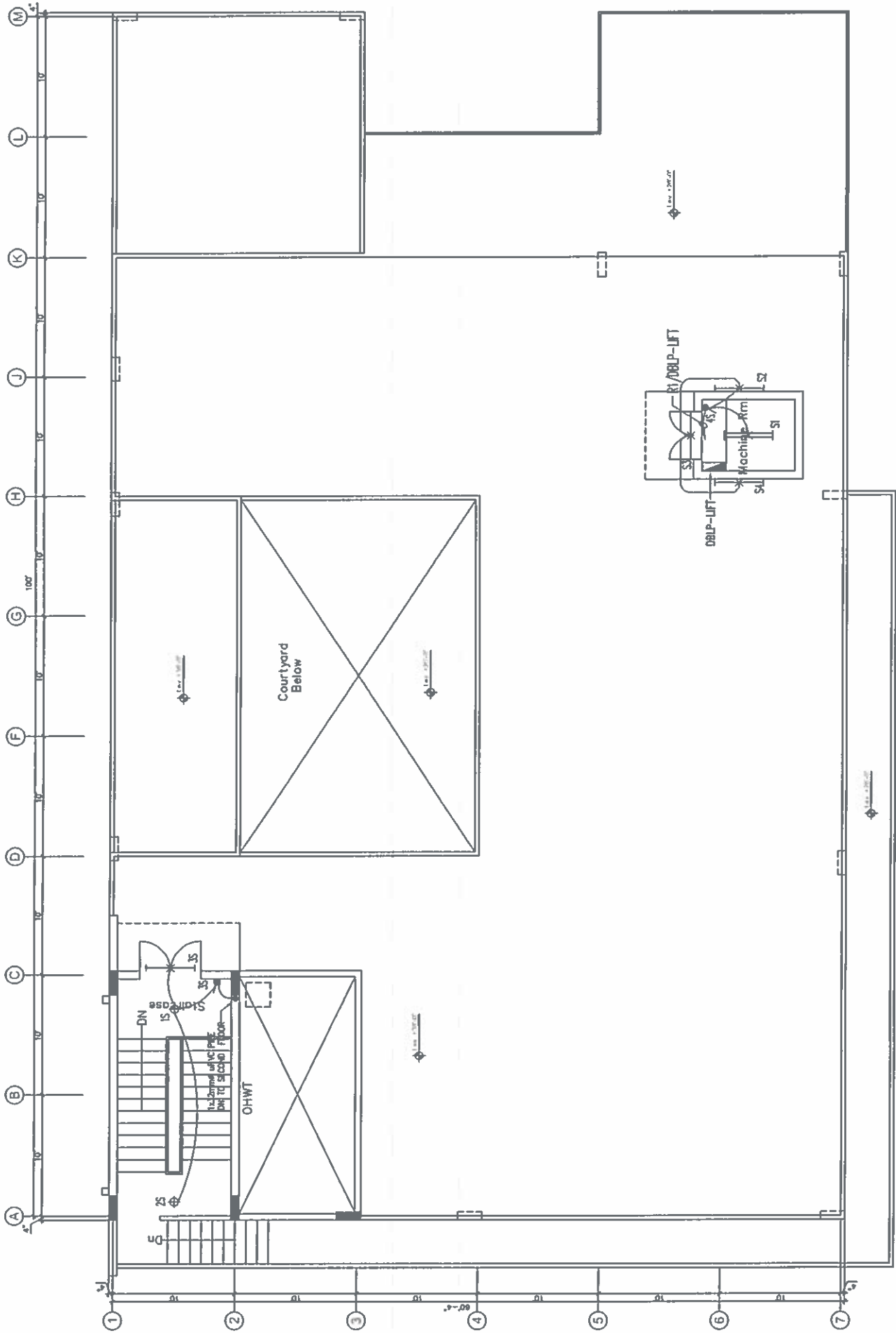
Revisions:

No	Details	Date
01	Issued to Tender	07.03.24
02	Issued to P&T Tender	14.02.24


Project: **Hilton Pharma Nanotechnology Centre at NED University**
NED University of Engineering and Technology, Karachi

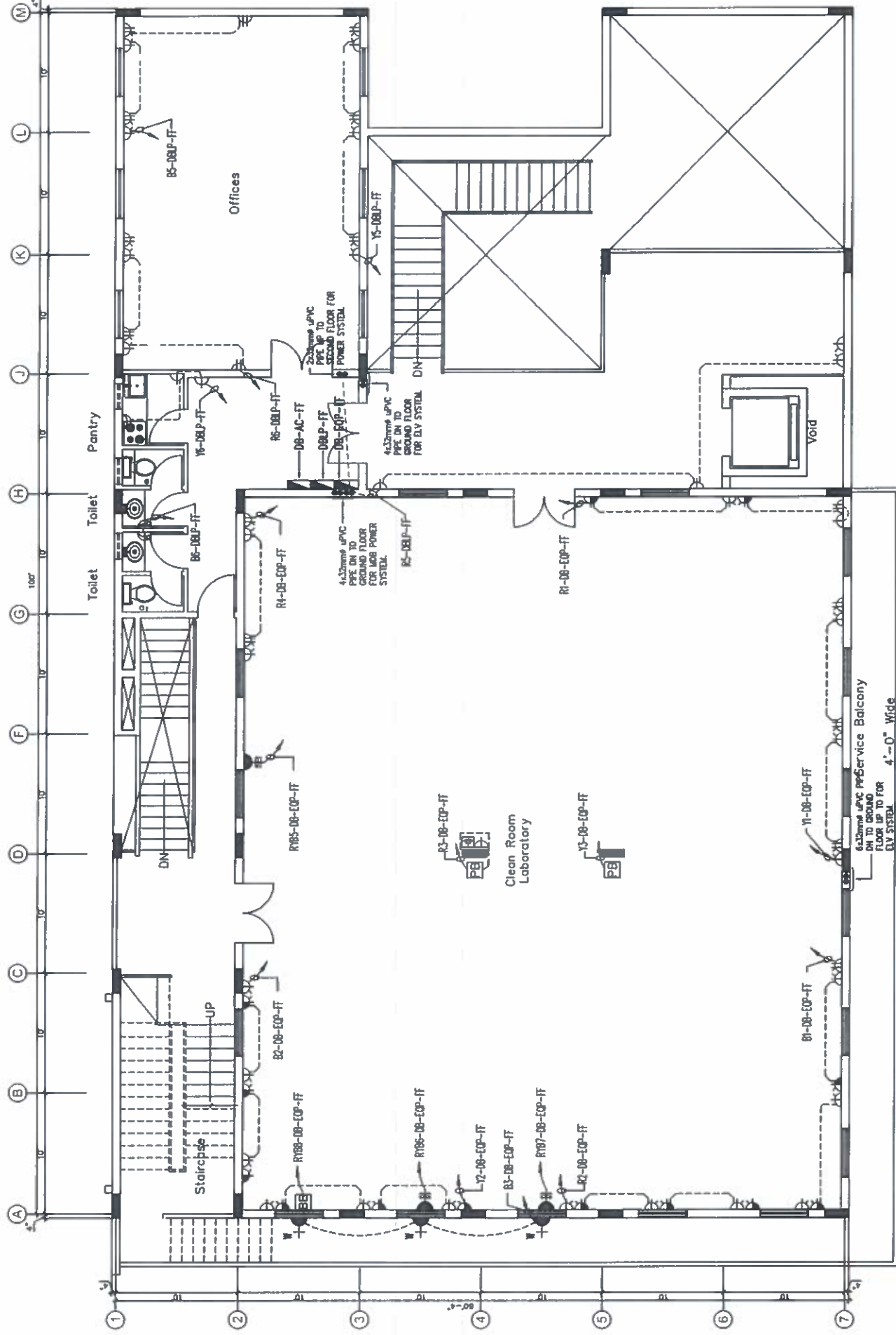
Title: **SECOND FLOOR LIGHTING LAYOUT**

Scale	1/8"=1'-0"	Dwg No	EL-12
Print Date	14 Feb 2024		
Date	14 Feb 2024		
Checked	KA		
Job No	NED-19-01		



ROOF PLAN

	Electrical Consultants Dr. Muhammad Mohsin Anan Department of Electrical Engineering NED University of Engineering and Technology, Karachi e-mail: mohsinanan@gmail.com	Notes	Revisions: <table><thead><tr><th>No</th><th>Details</th><th>Date</th></tr></thead><tbody><tr><td>01</td><td>Issued to Tender</td><td>31.08.23</td></tr><tr><td>02</td><td>Issued to R.F. Tender</td><td>14.02.24</td></tr><tr><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td></tr></tbody></table>	No	Details	Date	01	Issued to Tender	31.08.23	02	Issued to R.F. Tender	14.02.24							Project Hilton Pharma Nanotechnology Centre at NED University For NED University of Engineering and Technology, Karachi	Title ROOF LIGHTING LAYOUT	Scale 1/8"=1'-0"	Dwg No EL-13
				No	Details	Date																
				01	Issued to Tender	31.08.23																
				02	Issued to R.F. Tender	14.02.24																



FIRST FLOOR

Electrical Consultants

Dr. Muhammad Mohsin Aman
Department of Electrical Engineering
NED University of Engineering and Technology, Karachi
e-mail: mohsinaman@gmail.com

Notes

Revisions	
No	Date
01	Issued to Tender
02	Issued to Tender
03	Issued to Tender
04	Issued to Tender
05	Issued to Tender
06	Issued to Tender
07	Issued to Tender
08	Issued to Tender
09	Issued to Tender
10	Issued to Tender

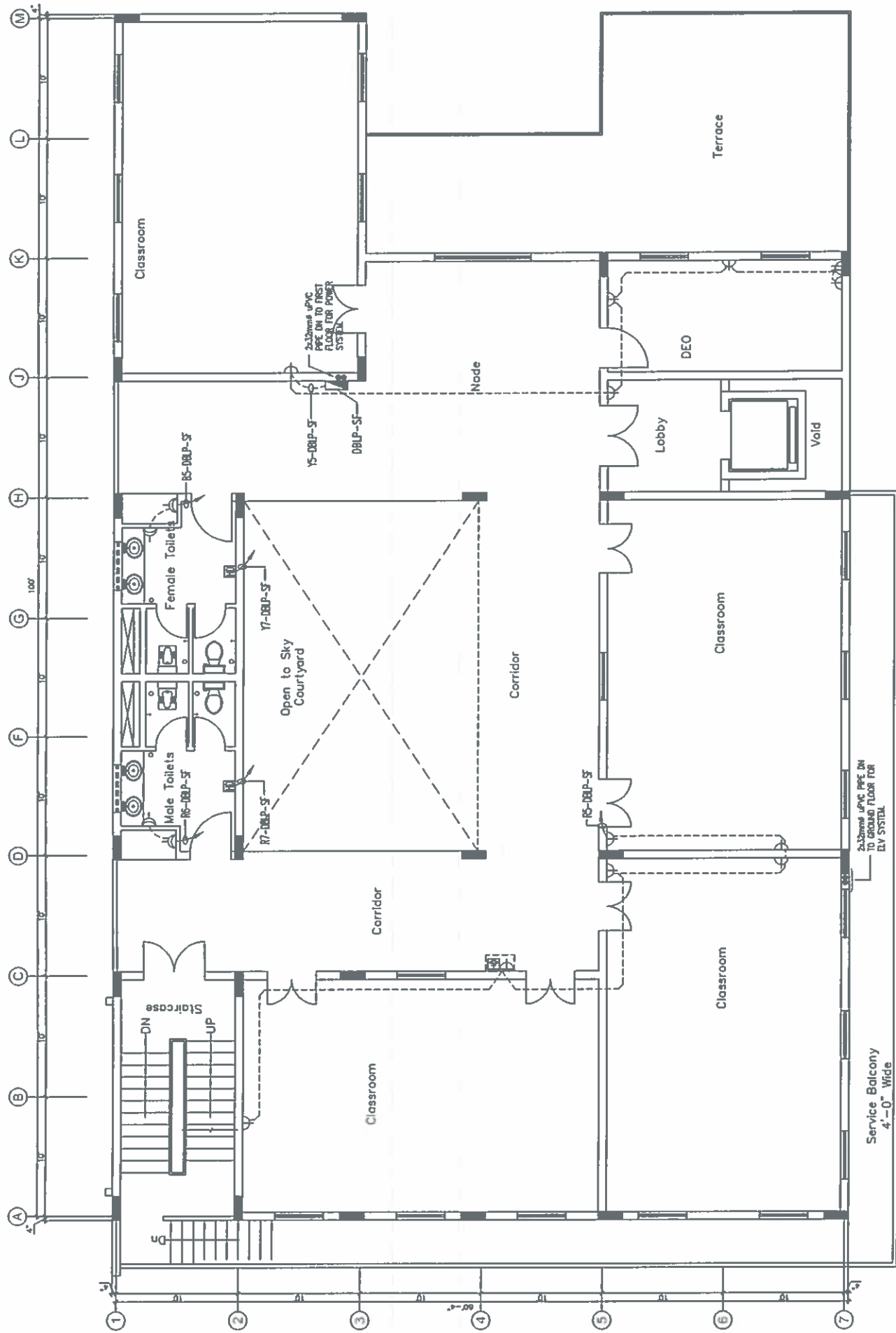
Project: Hilton Pharma Nanotechnology Centre at NED University
For: NED University of Engineering and Technology, Karachi

Title: FIRST FLOOR SMALL POWER LAYOUT


Scale:	1/8"=1'-0"
Print Date:	14 Feb 2024
Date:	14 Feb 2024
Checked:	KA
Job No:	NED-19-01

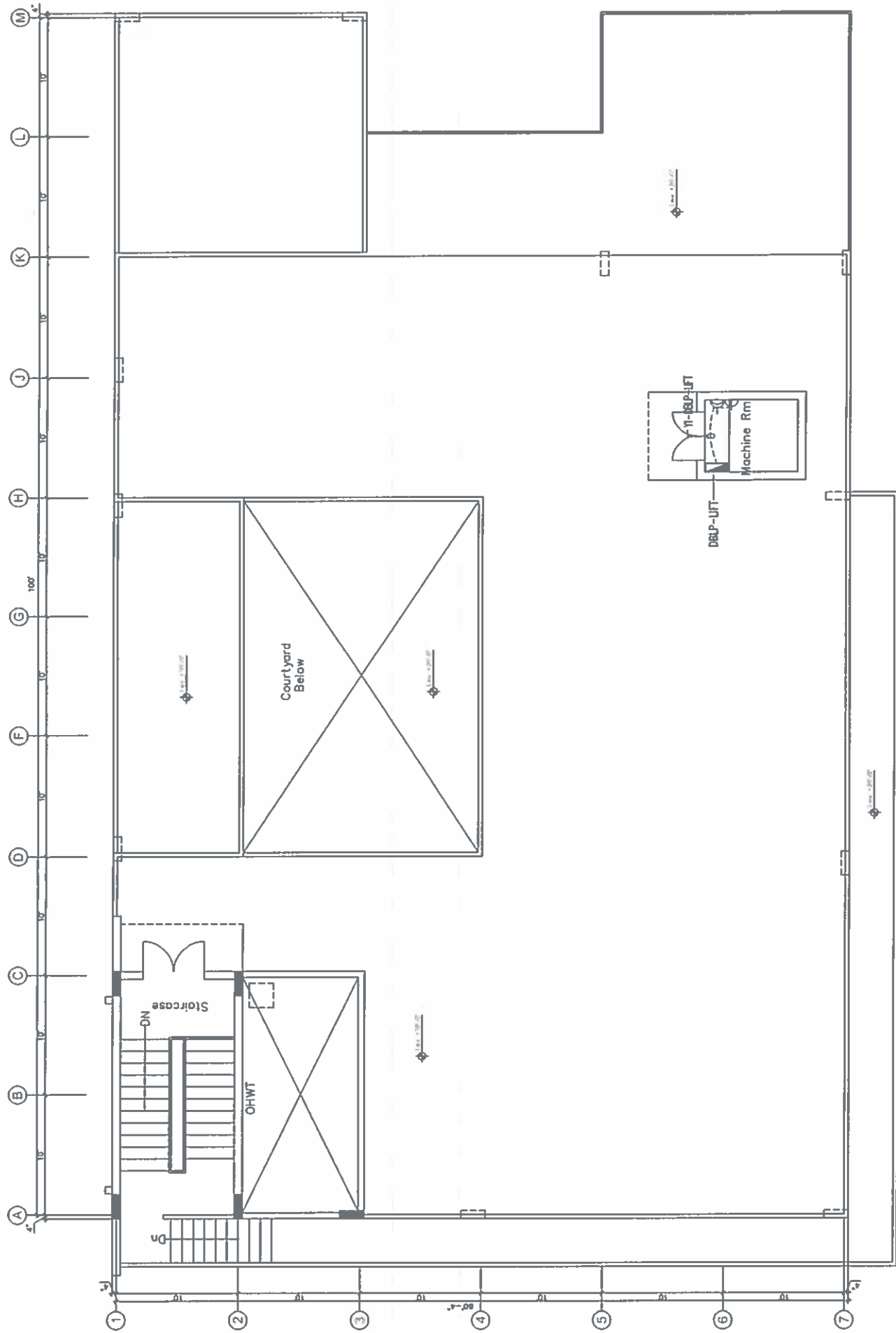
Dwg No

EL-15



SECOND FLOOR

	Electrical Consultant Dr. Muhammad Mohsin Anan Department of Electrical Engineering NED University of Engineering and Technology, Karachi e-mail: muhstamam@gmail.com	Notes	Revisions		Project Hilton Pharma Nanotechnology Centre at NED University For NED University of Engineering and Technology, Karachi	Title SECOND FLOOR SMALL POWER LAYOUT	Scale 1/8"=1'-0"	Draw No. EL-16
			No	Details			Date	Print Date
			01	Issued to Tender			31.03.24	14 Feb 2024
			02	Issued to Tender			14.02.24	14 Feb 2024
			Checked	KA	Job No	NED-19-01		



