



BIDDING DOCUMENT

Single Stage - Two Envelope Bidding Procedure

RE-RE-TENDER

**SUPPLY / FIXING / INSTALLATION /
COMMISSIONING OF HVAC FOR 3RD & 4TH FLOOR
OF SERO BIOLOGY BUILDING ON (TURNKEY
BASIS) AT OJHA CAMPUS, DUHS, KARACHI
REF NO: DUHS/W&S/2019/059**

**NIT NO. DUHS/W&S/2019/12
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A: INSTRUCTIONS TO BIDDERS. (ITB)

1. INTRODUCTION

1. GENERAL

1.1 Dow University of Health Sciences, Karachi intends to **SUPPLY / FIXING / INSTALLATION / COMMISSIONING OF HVAC FOR 3RD & 4TH FLOOR OF SEROBIOLOGY BUILDING ON (TURNKEY BASIS) AT OJHA CAMPUS, DUHS, KARACHI.**

2. ELIGIBLE BIDDERS

2.1. This Invitation for Bids is open to all original Manufacturers, within Pakistan and abroad, and their Authorized Agents / Importers / Bidders / Distributors.

2.2. A Bidder may be a natural person, private entity, government-owned entity or any combination of them with a formal intent to enter into an agreement or under an existing agreement in the form of a Joint Venture (JV). In the case of a JV:

- (a) all parties to the JV shall be jointly and severally liable for execution of the Contract in accordance with the Contract terms, and a relevant statement to this effect shall be included in the authorization mentioned under clause 2.2 (b), as well as in the Bid Form and the Form of Agreement (in case of a successful Bid); and
- (b) One of the partners shall be authorized to be in charge; and this authority shall be evidenced by submitting a power of attorney signed by legally authorized signatories of all the JV partners; and
- (c) The Bid, and in case of successful Bid, the Contract form, the contract shall be awarded to JV and signed by all the JV partners so as to be legally binding on all the partners;
- (d) The partner in charge shall be authorized to incur liabilities, receive payments and receive instructions for and on behalf of any or all partners of the joint venture;
- (e) A copy of the legally binding registered JV agreement entered into the joint venture must be provided by the joint venture partners and shall be submitted with the Bid. Failure to submit a valid JV Agreement along with the bid shall be the reason of disqualification.

2.3. Bidders should not be associated, or have been associated in the past, directly or indirectly, with a firm or any of its affiliates which have been engaged by the University to provide consulting services for the preparation of the design, specifications, and other documents to be used for the procurement of the goods to be purchased under this Invitation for Bids.

2.4. Government-owned enterprises may participate only if they are legally and financially autonomous, if they operate under commercial law, and if they are not a dependent agency of the Federal Govt. or Provincial Govt.

- 2.5. Bidder should not be eligible to bid if they are under a declaration of ineligibility for corrupt and fraudulent practices issued by any Government organization in accordance with sub **clause 34.1**.

3. ELIGIBLE GOODS

- 3.1 All goods and related services to be supplied under the contract shall have their origin in eligible source countries and all expenditures made under the contract shall be limited to such goods and services. For this purpose, the term “Goods” includes any Goods that are the subject of this Invitation for Bids and the term “Services” shall include related services such as transportation, insurance etc. **THE “ORIGIN” MEANS THE PLACE WHERE THE “GOODS” ARE MINED, GROWN, OR PRODUCED, OR THE PLACE FROM WHICH THE “RELATED SERVICES” ARE SUPPLIED.** Goods are produced through manufacturing or processing, or substantial and major assembly of ingredients / components, a commercially recognized product results that is substantially different in basic characteristics or in purpose or utility from its components.