ROOF PLAN



Electrical Consultants
Dr. Muhammad Mohsin Aman
Department of Electrical Engineering
NED University of Engineering and Technology, Karachi
e-mail: mohstamam@gmail.com

Notes

Revisions	
No	Details
01	Issued to T. order
02	Issued to T. order

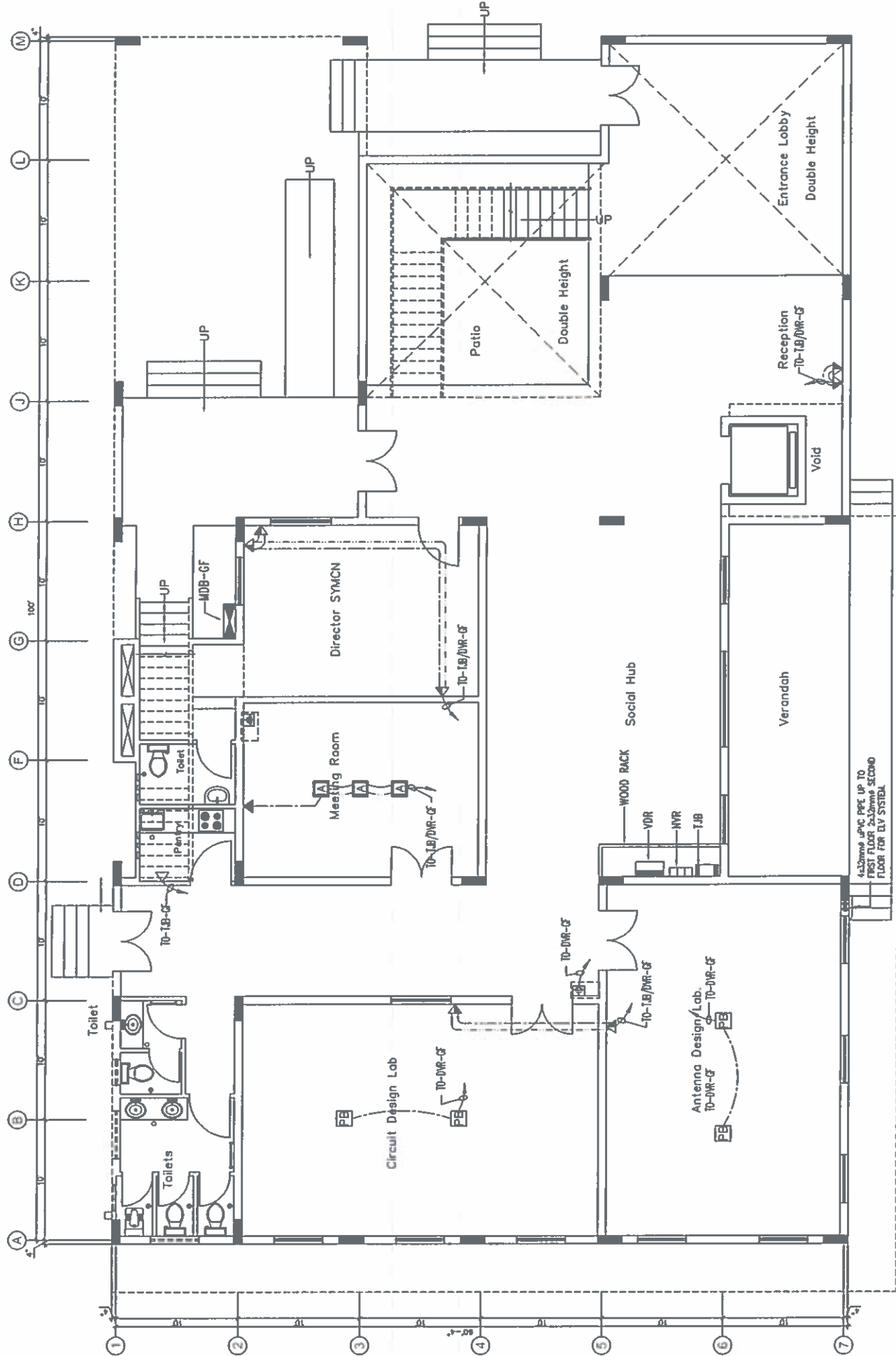
Project:
**Hilton Pharma
Nanotechnology Centre
at NED University**
For
**NED University of Engineering
and Technology, Karachi**

Title
**ROOF
SMALL POWER
LAYOUT**


Scale	1/8"=1'-0"
Print Date	14 Feb 2024
Date	14 Feb 2024
Checked	KA
Job No	NED-19-01

Dwg No

EL-17



GROUND FLOOR



Electrical Contributor:

Dr. Muhammad Mohsin Aman
Department of Electrical Engineering
NED University of Engineering and Technology, Karachi
e-mail: mohsinaman@gmail.com

Notes:

Revisions:

No	Details	Date
01	Issued to Tender	27-10-20
02	Issued to Ref tender	14-02-24

Project

Hilton Pharma
Nanotechnology Centre
at NED University

For
NED University of Engineering
and Technology, Karachi

Title

GROUND FLOOR
TELEPHONE & DATA
LAYOUT

Scale:

1/8"=1'-0"

Print Date

25 Sep 2020

Date

25 Sep 2020

Checked:

KA

Job No

NED-19-01

Dwg No

EL-18



Dr. Muhammad Mohsin Aman
Department of Electrical Engineering
NED University of Engineering and Technology, Karachi
e-mail: mohsinaman@neda.edu.pk

Notes

[illegible]

Revisions:

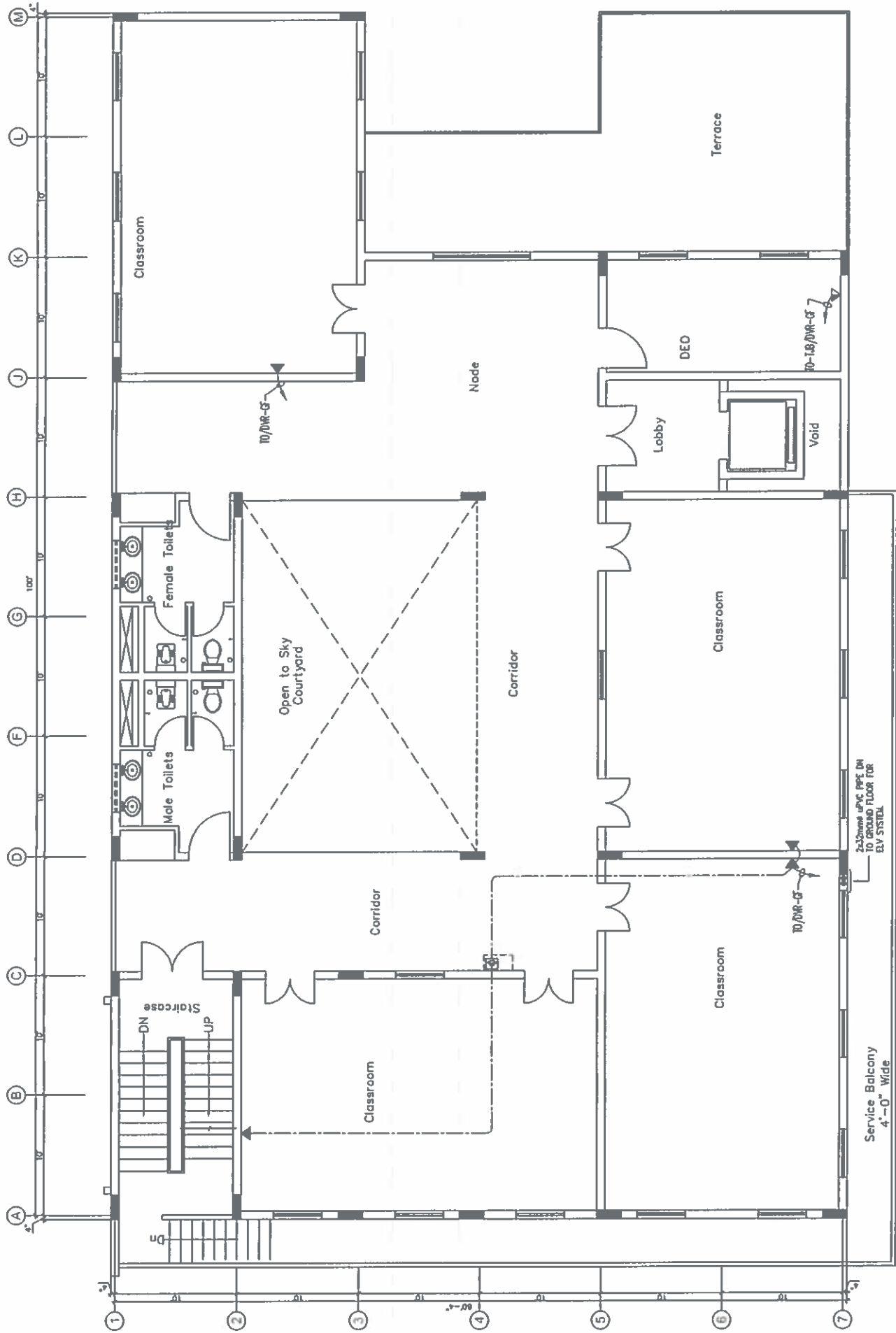
Project: **Hilton Pharma
Nanotechnology Centre
at NED University**
For: **NED University of Engineering
and Technology, Karachi**

**First Floor
Telephone & Data
Layout**

Scale	1/8"=1'-0"	Dwg. No.
-------	------------	----------

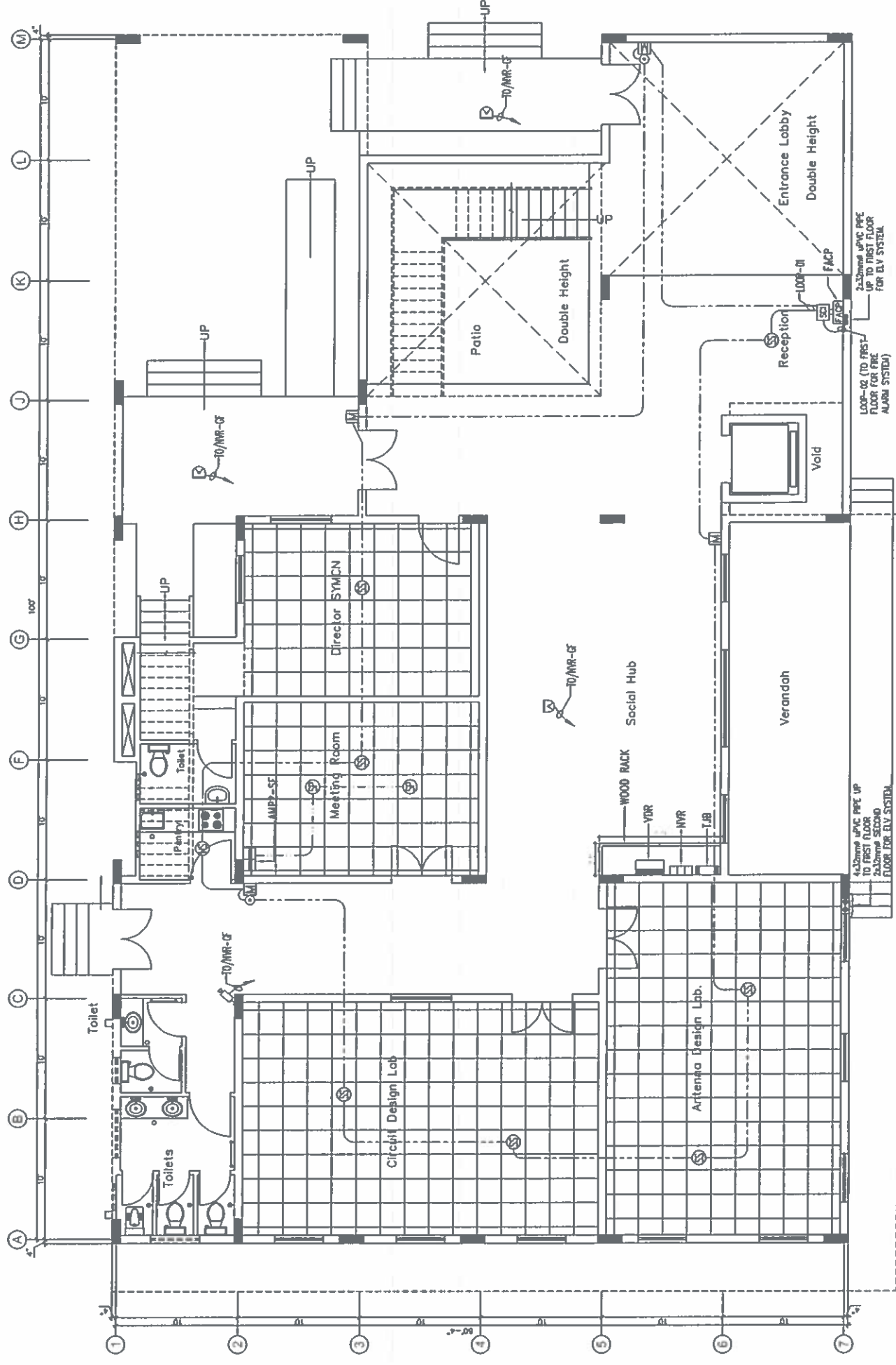
Scale	1/8"=1'-0"
Print Date	25 Sep 2020
Date	25 Sep 2020
Checked	KA
Job No.	NED-19-01

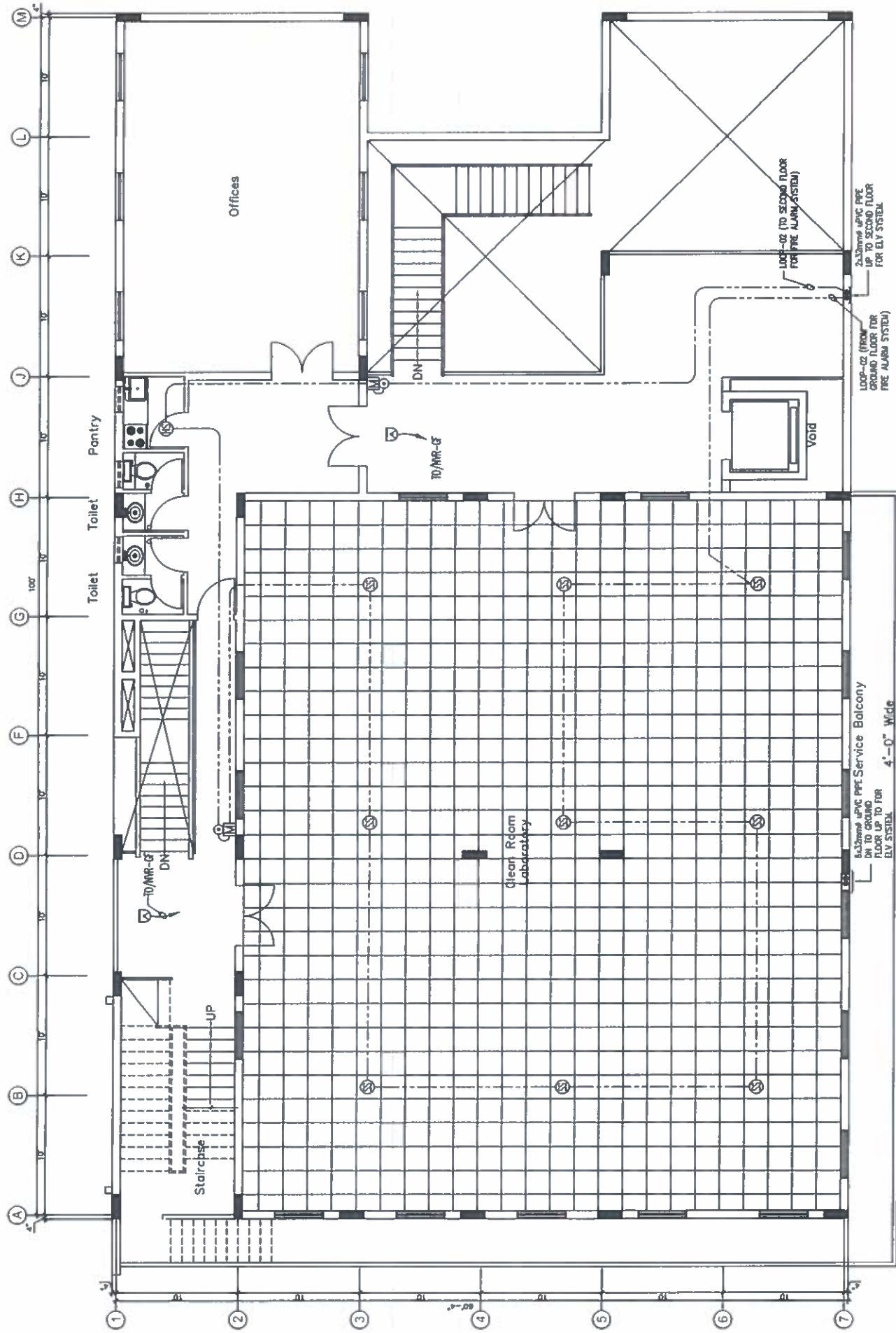
EL-19




SECOND FLOOR

	Electrical Consultants Dr. Muhammad Mohsin Aman Department of Electrical Engineering NED University of Engineering and Technology, Karachi e-mail: mohsinaman@gmail.com	Notes	Revisions: <table><tr><th>No</th><th>Details</th><th>Date</th></tr><tr><td>01</td><td>Issued for Tender</td><td>17-08-24</td></tr><tr><td>02</td><td>Issued for R.F. Number</td><td>14-02-24</td></tr><tr><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td></tr></table>	No	Details	Date	01	Issued for Tender	17-08-24	02	Issued for R.F. Number	14-02-24							Project: Hilton Pharma Nanotechnology Centre at NED University For: NED University of Engineering and Technology, Karachi	Title: SECOND FLOOR TELEPHONE & DATA LAYOUT	Scale: 1/8"=1'-0"	Dwg No. EL-20
				No	Details	Date																
				01	Issued for Tender	17-08-24																
				02	Issued for R.F. Number	14-02-24																





FIRST FLOOR



Dr. Muhammad Mohsin Aman

Department of Electrical Engineering

NED University of Engineering and Technology, Karachi

e-mail: mohsinaman@gmail.com

Notes

Revisions:

No	Details	Date
01	Issued to Tender	07.10.20
02	Issued to RfI Issue	14.02.24

Project:

Hilton Pharma
Nanotechnology Centre
at NED University

For
NED University of Engineering
and Technology, Karachi

Title:

FIRST FLOOR
FIRE ALARM & CCTV
SYSTEM LAYOUT

Scale:

1/8"=1'-0"

Drawn No

EL-22

Print Date

14 Feb 2024

Date

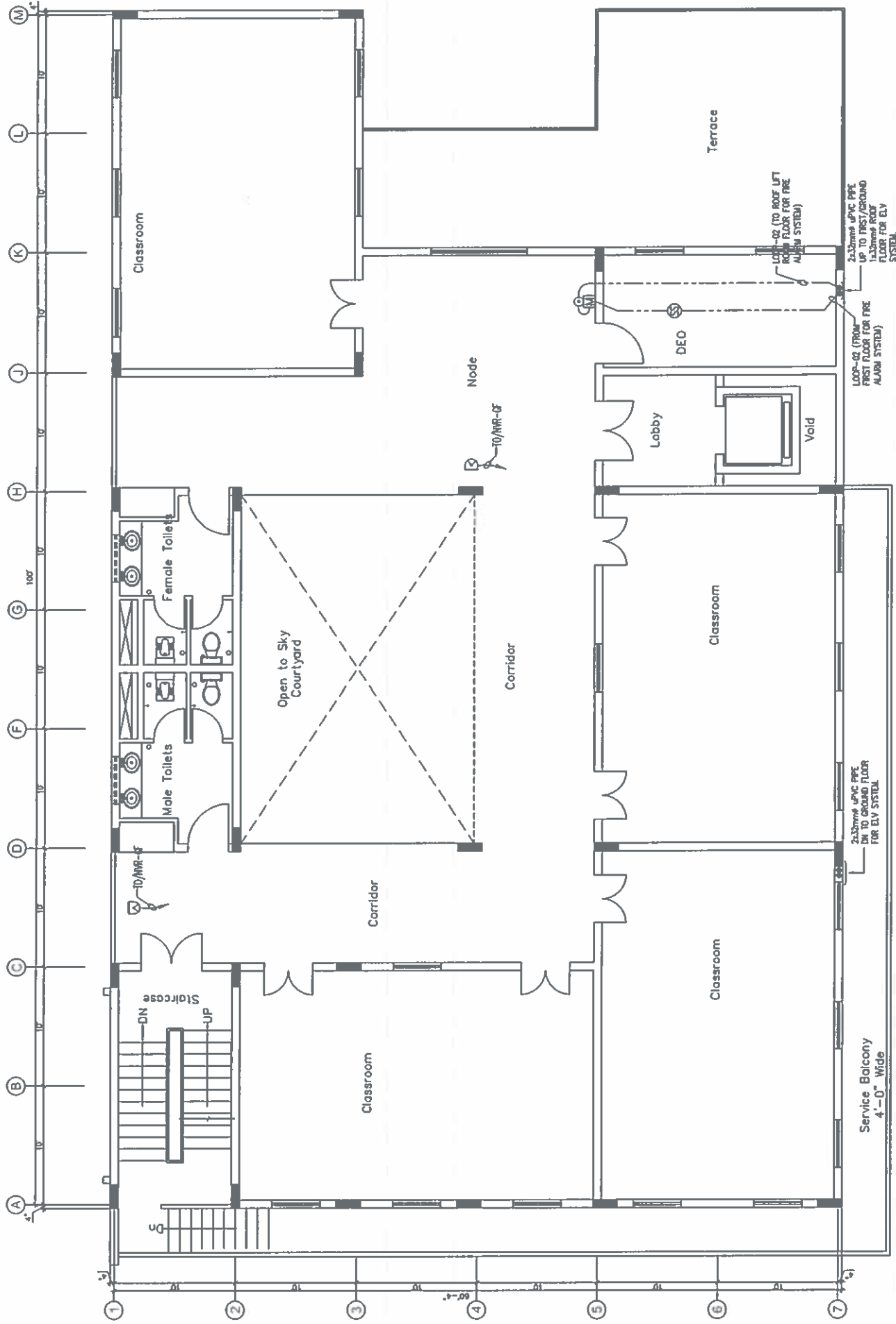
14 Feb 2024

Checked

KA

Job No

NED-19-01



SECOND FLOOR



Electrical Consultants
Dr. Muhammad Mohsin Aman
Department of Electrical Engineering
NED University of Engineering and Technology, Karachi
e-mail: mohsinaman@gmail.com

Notes

Revisions:

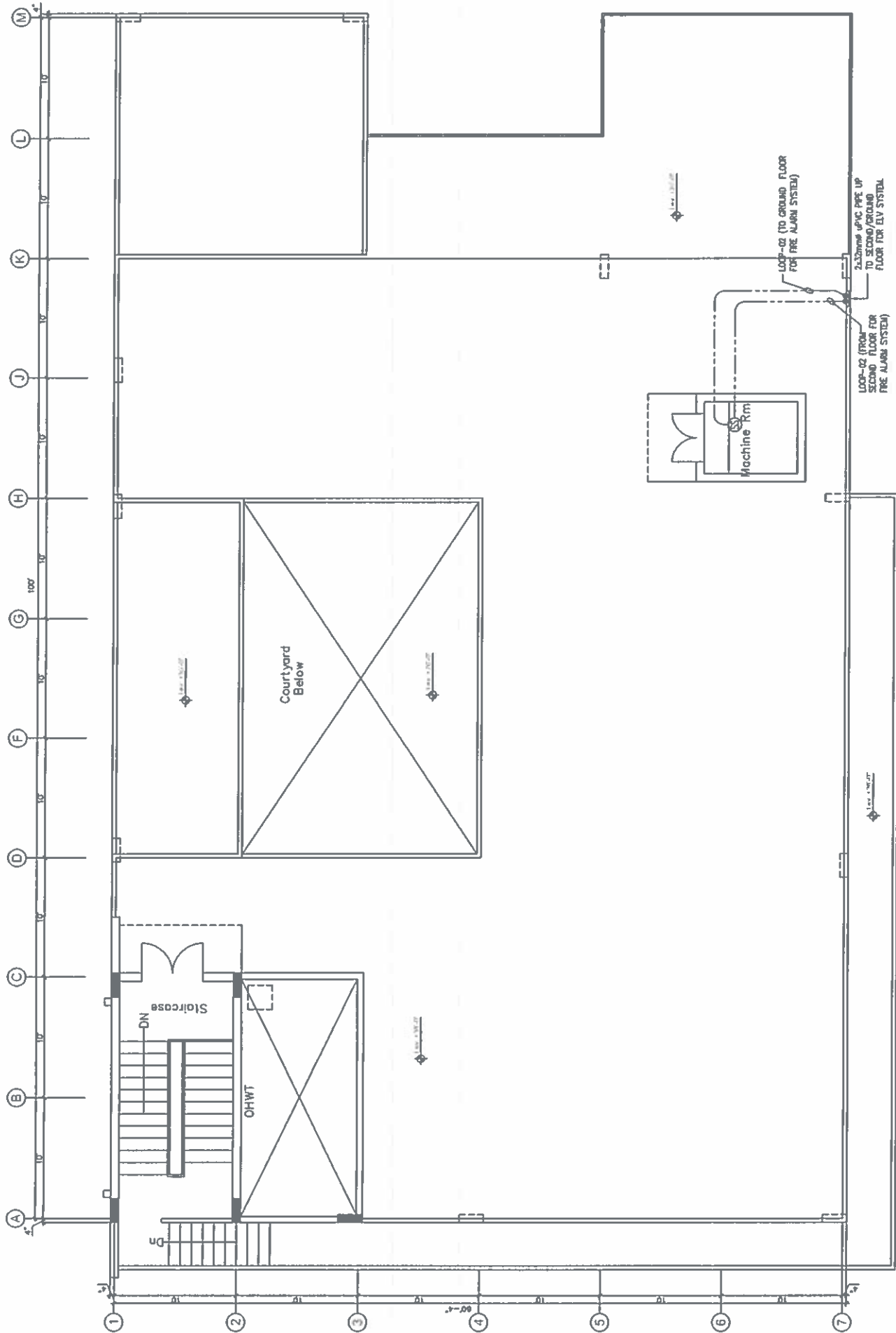
No	Details	Date
01	Revised to Tender	27.03.20
02	Revised to R.F.T. order	14.02.24

Project:
**Hilton Pharma
Nanotechnology Centre
at NED University**
NED University of Engineering
and Technology, Karachi


Title:
**SECOND FLOOR
FIRE ALARM & CCTV
SYSTEM LAYOUT**

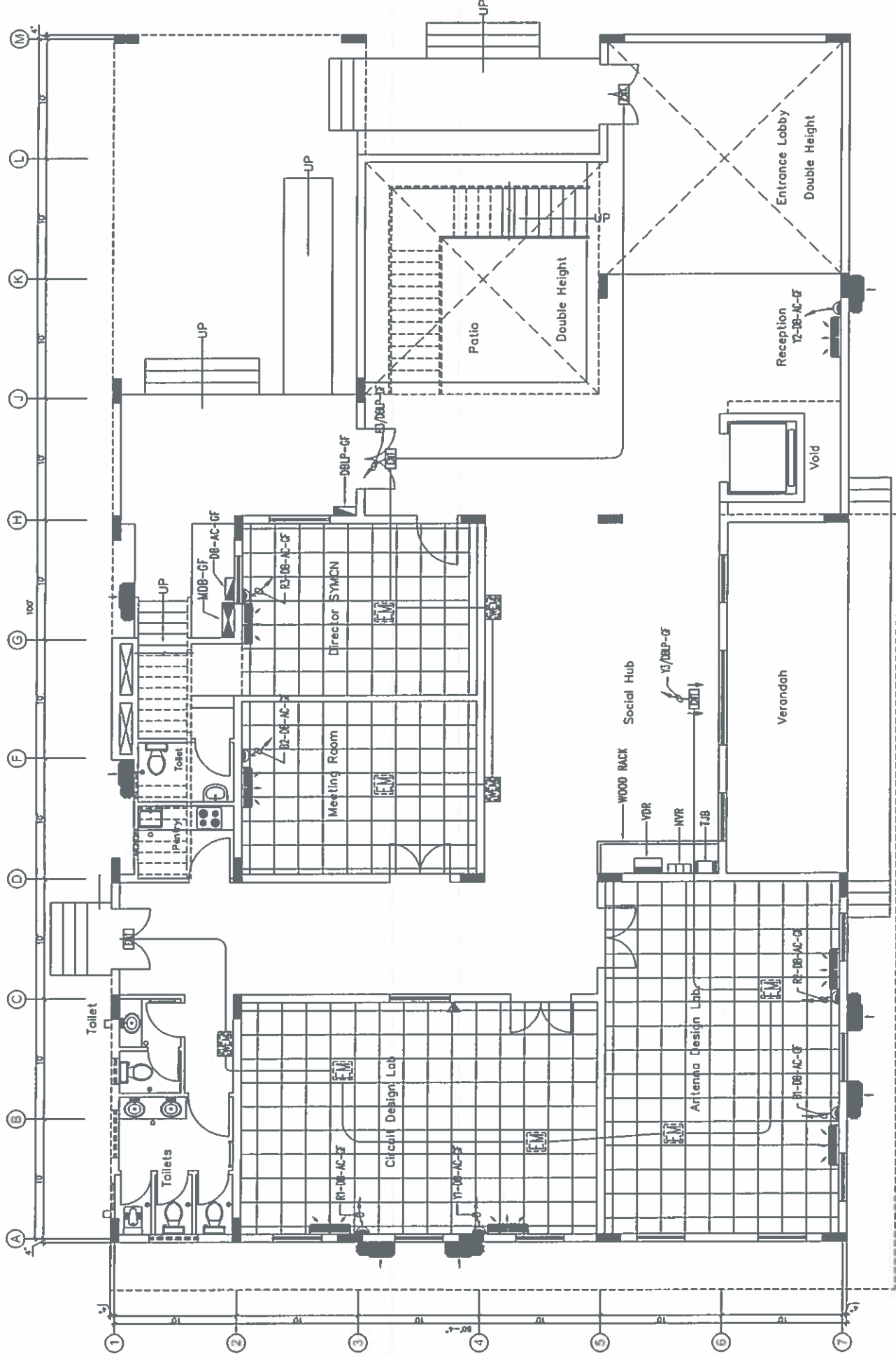
Scale:	1/8"=1'-0"	Dwg No
Print Date:	14 Feb 2024	
Date:	14 Feb 2024	
Checked:	KA	
Job No	NED-19-01	

EL-23




ROOF PLAN

	Electrical Consultants Dr. Muhammad Mohsin Aman Department of Electrical Engineering NED University of Engineering and Technology, Karachi e-mail: mohsinaman@gmail.com	Notes	Revisions: <table border="1"><thead><tr><th>No</th><th>Details</th><th>Date</th></tr></thead><tbody><tr><td>01</td><td>Issued to Tender</td><td>07.10.23</td></tr><tr><td>02</td><td>Issued to Refender</td><td>14.02.24</td></tr><tr><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td></tr></tbody></table>	No	Details	Date	01	Issued to Tender	07.10.23	02	Issued to Refender	14.02.24													Project Hilton Pharma Nanotechnology Centre at NED University	Title ROOF FIRE ALARM SYSTEM LAYOUT	Scale 1/8"=1'-0"	Dwg No EL-24
				No	Details	Date																						
01	Issued to Tender	07.10.23																										
02	Issued to Refender	14.02.24																										
				Print Date 14 Feb 2024	Date 14 Feb 2024	Checked KA	Job No NED-19-01																					



GROUND FLOOR



Electrical Consultants:

Dr. Muhammad Mohsin Aman
Department of Electrical Engineering
NED University of Engineering and Technology, Karachi
e-mail: mohsinaman@gmail.com

Notes:

Revisions:

No	Date
01	17.10.20
02	14.02.24

Project:

Hilton Pharma
Nanotechnology Centre
at NED University

Title:

GROUND FLOOR
EMERGENCY LIGHTING
& A.C LAYOUT

Scale:

1/8"=1'-0"

Print Date:

14 Feb 2024

Date:

14 Feb 2024

Checked:

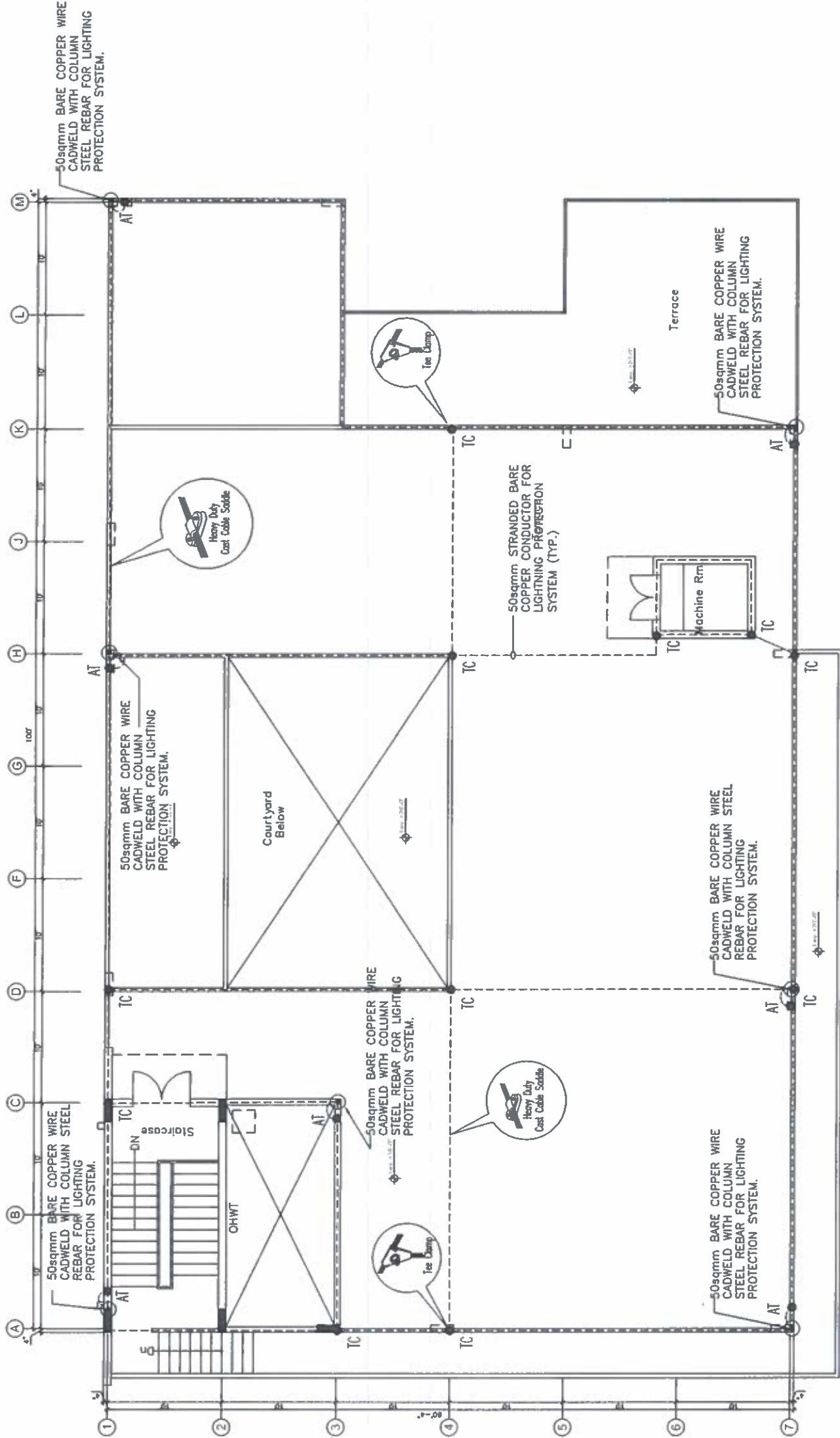
KA

Job No:

NED-19-01

Dwg. No.