THE BIDDING PROCEDURE

4. Single Stage - Two Envelope Procedure

- (a) Bid shall comprise a single package containing two separate envelopes. Each envelope shall contain separately the financial proposal and the technical proposal;
 - (b) Envelopes shall be marked as **“FINANCIAL PROPOSAL”** and **“TECHNICAL PROPOSAL”** in bold and legible letters to avoid confusion;
 - (c) Initially, only the envelope marked **“TECHNICAL PROPOSAL”** shall be opened;
 - (d) Envelope marked as **“FINANCIAL PROPOSAL”** shall be retained in the custody of the procuring agency without being opened;
 - (e) Procuring agency shall evaluate the technical proposal in a manner prescribed in advance, without reference to the price and reject any proposal which does not conform to the specified requirements;
 - (f) No amendments in the technical proposal shall be permitted during the technical evaluation;
 - (g) Financial proposals of technically qualified bids shall be opened publicly at a time, date and venue announced and communicated to the bidders in advance;
 - (h) Financial proposal of bids found technically non-responsive shall be returned unopened to the respective bidders; and
 - (j) Bid found to be the lowest evaluated or best evaluated bid shall be accepted.
- 4.2 The bids shall be opened in the presence of bidders or their authorized representative at the prescribed time, date and venue.

2. THE BIDDING DOCUMENTS

5. CONTENTS OF BIDDING DOCUMENTS

5.1 The Bidding Documents:

In addition to the Invitation for Bids (IFB) / Tender Notice, the bidding documents include:

- i. Instructions to Bidders (ITB);
- ii. General Conditions of Contract (GCC);
- iii. Special Conditions of Contract (SCC);
- iv. Schedule of Requirements;
- v. Technical Specifications;
- vi. Contract Form;
- vii. Manufacturer's Authorization Form;
- viii. Performance Guarantee Form;
- ix. Bid Form; and
- x. Price Schedules.

5.2 In case of discrepancies between the Invitation for Bids (IFB) / Tender Notice and the Bidding Documents, the Bidding Documents shall take precedence.

5.3 The bidders are expected to examine all instructions, forms, terms, and specifications in the bidding documents. Failure to furnish complete information required in the bidding documents or to submit a bid not substantially responsive to the bidding documents may result in rejection.

6. AMENDMENT / CLARIFICATION OF BIDDING DOCUMENTS

6.1 An interested bidder, who has obtained bidding documents, may request for clarification of contents of the bidding document in accordance with the Rule 23(1) of SPPRA Rules, 2010 (Amended upto date).

6.2 At any time prior to the deadline for submission of bids, the Procuring Agency may, for any reason, whether at its own initiative or in response to a clarification requested by a prospective Bidder, modify the bidding documents by amendment.

6.3 All prospective bidders that have received the bidding documents will be notified the amendment(s) in writing, which will be binding on them.

6.4 In order to allow prospective bidders reasonable time to take the amendment(s) into account in preparing their bids, the Procuring Agency may, at its discretion, extend the deadline for submission of the bids.

3. PREPARATION OF BIDS

7. LANGUAGE OF BID

7.1 Preparation of Bids

The bid prepared by the bidder, as well as all correspondence and documents relating to the bid exchanged by the bidder and the Procuring Agency shall be in English. Supporting documents and printed literature furnished by the bidder may be in another language provided these are accompanied by an accurate translation of the relevant passages in English, in which case for purposes of interpretation of the Bid, the translated version shall prevail.

8. DOCUMENTS COMPRISING THE BID

- 8.1 The bid prepared by the Bidder shall comprise the following:
- (a) Bid Form;
 - (b) Price Schedule;
 - (c) Documentary evidence to the effect that the Bidder is eligible to bid and is qualified to perform the Contract if its bid is accepted;
 - (d) Documentary evidence to the effect that the goods to be supplied by the Bidder are eligible goods and related services as defined in clause-3 and conform to the bidding documents; and
 - (e) Bid Security.