EL-25



ROOF PLAN



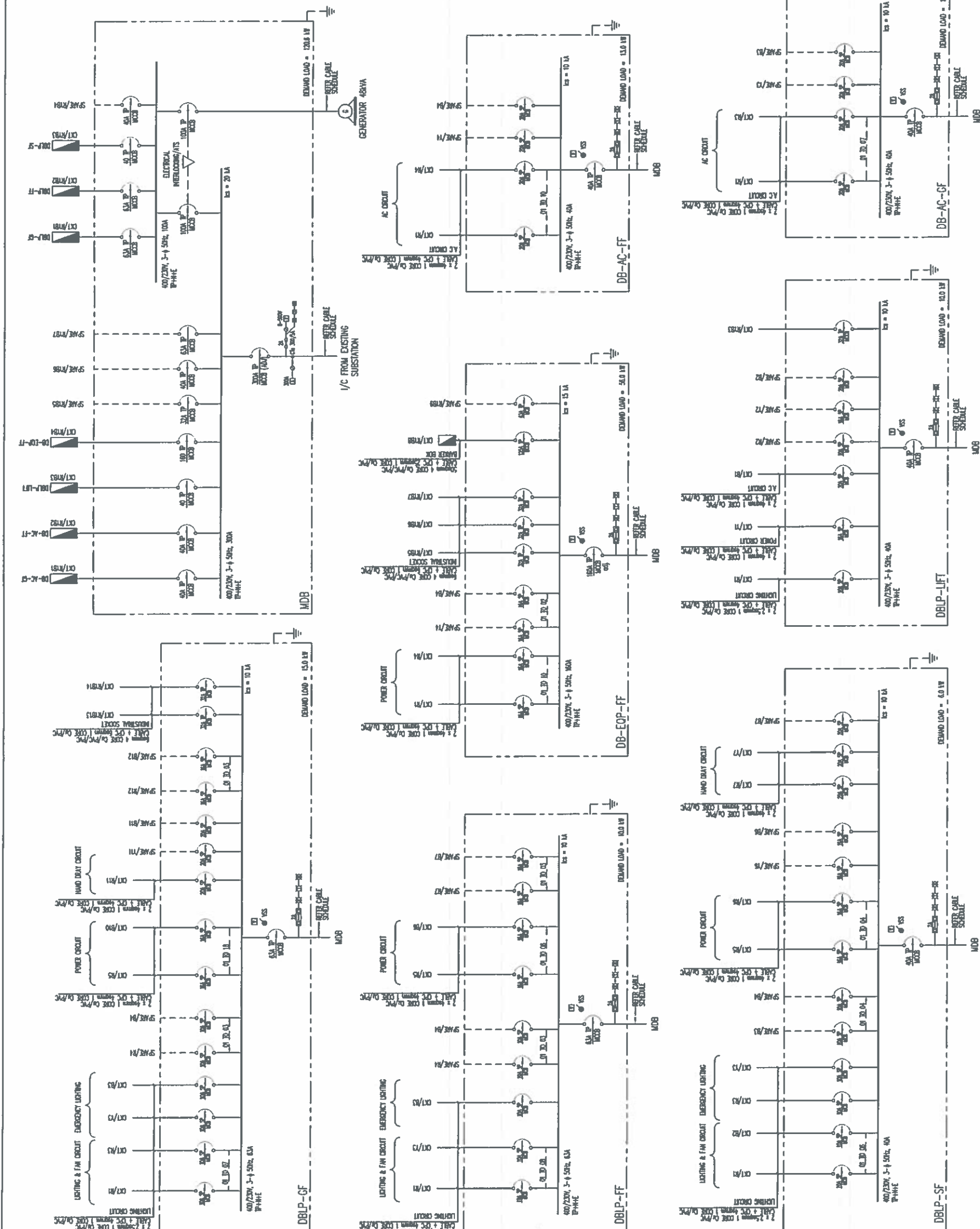
Dr. Muhammad Mohsin Aman
Department of Electrical Engineering
NED University of Engineering and Technology, Karachi
e-mail: mohsinaman@gmail.com


Revisions	
No	Date
01	17.10.20
02	14.02.24
03	14.02.24

Project
Hilton Pharma
Nanotechnology Centre
at NED University
For NED University of Engineering
and Technology, Karachi

Title
ROOF
LIGHTNING
PROTECTION

Scale:	1/8"=1'-0"	Dwg No	EL-30
Print Date:	14 Feb 2024		
Date:	14 Feb 2024		
Checked:	KA		
Job No	NED-19-01		





Electrical Consultants

Dr. Muhammad Mohsin Anan
Department of Electrical Engineering
NED University of Engineering and Technology, Karachi
e-mail: mohsinanan@gmail.com

Revisions:

No	Details	Date
01 <td>Issued to Tender</td> <td>07.10.20</td>	Issued to Tender	07.10.20
02 <td>Issued to Refinement</td> <td>14.02.21</td>	Issued to Refinement	14.02.21

Project:

Hilton Pharma
Nanotechnology Centre
at NED University

For:
NED University of Engineering
and Technology, Karachi

Title

SINGLE LINE
DIAGRAM

Scale

N.T.S

Drawn By

N.T.S

Checked By

K.A

Date

14 Feb 2024

Print Date

14 Feb 2024

Dwg No

EL-31

[illegible]

SHEET NO: 1		PROJECT: NED Nano Technology		PREPARED DATE: September 25, 2020	
FLOOR: Ground Floor				LAST UPDATED: February 15, 2024	
DB NAME: DA-AC-02					
NED FROM: A09				40A/PACB	
P CLASS: REFER SPECS				AC 1 (0.01mm Al/PVC) + 1C 1.01mm Cu ECC	
INSTRUMENT: REFER SINGLE LINE				BOTTOM/TOP	

LOCATION: CORRIDOR		RATING OF INCOMING CB: 40A/PACB	
MOUNTING: RECESSED		RATING OF INCOMING CABLE: AC 1 (0.01mm Al/PVC) + 1C 1.01mm Cu ECC	
CABLE ENTRY: BOTTOM		CABLE EXT: BOTTOM/TOP	
EXT (A): 10			

SL. #	CIR. #	CIR. DESCRIPTION	ICB Rating (30mA sensitivity)		ACS Rating	CIR. Rating CU/PVC	ICC WIRE SIZE CU/PVC	LIGHTING				CONNECTED LOADS (WATT)					LOAD PER CIRCUIT		REMARKS			
			12W	40W				Smart LED Panel (232)/2x18 (40W)	Emergency Light	Exit Light	Chromatic Fan	15A Outlet (100W)	13A Duplex	3-1in Universal Switch Socket	16A 3Pin Switch Socket	1.5 Ton Split AC	2.2 Ton Split AC	8		Y	W	
1	R11	AC Power	20	SP	4	4											1	0	2,250	0		
2	Y11	AC Power	20	SP	4	4												1	0	2,250	0	
3	B11	AC Power	20	SP	4	4													1	2,250	0	
4	R12	AC Power	20	SP	4	4													1	2,250	0	
5	Y12	AC Power	20	SP	4	4													1	0	0	2,250
6	B12	AC Power	20	SP	4	4													1	2,250	0	0
7	R13	AC Power	20	SP	4	4													1	0	2,250	0
8	Y13	Spare	20	SP	4	4													0	0	0	0
9	B13	Spare	20	SP	4	4													0	0	0	0

TOTAL		(Watt): 4,500		(kW): 0.75		C.L TOTAL (kW): 15.75	
TOTAL DEMAND		C.L TOTAL (kW): 15.75		LOAD (kW): 11			

C.L (Met)		Diversity Factor		Diversified Load (kW)	
AC/Plumbing pump Load		0.6		9.6	
T.L.DF LOAD (kW)		0.6		9.6	
10% SPARE CAPACITY					

	Electrical Consultants. Dr. Muhammad Mohsin Aman Department of Electrical Engineering NED University of Engineering and Technology, Karachi e-mail: mohsinaman@gmail.com	Notes:	Revisions: <table border="1"> <thead> <tr> <th>No</th> <th>Details</th> <th>Date</th> </tr> </thead> <tbody> <tr> <td>01</td> <td>Issued to Tender</td> <td>17.08.20</td> </tr> <tr> <td>02</td> <td>Issued to Rf Tender</td> <td>14.02.24</td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> </tbody> </table>	No	Details	Date	01	Issued to Tender	17.08.20	02	Issued to Rf Tender	14.02.24													Project: Hilton Pharma Nanotechnology Centre at NED University For: NED University of Engineering and Technology, Karachi	Title: DB SCHEDULES (SHEET 01 OF 03)	Scale: N T S	Dwg. No.
	No	Details		Date																								
01	Issued to Tender	17.08.20																										
02	Issued to Rf Tender	14.02.24																										
Print Date: 14 Feb 2024 Date: 14 Feb 2024 Checked: K.A Job No: NED-19-01																												

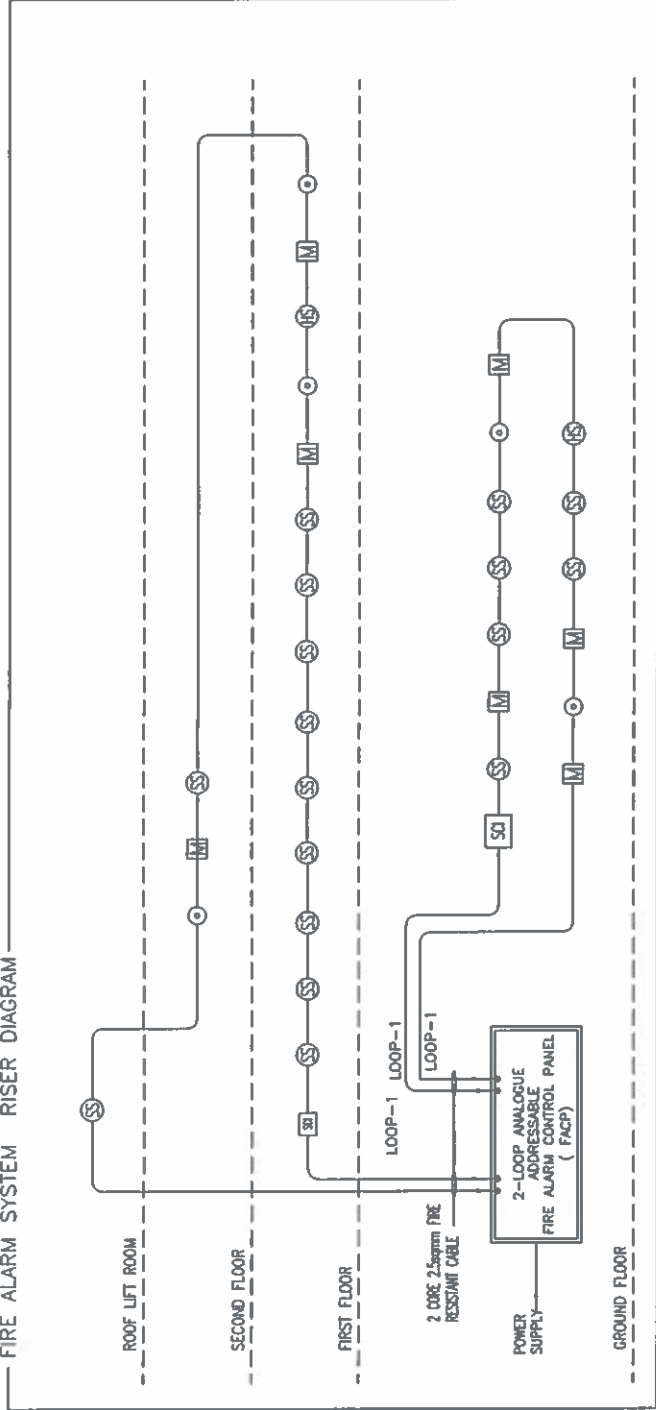
SHEET NO	1	PREPARED DATE	September 25, 2020
PROJECT	NED Neurotechnology	LAST UPDATED:	February 13, 2024
FLOOR	First Floor		
DB NAME	DB-EOP-FF	RATING OF INCOMING CB	160A(P)NCE(B)AdJ
		RATING OF INCOMING CABLE	4X1C-95gmm Cu(Pvc)Pvc • 1C 50
FED FROM:	MD8	CABLE EXIT	1gmm or ECC
IF CLASS	REFER SPECS		BOTTOM TOP
INSTRUMENT	REFER SINGLE LINE		

S#	CIR. #	CIR. DESCRIPTION	RC30 Rating (Junk Sensitivity)	ACB/MCB Rating	CIR. Baking Cu/PVC	ECC WIRE Cu/PVC	CONNECTED LOADS / POINT										LOAD PER CIRCUIT		REMARKS
							Equipment				Socket						1.5 Ton Split AC		
							Oven	Reactive Ion etching	Vacuum Thermal Evaporation	Air Filter	15A Outlets (Inlet)	13A Switch socket	13A Duplex socket	3-Pin Universal Socket	2Pin Socket	16A 2Pin Schuko socket			
			Amp	Amp	mm2	mm2	7,500W	15,000W	50,000W	500W	500W	100	200W	100W	150W	2,250W	Watt		

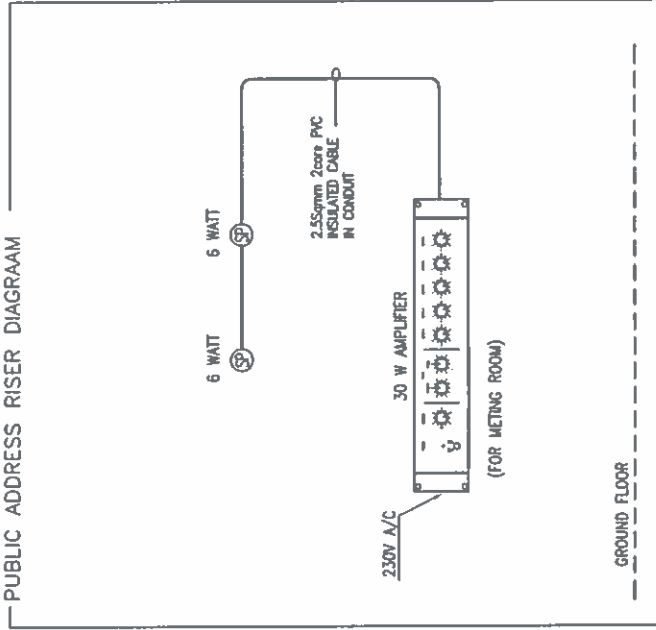
[illegible][illegible][illegible][illegible][illegible][illegible][illegible]

<p>Project Hilton Pharma Nanotechnology Centre at NED University NED University of Engineering and Technology, Karachi</p>	Title		Dwg No	
	DB SCHEDULES (SHEET 03 OF 03)			
	Scale	N.T.S		
	Print Date	14 Feb 2024		
	Date	14 Feb 2024		
Checked		K.A		
Join No		NED-19-01		