9. BID PRICES

- 9.1 The prices and discounts quoted by the Bidder in the Bid Form and in the Price Schedules shall conform to the requirements specified below.
- 9.2 All items in the Schedule of Supply must be listed and priced separately in the Price Schedules. If a Price Schedule shows items listed but not priced, their prices shall be assumed to be included in the prices of other items. Items not listed in the Price Schedule shall be assumed not to be included in the Bid.
- 9.3 The price to be quoted in the Bid Form shall be the total price of the Bid excluding any discounts offered.
- 9.4 The Bidder shall quote any unconditional discounts and the methodology for their application in the Bid Form.
- 9.5 Prices proposed in the Price Schedule Forms for Goods, shall be disaggregated, when appropriate. This disaggregation shall be solely for the purpose of facilitating the comparison of Bids by the Procuring Agency. This shall not in any way limit the Procuring Agency's right to contract on any of the terms offered:
- (a) Price Schedule For Goods offered from within the Procuring Agency's country:
 - (i) Detailed Specification of Stores
 - (ii) Model / Cat No.
 - (iii) Name of Manufacturer.
 - (iv) Country of Origin
 - (v) Quantity of Stores
 - (vi) Unit
 - (vii) the unit price of the goods quoted on delivered duty paid (DDP) basis, including all customs duties and sales and other taxes already paid or payable on the components and raw material used in the manufacture or assembly of goods, or on the previously imported goods of foreign origin;
 - (viii) If there is no mention of taxes, the offered/quoted price will be considered as inclusive of all prevailing taxes/duties. The benefit of exemption from or reduction in the GST or other taxes during the contract period shall be passed on to the Procuring Agency; and
 - (ix) the total price for the item.
 - (b) Price Schedule For Goods offered from outside the Procuring Agency's country:

- (i) Detailed Specification of Stores
- (ii) Model / Cat No.
- (iii) Name of Manufacturer.
- (iv) Country of Origin
- (v) Quantity of Stores
- (vi) Unit
- (vii) Currency of Bid
- (viii) the unit price of the goods quoted on CFR / CNF/ C&F / CPT basis (Karachi Port), in the Procuring Agency's country;
- (ix) the total price for the item in foreign currency.

9.6 Final Prices quoted by the Bidder shall be fixed during the Bidder's performance of the Contract and not subject to variation on any account. A Bid submitted with an adjustable price quotation shall be treated as nonresponsive and shall be rejected.

9.7 If it was proved during the contract period that bidder has supplied the contracted item(s) to any other purchasing agency in Pakistan at the prices lower than the contracted prices, the balance amount will be deducted from the bill and / or security deposit of the bidder.

10. BID CURRENCIES

10.1 Price shall be quoted in foreign currency for goods offered outside the Procuring Agency's country on CFR / CNF/ C&F / CPT Basis. **(FOR GROUP-A)**

10.2 Prices shall be quoted in Pakistani Rupees for goods offered within the Procuring Agency's country on delivered duty paid (DDP). **(FOR GROUP-B)**

11. DOCUMENTS ESTABLISHING BIDDER'S ELIGIBILITY AND QUALIFICATION

11.1 The documentary evidence of the Bidder's qualifications to perform the contract if its bid is accepted shall establish to the Procuring Agency's satisfaction:

- (a) that, in the case of a Bidder offering to supply goods under the contract which the Bidder did not manufacture or otherwise produce, the Bidder has been duly authorized by the goods' Manufacturer or producer to supply the goods in the Procuring Agency's country;
- (b) That the Bidder has the financial, technical, and production capability necessary to perform the contract;
- (c) that, in the case of a Bidder not doing business within the Procuring Agency's country, the Bidder is or will be (if awarded the contract) represented by an Agent in that country equipped, and able to carry out the Bidder's maintenance, repair, and spare parts-stocking obligations prescribed in the Conditions of Contract and/or Technical Specifications; and
- (d) That the Bidder meets the evaluation & qualification criteria of bidding document.

12. DOCUMENTS ESTABLISHING GOODS' ELIGIBILITY AND CONFORMITY TO BIDDING DOCUMENTS

- 12.1 Pursuant to ITB Clause 8, the Bidder shall furnish, as part of its bid, documents establishing the eligibility and conformity to the bidding documents of all goods and services which the Bidder proposes to supply under the contract.
- 12.2 The documentary evidence of the eligibility of the goods and services shall consist of a statement in the Price Schedule of the country of origin of the goods and services offered which shall be confirmed by a certificate of origin issued at the time of shipment.
- 12.3 The documentary evidence of conformity of the goods and services to the bidding documents may be in the form of literature, drawings, and data, and shall consist of:
- (a) a detailed description of the essential technical and performance characteristics of the goods; and
 - (b) an item-by-item commentary on the Procuring Agency's Technical Specifications demonstrating substantial responsiveness of the goods and services to those specifications, or a statement of deviations and exceptions to the provisions of the Technical Specifications.
- 12.4 For purposes of the commentary to be furnished pursuant to ITB Clause 12.3(b) above, the Bidder shall note that standards for workmanship, material, and equipment, as well as references to brand names or catalogue numbers designated by the Procuring Agency in its Technical Specifications, are intended to be descriptive only and not restrictive. The Bidder may substitute alternative standards, brand names, and/or catalogue numbers in its bid, provided that it demonstrates to the Procuring Agency's satisfaction that the substitutions ensure substantial equivalence to those designated in the Technical Specifications.

13. BID SECURITY

- 13.1 The Bidder shall furnish, as part of its proposal, a Bid Security in the amount and currency specified in the Bid Data Sheet and SCC. Unsuccessful bidders' Bid Security will be returned soon after approval of the successful Bidder. The successful Bidder's Bid Security will be discharged upon signing of contract and furnishing the Performance Security bond, duly guaranteed by a scheduled bank.
- 13.2 The Bid Security shall remain valid for a period of 28 days beyond the bid validity period.
- 13.3 The Bid Security is required to protect the Procuring Agency against the risk of Bidder's conduct, which would warrant the Security's forfeiture;
- 13.4 The Bid Security may be forfeited:
- (a) if a Bidder withdraws its bid during the period of bid validity; or
 - (b) in the case of a successful Bidder, the Bidder fails:
 - (i) to sign the Contract; or
 - (ii) to complete the supplies in accordance with the General Conditions of Contract.

14. BID VALIDITY

- 14.1 Bids shall remain valid for 90 days from the date of its opening. A bid valid for a shorter period shall be treated as non-responsive and rejected.
- 14.2 The Procuring Agency shall ordinarily be under an obligation to process and evaluate the bids within the stipulated bid validity period. However, for any reasons to be recorded in writing, if an extension is considered necessary, all those who have submitted their bids shall be asked to extend their respective bid validity period.

15. ALTERNATIVE BIDS

- 15.1 Unless otherwise indicated in the Bid Data Sheet, alternative bids shall not be considered.

4. SUBMISSION OF BIDS

16. SEALING AND MARKING OF BIDS

- 16.1 The envelopes shall:
- (a) bear the name and address of the Bidder;
 - (b) bear the specific identification Name and Number of this bidding process indicated in the Bid Data Sheet; and
 - (c) bear the Procuring Agency's name and address i.e. Dow University of Health Sciences, Directorate of Works & Services, Administration Block, Baba-e-Urdu Road, Karachi and a statement: **"DO NOT OPEN BEFORE,"** the time and date specified in the Bid Data Sheet.
- 16.2 If all envelopes are not sealed and marked as required, the Procuring Agency will assume no responsibility for the misplacement or premature opening of the bid.

17. DEADLINE FOR SUBMISSION OF BIDS

- 17.1 Bids must be submitted by the bidders and received by the Procuring Agency at the specified address not later than the time and date specified in the Bid Data Sheet.
- 17.2 The Procuring Agency may, at its convenience, extend this deadline for submission of bids by amending the bidding documents in which case all rights and obligations of the Procuring Agency and the Bidders previously subject to the deadline will thereafter be subject to the deadline as extended.

18. LATE BID

- 18.1 Any bid received by the Procuring Agency after the deadline for submission of bids prescribed by the Procuring Agency shall not be entertained and returned unopened to the bidder.

19. WITHDRAWAL OF BIDS

- 19.1 The Bidder may after its submission withdraw prior to the expiry of the deadline prescribed for submission of bids.