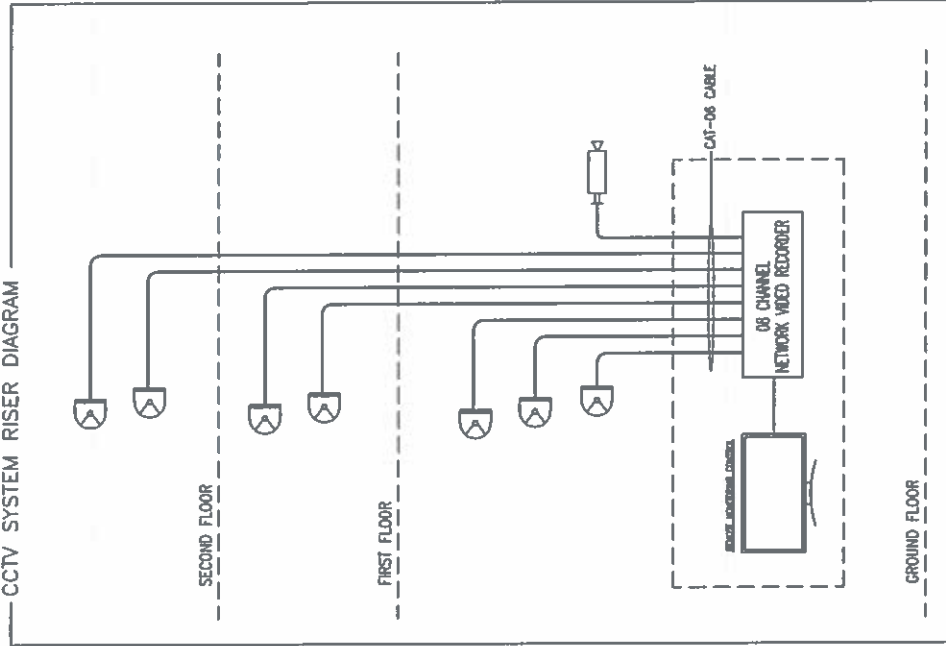
FIRE ALARM SYSTEM RISER DIAGRAM



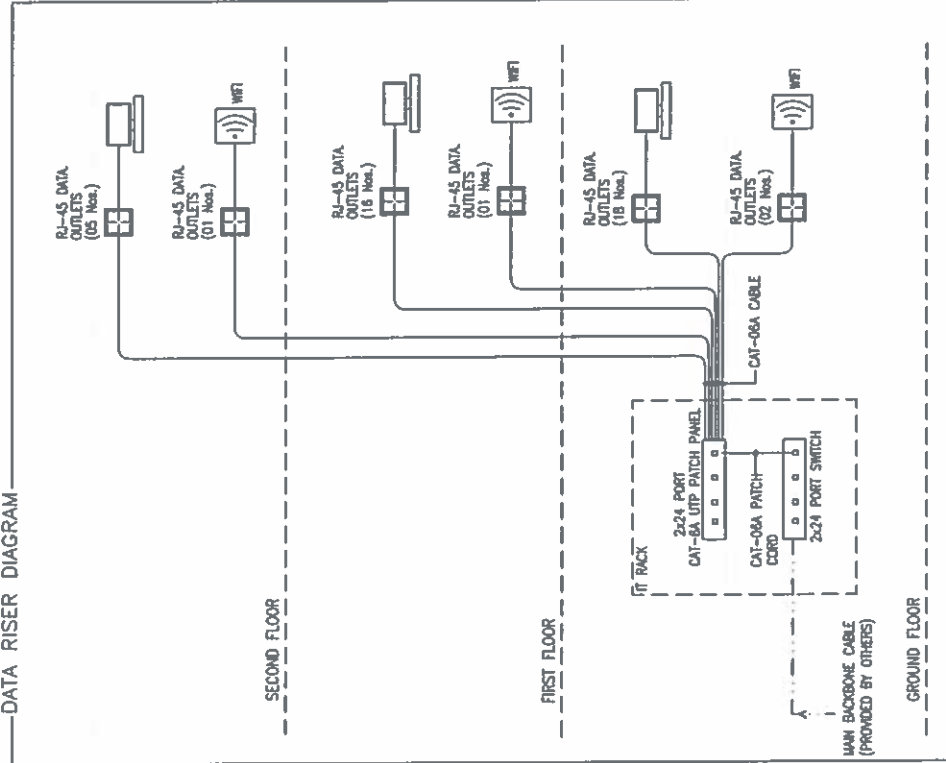
PUBLIC ADDRESS RISER DIAGRAM



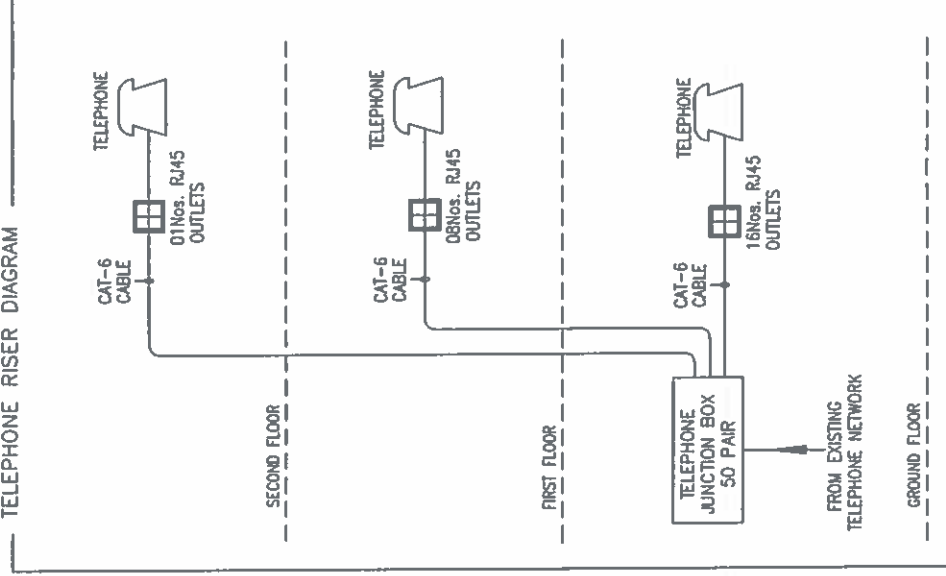
CCTV SYSTEM RISER DIAGRAM



DATA RISER DIAGRAM



TELEPHONE RISER DIAGRAM



Electrical Consultants:

Dr. Muhammad Mohsin Aman
Department of Electrical Engineering
NED University of Engineering and Technology, Karachi
e-mail: mohsinaman@gmail.com

Notes

Revisions

No	Details	Date
01	Issued to Tender	17.10.23
02	Issued to Ref order	14.02.24

Project:

Hilton Pharma
Nanotechnology Centre
at NED University
For
NED University of Engineering
and Technology, Karachi

Title

**TELEPHONE, DATA,
CCTV, & FIRE ALARM
SYSTEM RISERS
DIAGRAMS**

Scale: N.T.S

Print Date: 14 Feb 2024

Date: 14 Feb 2024

Checked: K.A

Job No: NED-19-01

Dwg No:

EL-35

PLUMBING TENDER DRAWINGS

CONSTRUCTION OF HILTON PHARMA NANO TECHNOLOGY CENTRE (Remaining Works)

NED University of Engineering and Technology, Karachi

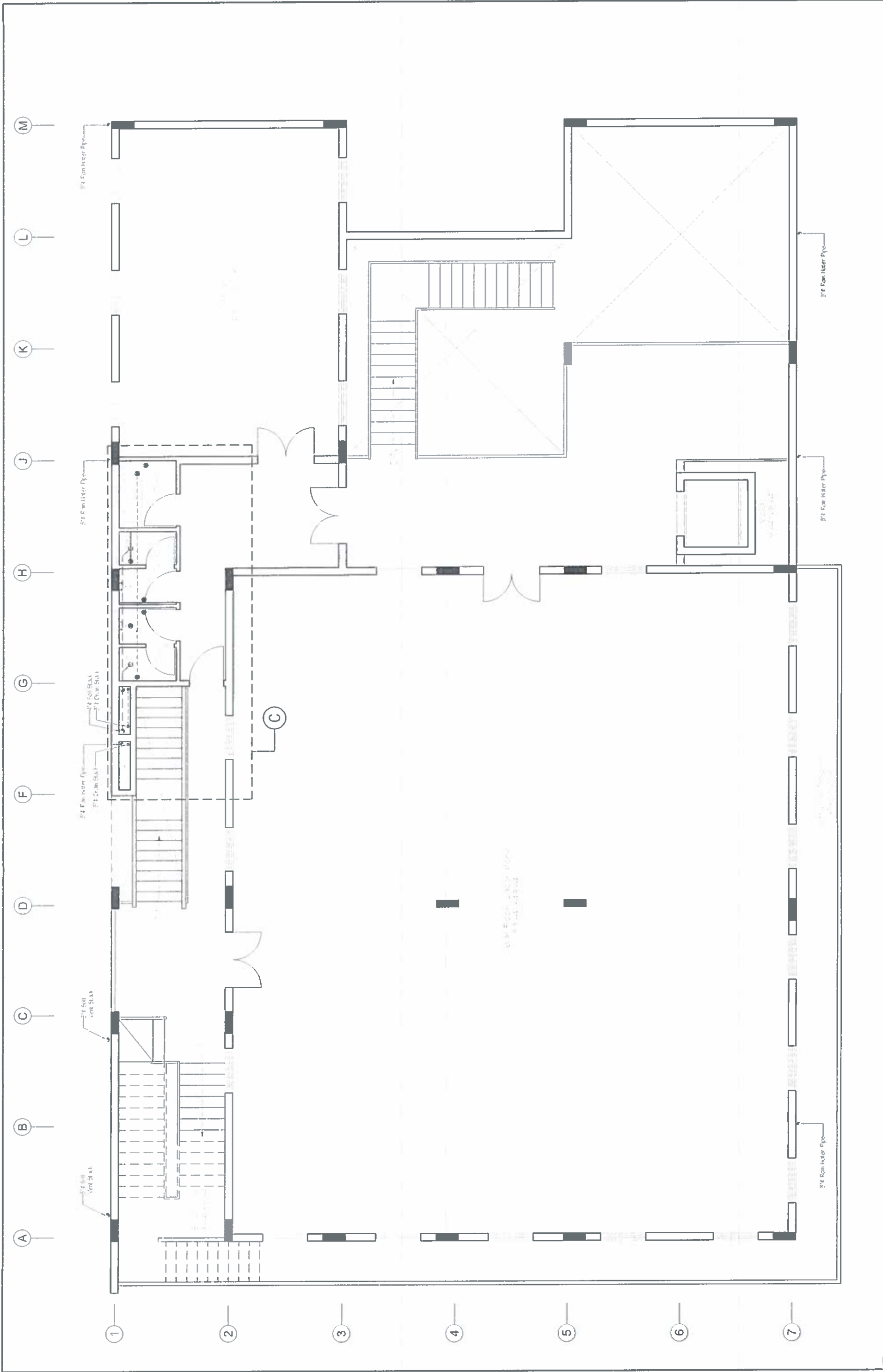
MARCH – 2024

Plumbing Consultant
Fariha A. Ubaid

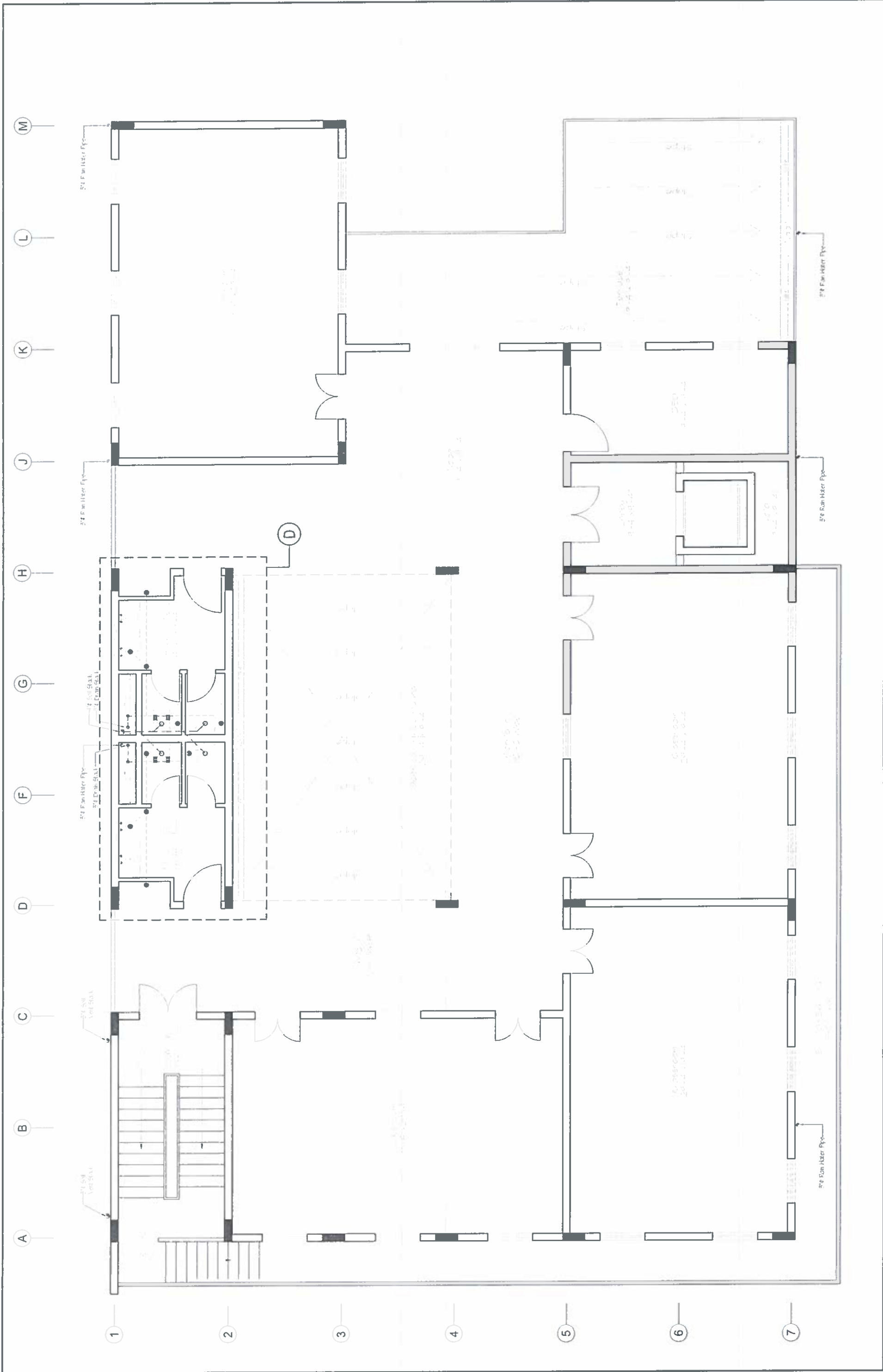
Associate Professor
Department of Architecture and Planning
NED University of Engineering and Technology
Email: ufariha@neduet.edu.pk

List of Plumbing Working Drawings

No	Dwg. No.	Title
1		General Notes and Legend
2		General Details
3	PL-01	Ground Floor Sewerage & Drainage Plan
4	PL-02	First Floor Sewerage & Drainage Plan
5	PL-03	Second Floor Sewerage & Drainage Plan
6	PL-04	Roof Sewerage & Drainage Plan
7	PL-05	Ground Floor Water Supply Layout Plan
8	PL-06	First Floor Water Supply Layout Plan
9	PL-07	Second Floor Water Supply Layout Plan
10	PL-08	Roof Water Supply Layout Plan
11	PL-09	Detail A Sewerage & Drainage Plan
12	PL-10	Detail A Water Supply Layout Plan
13	PL-11	Detail B Sewerage & Drainage Plan
14	PL-12	Detail B Water Supply Layout Plan
15	PL-13	Detail C Sewerage & Drainage Plan
16	PL-14	Detail C Water Supply Layout Plan
17	PL-15	Detail D Sewerage & Drainage Plan
18	PL-16	Detail D Water Supply Layout Plan
19	PL-17	Detail E Water Supply Layout Plan



PL-02	Dwg No.	
	Scale	1/8"=1'-0"
	Print Date	19 Jan 2024
	Date	15 Jul 2019
First Floor Plumbing & Sewage Layout	Checked	FAU
	Job No.	NED-19-01
	Project	
	Hilton Pharma Nanotechnology Centre at NED University	
For	NED University of Engineering and Technology, Karachi	
	Project	
	Hilton Pharma Nanotechnology Centre at NED University	
	For	
Plumbing Consultant:	Fariha A. Ubaid	
	Associate Professor	
	Department of Architecture and Planning	
	NED University of Engineering and Technology, Karachi	
Notes:	1. For any discrepancies refer to Architect.	
	2.	





Faculty Coordinator:
Fariha A. Ubaid
Associate Professor
Department of Architecture and Planning
NED University of Engineering and Technology, Karachi
e-mail: fariha@nedaed.com

Notes
1. For any discrepancies refer to Architect.
2.

Project:
Hilton Pharma
Nanotechnology Centre
at NED University

Project No.:

Drawn by:

Checked by:

Scale: 1/8"=1'-0"