5. OPENING AND EVALUATION OF BIDS

20. OPENING OF BIDS BY THE PROCURING AGENCY

- 22.1 The Procuring Agency will open all bids in the presence of bidders' representatives who choose to attend, at the time, on the date, and at the place specified in the Bid Data Sheet. The bidders' representatives who are present shall sign a register evidencing their attendance.
- 22.2 The bidders' names, bid modifications or withdrawals, bid prices, discounts, and the presence or absence of requisite bid security and such other details as the Procuring Agency, at its discretion, may consider appropriate, will be announced at the opening. No bid shall be rejected at bid opening, except for late bids, which shall be returned unopened to the Bidder pursuant to ITB Clause 18.
- 22.3 Bids (and modifications sent pursuant to ITB Clause 19) that are not opened and read out at bid opening shall not be considered further for evaluation, irrespective of the circumstances. Withdrawn bids will be returned unopened to the bidders.

21. CLARIFICATION OF BIDS

- 21.1 During evaluation of the bids, the Procuring Agency may, at its discretion, ask the Bidder for a clarification of its bid. The request for clarification and the response shall be in writing, and no change in the prices or substance of the bid shall be sought, offered, or permitted.

22. PRELIMINARY EXAMINATION

- 22.1 The Procuring Agency will examine the bids to determine whether they are complete, whether any computational errors have been made, whether required sureties have been furnished, whether the documents have been properly signed, and whether the bids are generally in order.
- 22.2 Arithmetical errors will be rectified on the following basis. If there is a discrepancy between the unit price and the 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 the Supplier does not accept the correction of the errors, its bid will be rejected, and its bid security may be forfeited. If there is a discrepancy between words and figures, the amount in words will prevail.
- 22.3 The Procuring Agency may waive any minor informality, nonconformity, or irregularity in a bid which does not constitute a material deviation, provided such waiver does not prejudice or affect the relative ranking of any Bidder.
- 22.4 Prior to the detailed evaluation, pursuant to ITB Clause 23 the Procuring Agency will determine the substantial responsiveness of each bid to the bidding documents. For purposes of these Clauses, a substantially responsive bid is one which conforms to all the terms and conditions of the bidding documents without material deviations. Deviations from, or objections or reservations to critical provisions, such as those concerning Bid Security, Applicable Law, and Taxes and Duties, will be deemed to be a material deviation. The Procuring Agency's determination of a bid's responsiveness is to be based on the contents of the bid itself without recourse to extrinsic evidence.

- 22.5 If a bid is not substantially responsive, it will be rejected by the Procuring Agency and may not subsequently be made responsive by the Bidder by correction of the nonconformity.

23. EVALUATION AND COMPARISON OF BIDS

- 23.1 The Procuring Agency will evaluate and compare the bids which have been determined to be substantially responsive, pursuant to ITB Clause 22.
- 23.2 The Procuring Agency's evaluation of a bid will be on delivered duty paid (DDP) inclusive of prevailing duties/taxes and CFR / CNF/ C&F / CPT basis and will exclude any allowance for price adjustment during the period of execution of the contract, if provided in the bid.
- 23.3 The Procuring Agency's evaluation of a bid will take into account, in addition to the bid price quoted, one or more of the following factors, and quantified in ITB Clause 24:
- (a) **Incidental costs**
Incidental costs provided by the bidder will be added by Procuring Agency to the bid price at the final destination.
 - (b) **Delivery schedule offered in the bid**
The goods covered under this invitation are required to be delivered (shipped) within an acceptable range of weeks specified in the Schedule of Requirement.
 - (c) **Deviations in payment schedule from that specified in the Special Conditions of Contract**
Bidders shall state their bid price for the payment schedule outlined in the SCC. Bids will be evaluated on the basis of this base price. Bidders are, however, permitted to state an alternative payment schedule and indicate the reduction in bid price they wish to offer for such alternative payment schedule. The Procuring Agency may consider the alternative payment schedule offered by the selected Bidder.
 - (d) **Cost of components, mandatory spare parts, and service**
The Procuring Agency will estimate the cost of spare parts usage in the initial period of operation, based on information furnished by each Bidder, as well as on past experience of the Procuring Agency or other procuring agencies in similar situations. Such costs shall be added to the bid price for evaluation.
 - (e) **Availability of spare parts and after sales services for the equipment offered in the bid**
The cost to the Procuring Agency of establishing the minimum service facilities and parts inventories, as outlined in the Bid Data Sheet or elsewhere in the bidding documents, if quoted separately, shall be added to the bid price.
 - (f) **Projected operating and maintenance costs during the life of the equipment;**
Since the operating and maintenance costs of the goods under procurement form a major part of the life cycle cost of the equipment, these costs will be