Plot Date: 19 Jan 2024

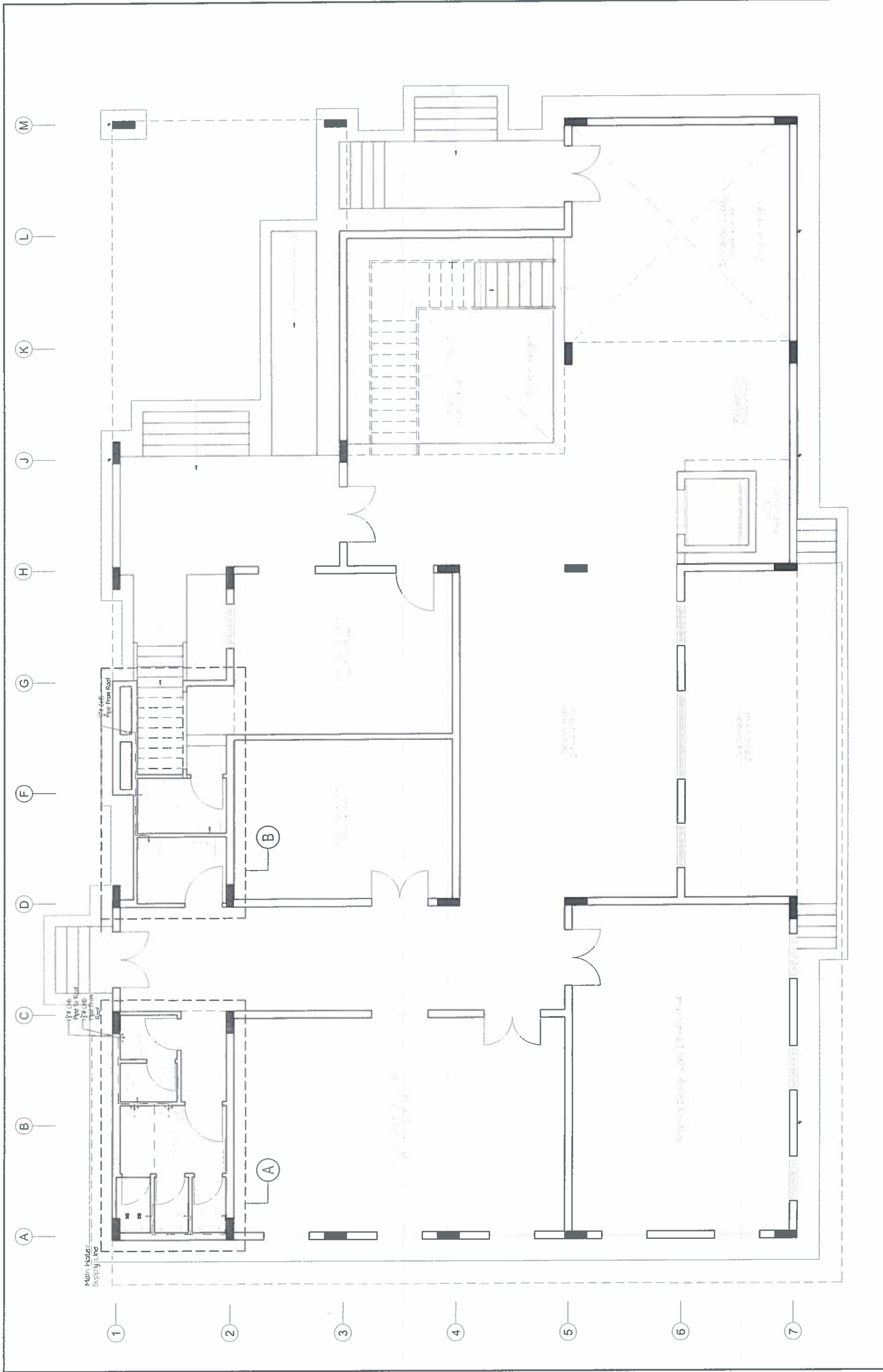
Date: 15 Jul 2019

Clerked: FAU

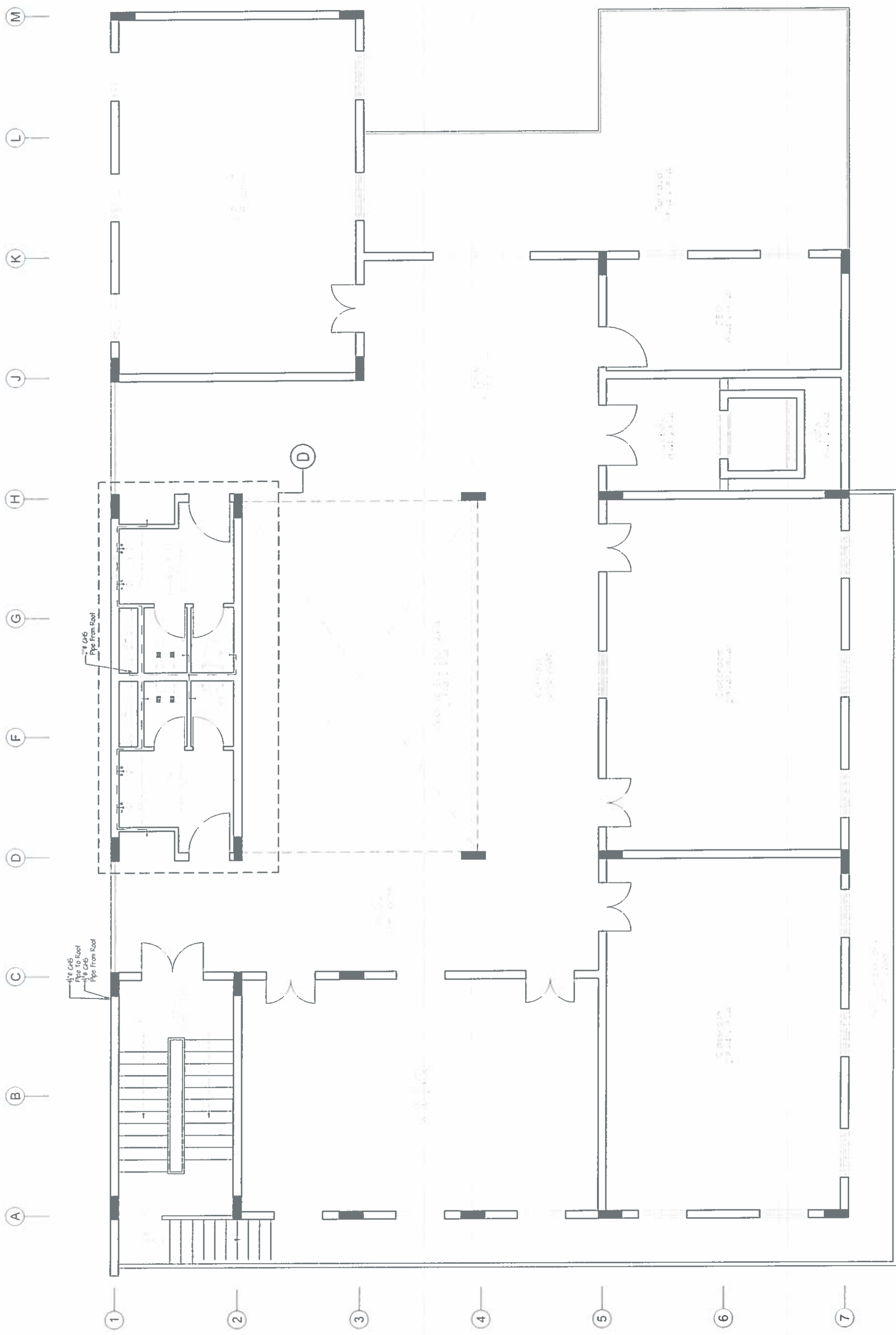
Job No.: NED-19-01

Title:
**Second Floor
Plumbing &
Sewage Layout**

Dwg No.:
PL-03



	Planning Consultant: Fariha A. Ubaid Associate Professor Department of Architecture and Planning NED University of Engineering and Technology, Karachi e-mail: fariha@ned.edu.pk	Notes: 1. For any discrepancies refer to Architect 2.	Project: Hilton Pharma Nanotechnology Centre at NED University File: NED University of Engineering and Technology Karachi	Title: Ground Floor Water Supply Layout Plan	Scale: 1/8"=1'-0"	Dwg. No.: PL-05
						Print Date: 19 Jan 2024 Date: 15 Jul 2019 Checked: FAU Rev. No.: NED-19-01



Plumbex Consulting:

Fariha A. Ubaid

FARUK A. ODEH
Associate Professor
Department of Architecture and Planning
MED University of Engineering and
Technology, Karachi
e-mail: faruk@med.ac.in

Notes
1 - For any discrepancies refer to Architect.
2 -

Revisions	
No.	Details
	Date

Project: Hilton Pharma
Project: Nanotechnology Centre
at NED University
F4: NED University of Engineering
and Technology, Karachi

**Second Floor
Water Supply
Layout Plan**

1/8" = 1'-0"

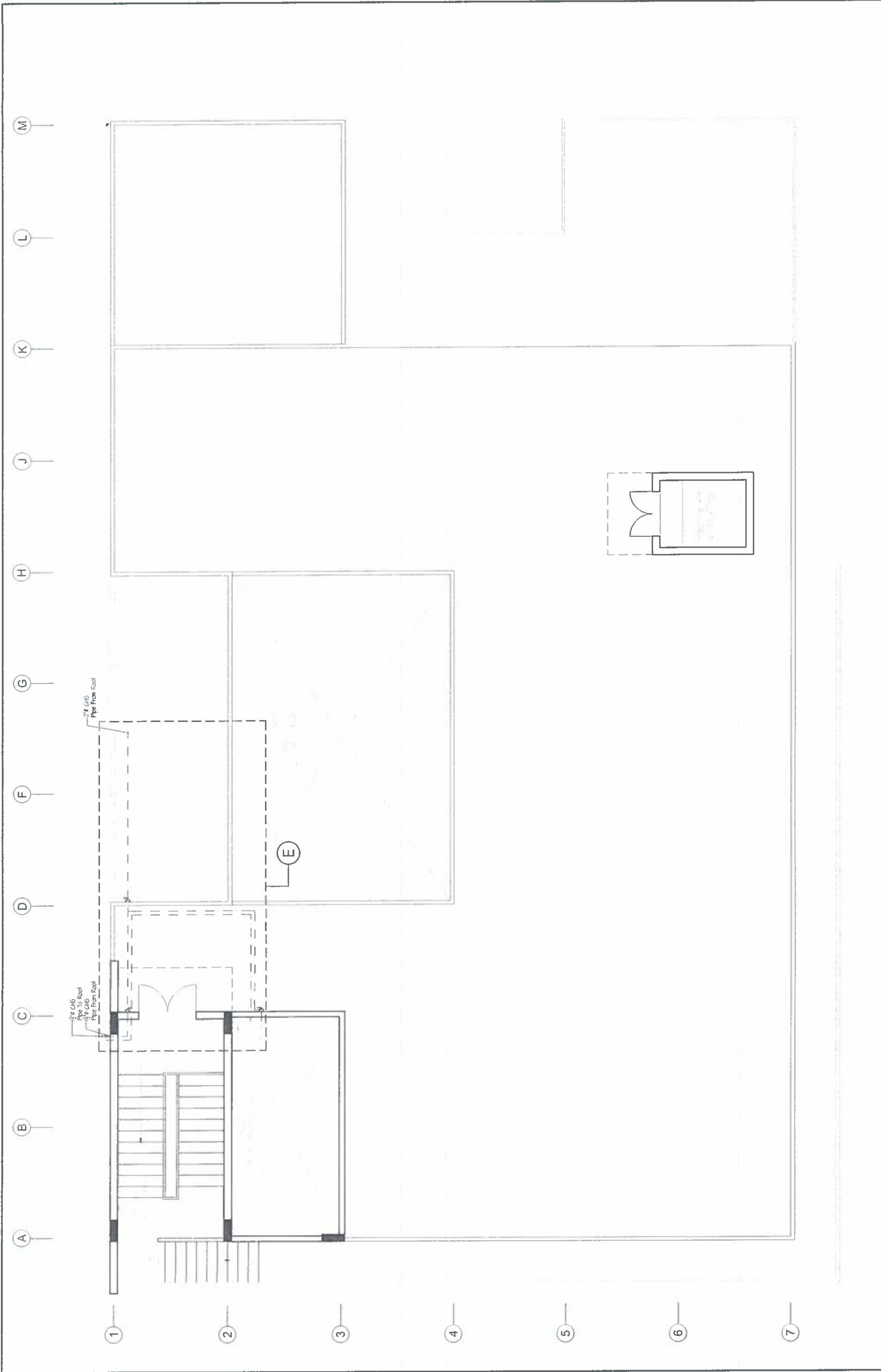
Print Date: 19 Jan 2024

Date	15 Jul 2010
------	-------------

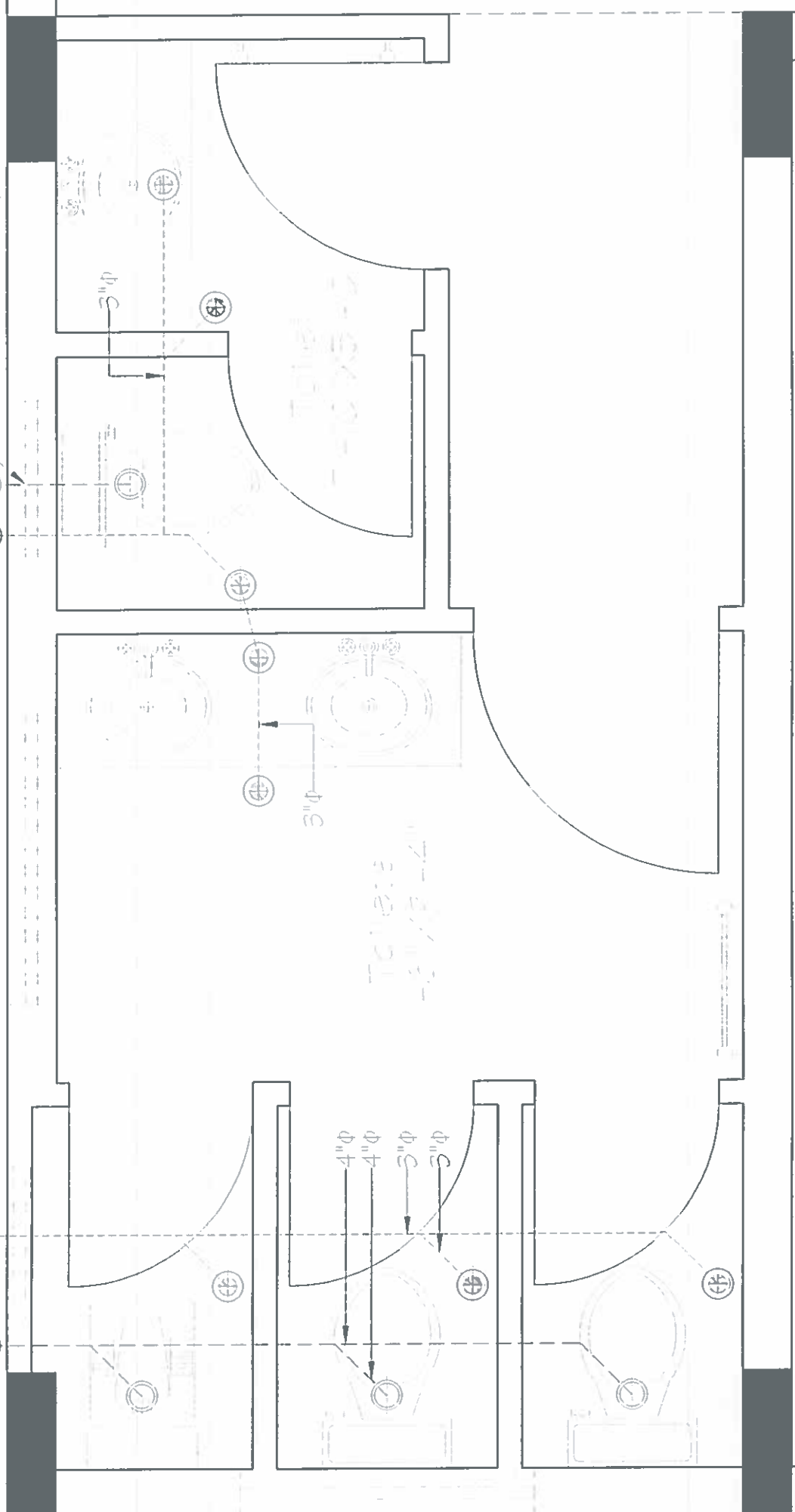
[illegible]

14. MED 10 01

PL-079



	Planning Consultant: Fariha A. Ubaid Assoc. Life Professor Department of Architecture and Planning NED University of Engineering and Technology, Karachi f.ubaid@ned.edu.pk	Notes: 1. For any discrepancies refer to Architect 2.	Rev. Appr. N. Ubaid	Date	Project: Hilton Pharma Nanotechnology Centre at NED University File: NED University of Engineering and Technology, Karachi	Title: Roof Water Supply Layout Plan		Scale: 1/8" = 1'-0"	Dwg. No.:
								Print Date: 19 Jan 2024	PL-08
								Date: 15 Jul 2019	
								Checked: FAU	Job No.: NED-19-01



Planning Consultant:

Fariha A. Ubaid
Associate Professor
Department of Architecture and Planning
HED University of Engineering and
Technology, Khatim
Khatim, Gujranwala (Punjab)

Notes
1 - For any discrepancies refer to Architect.

Revised 10/2015

No.	Details	Date
-----	---------	------

Project
Hilton Pharma
Nanotechnology Centre
at NED University

For
NED University of Engineering

Title: Detail A
Sewerage &
Drainage Layout

$\mathbb{P}^1 \times \mathbb{P}^1 \rightarrow \mathbb{P}^1$

Conf. 1/2000-11/010

Print Date 19 Jan 2024

15-Jul-2019

[illegible]

1041

60-7a



Planning Consultant:

Fariha A. Ubaid
Associate Professor
Department of Architecture and Planning
NED University of Engineering and
Technology, Karachi
e-mail: fariha@neda.net.com

Notes:
1 - For any discrepancies refer to Architect.

100

[illegible]

Printed

**Hilton Pharma
Nanotechnology Centre
at NED University**

Title
Detail A
Water S
Layout

0014-1801/97/0005-0000\$05.00/0

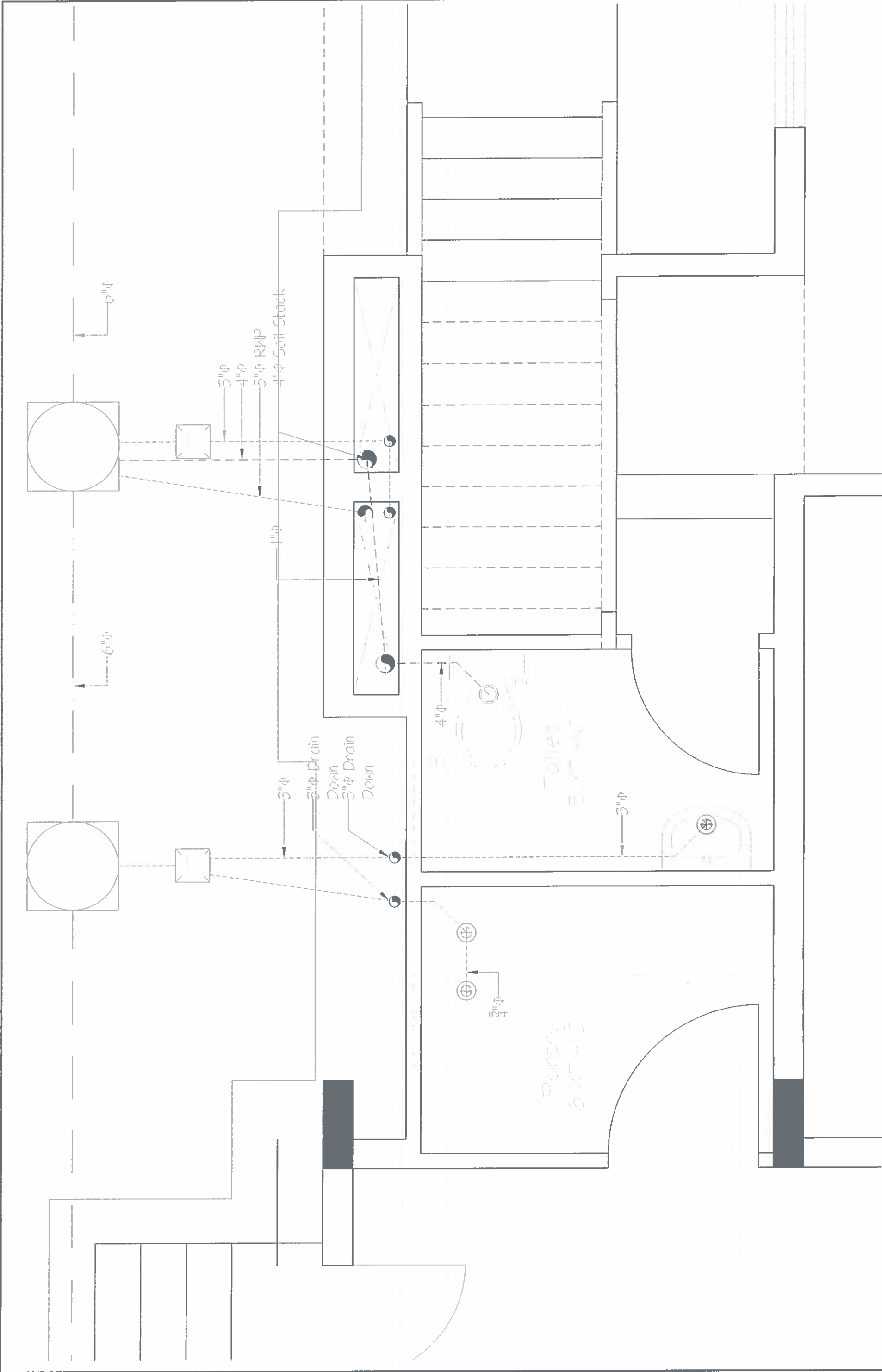
3000


2000

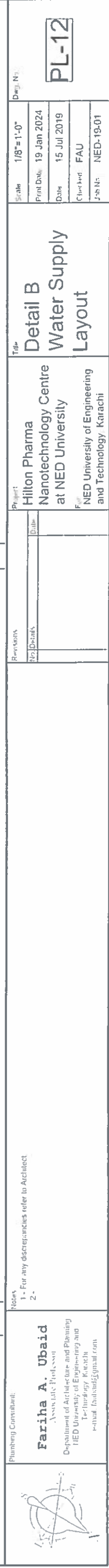
2000

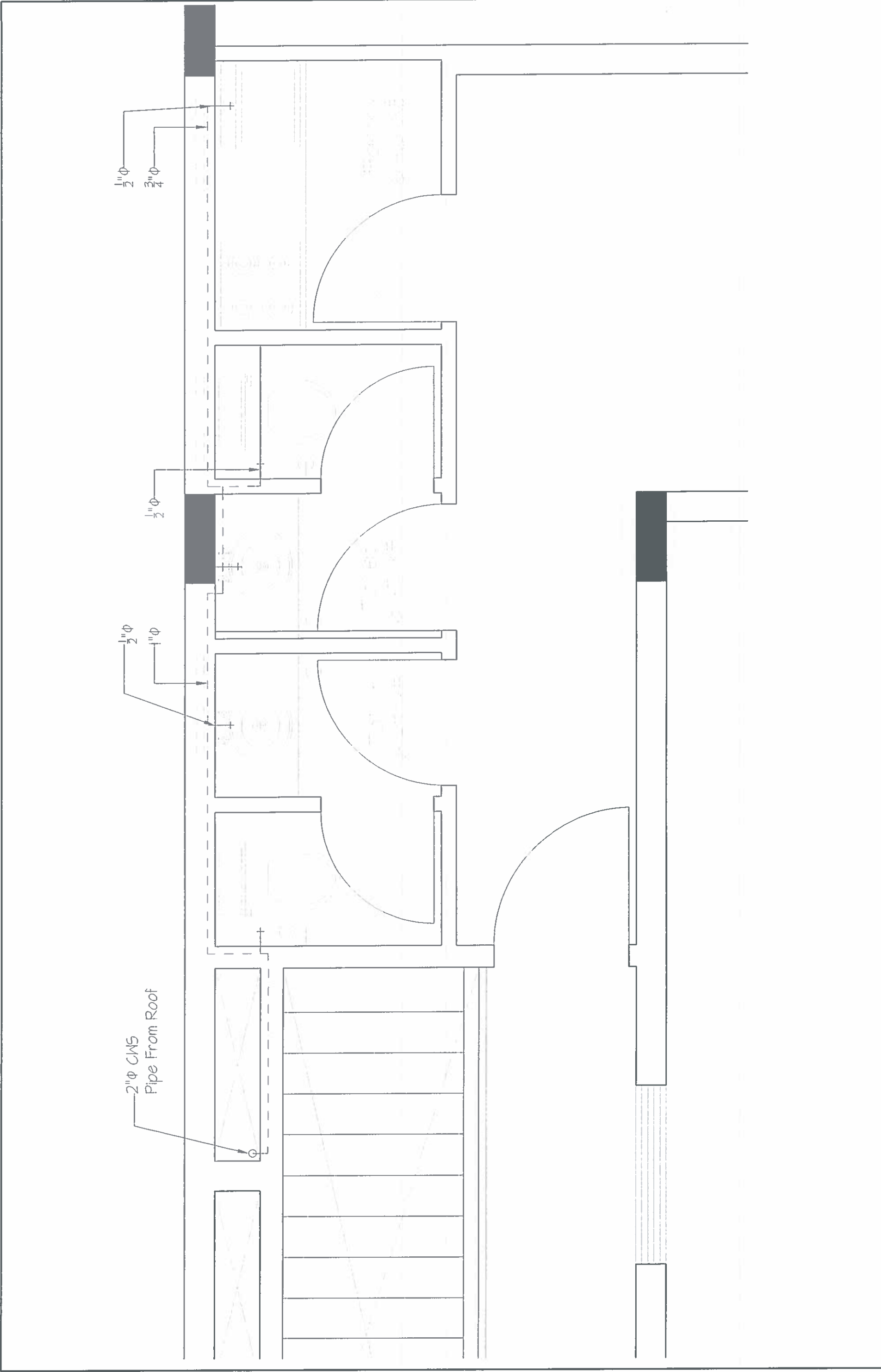
2000

PL-10

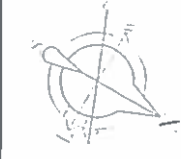
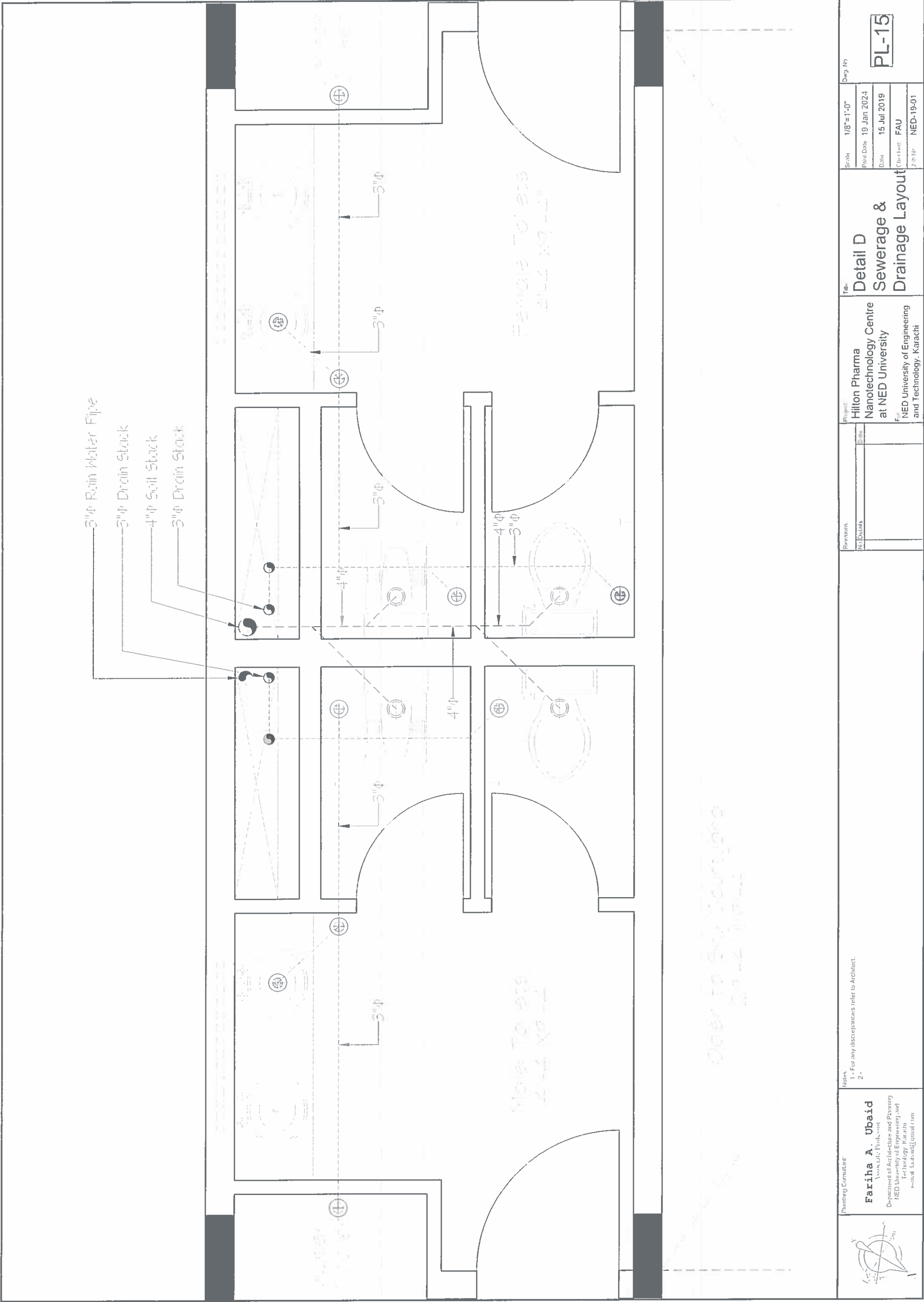


	Planning Consultant: Fariha A. Ubaid Associate Professor Department of Architecture and Planning NED University of Engineering and Technology Karachi e-mail: f.ubaid@nedu.edu.pk	Notes 1- For any discrepancies refer to Architect. 2-	Revision <table border="1"><thead><tr><th>No.</th><th>Details</th></tr></thead><tbody><tr><td> </td><td> </td></tr><tr><td> </td><td> </td></tr><tr><td> </td><td> </td></tr></tbody></table>	No.	Details							Project: Hilton Pharma Nanotechnology Centre at NED University File: NED University of Engineering and Technology, Karachi	Title: Detail B Sewerage & Drainage Layout		Scale: 1/8"=1'-0"	Dwg No.
				No.	Details											
Print Date 19 Jan 2024	PL-11															
Date 15 Jul 2019																
Checked FAU																
						Job No. NED-19-01										





	Planning Consultant: Fariha A. Ubaid Associate Professor Department of Architecture and Planning NED University of Engineering and Technology, Karachi f.ubaid@neduniv.edu.pk	Notes: 1 - For any discrepancies refer to Architect 2 -	<table><tr><th colspan="3">Revisions</th></tr><tr><th>No.</th><th>Details</th><th>Date</th></tr><tr><td> </td><td> </td><td> </td></tr></table>	Revisions			No.	Details	Date				<table><tr><td colspan="2">Project: Hilton Pharma Nanotechnology Centre at NED University</td><td rowspan="5">For: NED University of Engineering and Technology, Karachi</td></tr><tr><td colspan="2">Title: Detail C Water Supply Layout</td></tr></table>	Project: Hilton Pharma Nanotechnology Centre at NED University		For: NED University of Engineering and Technology, Karachi	Title: Detail C Water Supply Layout		Scale: 1/8" = 1'-0"		Dwg No.: PL-14
				Revisions																	
				No.	Details	Date															
				Project: Hilton Pharma Nanotechnology Centre at NED University		For: NED University of Engineering and Technology, Karachi															
Title: Detail C Water Supply Layout																					
Print Date: 19 Jan 2024																					
Date: 15 Jul 2019																					
Checked by: FAU																					
Job No.: NED-19-01																					



Plumbing Consultant
Fariha A. Ubaid
Associate Professor
Department of Architecture and Planning
NED University of Engineering and Technology, Karachi
e-mail: fariha.ubaid@gmail.com

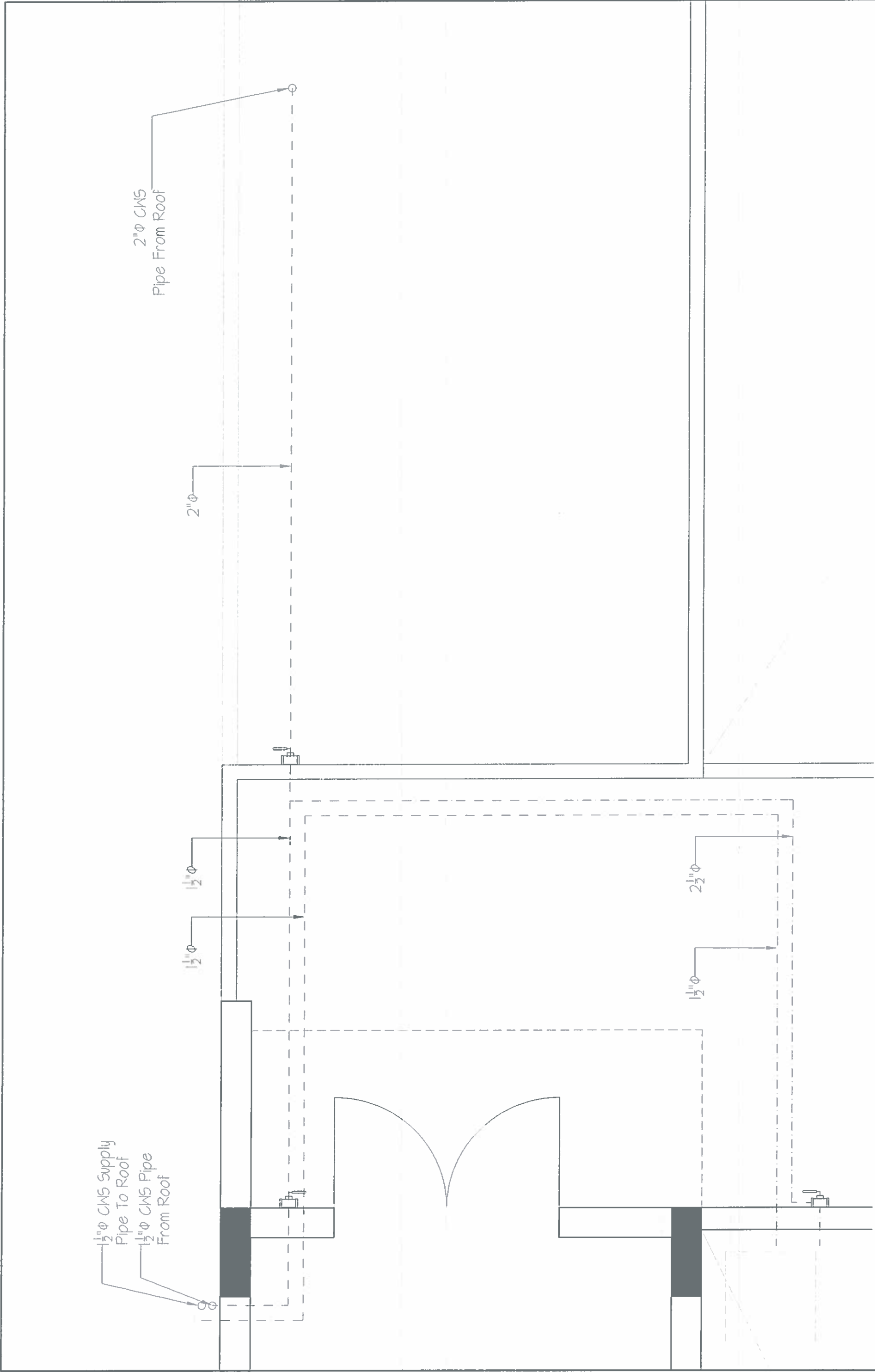
- Notes
- 1- For any discrepancies refer to Architect.
 - 2-


Revisions	
No.	Date

Project
**Hilton Pharma
Nanotechnology Centre
at NED University**
F
NED University of Engineering
and Technology, Karachi

Title
**Detail D
Sewerage &
Drainage Layout**

Scale	1/8" = 1'-0"	Dwg. No
Print Date	19 Jan 2024	PL-15
Date	15 Jul 2019	
Checked	FAU	
J. H. No	NED-19-01	



<div></div>	<div>Planning Consultant: Fariha A. Ubaid <small>Associate Professor</small> Department of Architecture and Planning NED University of Engineering and Technology, Karachi <small>E-mail: f.ubaid@neduet.edu.pk</small></div>	<div>Notes: 1. For any discrepancies refer to Architect 2.</div>	<div>Revisions: <table><tr><th>No.</th><th>Details</th><th>Date</th></tr><tr><td>1</td><td></td><td>15 Jul 2019</td></tr></table></div>	No.	Details	Date	1		15 Jul 2019	<div>Project: Hilton Pharma Nanotechnology Centre at NED University For: NED University of Engineering and Technology, Karachi</div>	<div>Title: Detail E Water Supply Layout</div>	Scale: 1/8"=1'-0"	Drawn By:
				No.	Details	Date							
				1		15 Jul 2019							
				Print Date: 19 Jan 2024	Date: 15 Jul 2019	Client: FAU							
		Job No: NED-19-01											

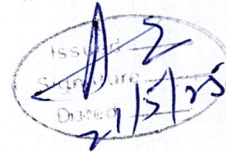
OFFICE ORDER

The University has constituted the procurement Committee comprising of the following for construction of Hilton Pharma Nano Technology Centre at NED University of Engineering & Technology:

- | | |
|----------------------------|----------|
| 1. Dr. Syed Salman Mobeen | Convener |
| Assistant Professor | |
| Dept. of Civil Engg. | |
| 2. Engr. Sadia Jabeen | Member |
| Civil Engineer | |
| HEJ, University of Karachi | |
| 3. Engr. Khurshid Akhtar | Member |
| Project Coordinator | |
| Mega-V, NEDUET | |

The ToR / functions / responsibilities of the aforesaid Procurement Committee will be in accordance with Rule-8 of SPP Rules.

Khurshid
REGISTRAR



ok

To:

All above

Copy for information to:

1. Director Works & Service
2. Director Finance
3. Ag. Resident Auditor

NED UNIVERSITY OF ENGINEERING & TECHNOLOGY

No. DR (Estab)/(1003)/5730

Dated: 27/05/2016

OFFICE ORDER

In supersession of this office order No. DR (Estab)/(1003)/11418 dated 02-11-2015, the University Administration has constituted the Complaint Redressal Standing Committee comprising of the following officers to address complaints regarding all procurement issues in the University in pursuance of Clause 31(1) of the SPPRA rules:

- | | | |
|----|---|----------|
| 1. | Prof. Dr. Saad Ahmed Qazi
Dean (ECE) | Convener |
| 2. | Independent Professional from the relevant field | Member |
| 3. | Nominee of Accountant General Sindh | Member |


Ag-REGISTRAR/27/5/2016

To:

The Convener & all members

Copy for information to:

1. Dean (ECE)
2. Director Planning & Projects
3. Director Finance
4. Director, Procurement Cell
5. Ag. Resident Auditor



DAWN

NED UNIVERSITY OF ENGINEERING & TECHNOLOGY

Director
Procurement
PROCUREMENT CELL
University Road, Karachi-75270

Tel: 9926 1261 - 68 (Ext: 2220 & 2501) Fax: 9926 1255
Email: dp@neduet.edu.pk Website: <http://www.neduet.edu.pk>
Ref: PC/NED/77266/9813 Date: 19.06.2025

SAY NO TO CORRUPTION

NOTICE INVITING TENDER

NEDUET invites sealed bids on Single Stage One Envelope procedure from Reputable and Well Experienced Firms / Companies to carry out following works:

Construction of Hilton Pharma Nano Technology Centre (Remaining Works) at NEDUET.

Tender No. PC/NED/DWS/ 6945-B/2025

Issuance of Documents from	Last Date of Issuance of Tender Documents	Tenders Submission Deadline	Tenders Opening Date / Time
24.06.2025	09.07.2025	10.07.2025 10:30 am	10.07.2025 11:00 am

Estimated Cost (Rs. In Million) 87.975

Tender Fee Rs. 7000

Time of Completion, 10 Months

ELIGIBILITY CRITERIA:

- Valid Professional Tax Certificate of Govt. of Sindh
- Income Tax returns filed for the last 03 years with Documentary Proof.
- Audit report / bank Statement of the firm for last 03 years showing the yearly above Rs 88 million.
- Details of Equipment's, Machineries and Transport owned by firm / contractor with documented proofs.
- Valid Registration with Pakistan Engineering Council in relevant Category: C-4 & above and have specialized codes CE-10, EE-11 or EE-11(vi).
- Affidavit on Original Stamp Paper affirming that the firm has never been black listed, not involved in any Litigation with any Government, Semi-Government & Autonomous Body.
- List of Similar Projects executed in last 05 years & atleast 02 projects with Cost of work over Rs 40 million showing Documentary proof (Work Orders and Work Completion Certificate).
- Valid Registration with tax authorities (Federal Board of Revenue, Sindh Revenue Board) with proof of company in Active Tax Payer list, Professional Tax paid & copy of CNIC along with company registration proof.
- Valid Registered License from Electrical Inspector for Electrical Works. However, those who have applied for registration or renewal will also be eligible but it should be submitted within 14 days after opening of the bid. In case of non-compliance, bid shall be rejected.

Terms & Conditions:

- Under these conditions bid shall be Rejected:
 - Black listed firms.
 - Unsigned & Stamp Bid.
 - Conditional and telegraphic bids/tender.
 - Bids received after specified date and time.
 - Bids not accompanied by bid security of required amount and form, as mentioned in Tender Documents.
- Bid Validity Period: - (90) days from the date of opening of tender.
- Bid Security: 2% of bid cost in the form of Deposit at Call or Pay Order or Demand Draft or a Bank Guarantee issued by a scheduled bank in favor of Director Finance NEDUET, Karachi.

Tender Fee in shape of Payorder / bank draft should be in favor of Director Finance NEDUET. Procuring Agency reserves the right to reject all or any bids subject to the relevant provisions of Sindh Public Procurement Rules 2010 (Amended upto date). Bidding documents can be obtained and shall be submitted in the office of DDP as per above schedule. Bidders are requested to give their Best and Final Price as "No negotiations" is permitted. Bidding Documents containing detailed terms and conditions are available at Websites <https://www.neduet.edu.pk> and <https://www.portalsindh.eprocure.gov.pk>. In case of public holiday or any holiday or non-working day due to Force Majeure, the next official working day shall be deemed to be date for issuance, submission and opening of tenders. NEDUET shall not be responsible for any cost or expenses incurred by bidders.

Director Procurement

جمعہ 23 مئی 1446ھ 20 جون 2025ء

www.jang.com.pk

f JangDotComDotPk @ jangdotcom jang_akhbar

باقاعدہ تصدیق شدہ اشاعت پاکستان کے روزنامہ ریلیہ

ABC CERTIFIED



NED UNIVERSITY
OF ENGINEERING & TECHNOLOGY



Director
Procurement

PROCUREMENT CELL
University Road, Karachi-75270

Tel: 9926 1261 - 68 (Ext: 2220 & 2501) Fax: 9926 1255
Email: dp@neduet.edu.pk Website: http://www.neduet.edu.pk

Ref: PC/NED/77266/9813

Date: 19.06.2025

SAY NO TO CORRUPTION

نوٹس برائے طلبی ٹینڈر

NEDUET مہربند بولیوں Single Stage One Envelope طریقہ کار کے تحت معزز اور تجربہ کار فرما / کمپنیز سے درج ذیل کاموں کی انجام دہی کے لیے طلب کرتا ہے:

Construction of Hilton Pharma Nano Technology Centre (Remaining Works) at NEDUET.			
Tender No. PC/NED/DWS/ 6945-B/2025			
Issuance of Documents from	Last Date of Issuance of Tender Documents	Tenders Submission Deadline	Tenders Opening Date / Time
24.06.2025	09.07.2025	10.07.2025 10:30 am	10.07.2025 11:00 am
Estimated Cost (Rs. In Million) 87.975			
Tender Fee Rs. 7000			
Time of Completion, 10 Months			

اہلیت کے معیارات

- حکومت سندھ کا قابل قبول پروفیشنل ٹیکس سرٹیفکیٹ۔
- گزشتہ تین (03) سالوں کے فائل شدہ واکم ٹیکس ریٹرنز بعد دستاویزی ثبوت۔
- گزشتہ تین (03) سالوں کے لیے کمپنی کی آڈٹ رپورٹ / بینک اسٹیٹمنٹ جس میں سالانہ آمدن 88 ملین روپے سے زائد ہو۔
- کمپنی / کنٹریکٹر کی ملکیٹی مشینری، آلات اور ٹرانسپورٹ کی تفصیلات بعد دستاویزی ثبوت۔
- پاکستان انجینئرنگ کونسل میں متعلقہ کیریئر میں قابل قبول رجسٹریشن: C-4 یا اس سے اوپر اور مخصوص کوڈز EE-11، CE-10 یا EE-11 (vi)۔
- اصل اسٹامپ پیپر پر حلف نامہ کہ کمپنی کو کبھی بلیک لسٹ نہیں کیا گیا، نہ ہی کسی سرکاری، نیم سرکاری یا خود مختار ادارے کے ساتھ کسی قانونی چارہ جوئی میں ملوث رہی ہو۔
- گزشتہ پانچ (05) سالوں میں مکمل کردہ مشابہ منصوبوں کی فہرست اور کم از کم دو منصوبے جن کی لاگت 40 ملین روپے سے زائد ہو، جن کے ورک آرڈرز اور تحصیل کے سرٹیفکیٹس بطور دستاویزی ثبوت موجود ہوں۔
- ٹیکس اتھارٹیز (فیڈرل بورڈ آف ریویو، سندھ ریویو بورڈ) کے ساتھ قابل قبول رجسٹریشن بعد ایکٹیو ٹیکس میٹریسٹ میں موجودگی کا ثبوت، پروفیشنل ٹیکس کی ادائیگی، شائع شدہ کارڈ کی نقل اور کمپنی رجسٹریشن کا ثبوت۔
- ایگزیکٹو ورکس کے لیے ایگزیکٹو انجینئر سے قابل قبول رجسٹرڈ لائسنس۔ تاہم، جنہوں نے رجسٹریشن یا تجدید کے لیے درخواست دی ہے وہ بھی اہل ہوں گے، لیکن بولی کھلنے کے 14 دن کے اندر اس کا ثبوت جمع کرانا لازم ہو گا۔ عدم تعمیل کی صورت میں بولی مسترد کر دی جائے گی۔

شرائط و ضوابط

(الف) درج ذیل صورتوں میں بولی مسترد کر دی جائے گی:

- بلیک لسٹ شدہ فرما
- دستخط اور اسٹامپ کے بغیر بولی
- مشروط اور ٹیلی گرافک بولی / ٹینڈر
- مقررہ تاریخ اور وقت کے بعد موصول ہونے والی بولیاں
- ایسی بولیاں جن کے ساتھ مطلوبہ رقم اور طریقہ کے مطابق بڑھتی ہوئی رقم نہ ہو، جیسا کہ ٹینڈر دستاویزات میں درج ہے۔

(ب) بولی کی درجہ کی مدت: بولی کھلنے کی تاریخ سے 90 دن۔

(ج) بڑھتی ہوئی بولی کی قیمت کا 2 فیصد، ڈپازٹ ایٹ کال، بے آرڈر، ڈیمانڈ ڈرافٹ یا بینک گارنٹی کی صورت میں، جو کسی شیڈیولڈ بینک کی جانب سے ڈائریکٹر ٹرانس NEDUET کراچی کے حق میں جاری کی گئی ہو۔

ٹینڈر فیس بے آرڈر / بینک ڈرافٹ کی شکل میں ڈائریکٹر ٹرانس NEDUET کے نام پر ہونی چاہیے۔ فریڈ ای انجینیئر کو سندھ پبلک پروکیورمنٹ روٹرو 2010 (ترمیم شدہ) کی متعلقہ دفعات کے تحت کسی بھی یا تمام بولیوں کو مسترد کرنے کا حق حاصل ہے۔ بولی کی تفصیلی شرائط و ضوابط پر مشتمل دستاویزات <https://www.neduet.edu.pk> اور <https://www.portalsindh.eprocure.gov.pk> سے دستیاب ہیں اور DDP کے دفتر میں جمع کروائی جاسکتی ہیں۔ بولی دہندگان سے درخواست کی جاتی ہے کہ وہ اپنی بہترین اور حتمی قیمت دیں کیونکہ "کسی قسم کی بات چیت کی اجازت نہیں"۔ اگر کسی عوامی تھیلی یا غیر متوقع تھیلی / فورس میجر کی صورت میں مقررہ دن پر کام نہ ہو، تو اس کا سرکاری کام کا دن ٹینڈر کے اجراء جمع اور کھولنے کی تاریخ تصور کیا جائے گا۔ NEDUET بولی دہندگان کی جانب سے اٹھائے گئے کسی بھی خرچ یا لاگت کا ذمہ دار نہیں ہو گا۔

ڈائریکٹر پروکیورمنٹ



NED UNIVERSITY OF ENGINEERING & TECHNOLOGY



Director
Procurement

PROCUREMENT CELL
University Road, Karachi-75270

Tel: 9926 1261 - 68 (Ext: 2220 & 2501) Fax: 9926 1255
Email: dp@neduet.edu.pk Website: http://www.neduet.edu.pk

Ref: PC/NED/77266/9813

Date: 19.06.2025

SAY NO TO CORRUPTION

ٽينڊر گھرائڻ جو نوٽيس

NEDUET مھربند واڪ Single Stage One Envelope
طريقيڪار جي تحت معزز ۽ تجربڪار فرمز/ڪمپنيون کان هيٺ ڏنل ڪمن
جي انجاء ڏيڻ جي لاءِ طلب ڪري ٿو:

Construction of Hilton Pharma Nano Technology
Centre (Remaining Works) at NEDUET.

Tender No. PC/NED/DWS/ 6945-B/2025

Issuance of Documents from	Last Date of Issuance of Tender Documents	Tenders Submission Deadline	Tenders Opening Date / Time
24.06.2025	09.07.2025	10.07.2025 10:30 am	10.07.2025 11:00 am
Estimated Cost (Rs. In Million) 87.975			
Tender Fee Rs. 7000			
Time of Completion, 10 Months			

اهليت جا معيار:

- سنڌ حڪومت جو قابل قبول پروفيشنل ٽيڪس سرٽيفڪيٽ.
- گذريل ٽن (03) سالن جا قائم شدہ انڪر ٽيڪس ريترنز سان دستاويزي ثبوت.
- گذريل ٽن (03) سالن جي لاءِ ڪمپني جي آڊٽ رپورٽ/بينڪ اسٽيٽمينٽ جنهن ۾ سالياني آمدن 88 ملين روپين کان وڌيڪ هجي.
- ڪمپني/ڪنٽريڪٽر جي ملڪيتي مشينري، اوزارن ۽ ٽرانسپورٽ جا تفصيل سان دستاويزي ثبوت.
- پاڪستان انجنيئرنگ ڪائونسل ۾ لاڳاپيل ڪنٽريڪٽري ۾ قابل قبول رجسٽريشن: C-4 يا ان کان مٿي، ۽ مخصوص ڪوڊز CE-11.10 يا EE-11(vi).
- اصل اسٽامپ پيپر تي حلف نامو ۽ ڪمپني کي ڪڏهن بليڪ لسٽ نه ڪيو ويو آهي، نه وري ڪنهن سرڪاري، تير سرڪاري يا خود مختيار اداري سان ڪنهن قانوني چاره جوئي ۾ ملوث رهي آهي.
- گذريل پنج (05) سالن ۾ مڪمل ڪيل ساڳي نوعيت جي منصوبن جي فهرست ۽ گهٽ ۾ گهٽ ٻه منصوبا جن جي لاڳت 40 ملين روپين کان وڌيڪ هجي، جن جا ورڪ آرڊرز ۽ تڪميل جا سرٽيفڪيٽس بطور دستاويزي ثبوت موجود هجن.
- ٽيڪس اٿارٽيز (فيڊرل بورڊ آف روينيو، سنڌ روينيو بورڊ) وٽ قابل قبول رجسٽريشن سان ايڪسٽيٽيڪس پيئر لسٽ ۾ موجودگي جو ثبوت، پروفيشنل ٽيڪس جي ادائگي، شناختي ڪارڊ جي نقل ۽ ڪمپني رجسٽريشن جو ثبوت.
- ايڪسٽيٽيڪل ورڪس جي لاءِ ايڪسٽيٽيڪل انسپيڪٽر وٽان قابل قبول رجسٽريشن لاگيسٽس، تنهن هوندي، جن رجسٽريشن يا تجديد جي لاءِ درخواست ڏني آهي اهي پڻ اهل هوندا، هر واڪ کولڻ جي 14 ڏينهن جي اندر ان ڳالهه جو ثبوت جمع ڪرائڻ لازمي هوندو. تعميل نه ٿيڻ جي صورت ۾ واڪ رد ڪيا ويندا.

شرط ۽ ضابطو:

(الف) هيٺين صورتن ۾ واڪ رد ڪيا ويندا:

- بليڪ لسٽ شدہ فرمز
- دستخط ۽ اسٽامپ کان سواءِ واڪ
- مشروط ۽ ٽيليگرافڪ واڪ/ٽينڊر
- مقرر ڪيل تاريخ ۽ وقت کانپوءِ وصول ٿيندڙ واڪ
- اهڙا واڪ جن سان گڏ گهريل رقم ۽ طريقي جي مطابق بد سيڪيورٽي شامل نه هجي. جيئن ٽينڊر دستاويزن ۾ درج آهي.

(ب) واڪ جي درستگي جو مدو: واڪ کولڻ جي تاريخ کان 90 ڏينهن

(ج) بد سيڪيورٽي: واڪ جي قيمت جو 2 سيڪڙو ڊپازٽ ايٽ ڪال، ٻي آرڊر، ڊيمانڊ ڊرافٽ يا بينڪ گارنٽي جي صورت ۾، جيڪا ڪنهن شيڊيولڊ بينڪ پاران پائڻ ڪندڙ فنڊس NEDUET ڪراچي جي حق ۾ جاري ڪئي وئي هجي.

ٽينڊر فيس ٻي آرڊر/بينڪ ڊرافٽ جي صورت ۾ ڊائريڪٽر جنرل نئشنل NEDUET جي نالي تي هجڻ گهرجي. خريداري ايجنسي کي سنڌ پبلڪ پروڪيورمينٽ رولز 2010 (ترميم شدہ) جي لاڳاپيل دفعات جي تحت ڪنهن به يا مٿي واڪن کي مسترد ڪرڻ جو حق حاصل آهي. واڪ جي تفصيلي شرط ۽ ضابطن تي مشتمل دستاويز <https://www.neduet.edu.pk> ۽ <https://www.portalsindh.eprocure.gov.pk> تي دستياب آهن ۽ DDP جي دفتر ۾ جمع ڪرائي سگهجن ٿا. واڪ ڏيندڙن کي درخواست ٿي ڪجي ته اهي پنهنجي بهترين ۽ حتمي قيمت ڏيڻ چوڻ ۽ ڪنهن قسم جي ڳالهه پوراءِ جي اجازت نه آهي. جيڪڏهن ڪنهن عوامي تعطيل يا غير متوقع تعطيل/فورس ميجر جي صورت ۾ مقرر ڪيل ڏينهن تي ڪم نه ٿيو ته اڳئين سرڪاري ڪم جو ڏينهن ٽينڊر جي اجراءِ جمع ۽ کولڻ جي تاريخ تصور ڪيو ويندو. NEDUET، واڪ ڏيندڙ پاران ڪئي ويندڙ ڪنهن به خرچ يا لاڳت جي ذميواري نه هوندي.

ڊائريڪٽر پروڪيورمينٽ