evaluated in accordance with the criteria specified in the Bid Data Sheet or in the Technical Specifications.

(g) **Performance and productivity of the equipment offered**

Bidders shall state the guaranteed performance or efficiency in response to the Technical Specification. For each drop in the performance or efficiency below the norm of 100, an adjustment for an amount will be added to the bid price, representing the capitalized cost of additional operating costs over the life of the plant, using the methodology specified in the Bid Data Sheet or in the Technical Specifications.

23.4 For the purpose of comparison of bids quoted in different currencies, price shall be converted into Pakistani Rupees. The rate of exchange shall be the selling rate prevailing seven working days before the date of opening of the bids, as notified by the National Bank of Pakistan (NBP) / State Bank of Pakistan (SBP).

24. EVALUATION / QUALIFICATION CRITERIA

24.1 The procuring agency reserves the right to evaluate and compare the bids on itemized basis OR on the basis of a group of similar nature goods OR goods compatible with each other.

24.2 The following merit point system for weighing evaluation factors/criteria will be applied for technical proposals.

24.3 Bidders achieving minimum 70 marks will be considered only for further process. Documentary evidence must be attached in support of each parameter.

24.4 The Financial bid will be evaluated on the aggregated amount Group-A + Group-B in Pak Rupees. Conversion Rate should 7 (Seven) working days prior to open of bid date issue by NBP / SBP.

24.5 Any Bid not meeting the mandatory requirements of evaluation criteria will be disqualified / rejected straight away and will not be considered for further evaluation.

A. PRODUCT EVALUATION

S#	PARAMETERS / SUB-PARAMETERS	Total Marks
1	Conformity to the Purchaser's Specifications (Mandatory)	25
1.1	Fully compliant with the required specifications	25
1.2	Compliant with minor deviation (up to 10% subject to main function is not effected)	20
1.3	Non-compliant to required specifications	Disqualify
2	Product Certification	15
2.1	USA Food & Drug Administration (USA-FDA) and European Community (CE) MDD or Japan Industrial Standard (JIS) / Cooling Technology Institute (CTI) / Japan Quality Assurance Organization (JQAO) / Certificate issued by Ministry of Health, Labour and Welfare Govt. of Japan	15
2.2	European Community (CE) MDD and Japan Industrial Standard (JIS) / Japan Quality Assurance Organization (JQAO) / Certificate issued by Ministry of Health, Labour and Welfare Govt. of Japan	12
2.3	USA - Food and Drug Administration (USA-FDA)	10

2.4	European Community (CE) MDD	08
2.5	Japan Industrial Standard (JIS)/Japan Quality Assurance Organization (JQAO)/ Certificate issued by Ministry of Health, Labour and Welfare Govt. of Japan	08
TOTAL MARKS PRODUCT EVALUATION (A)		40

B. BIDDER EVALUATION

S#	PARAMETERS / SUB-PARAMETERS	Total Marks
3.	Manufacturer's Authorization (Mandatory)	10
3.1	Valid Authorization of Manufacturer of goods	10
3.2	Non-submission of valid manufacturer's authorization	Disqualify
4.	Legal Requirement (Mandatory)	08
4.1	Bid Form (without prices)	2
4.2	Tender Purchase Receipt	2
4.3	Taxation Certificate (NTN and GST)	2
4.4	Affidavit on Stamp Paper of Rs. 100/- that: <ul style="list-style-type: none"> - Bidder is not involved in any litigation with the Public / Private Sector University / Government / Semi Government Organization (Provincial / Federal / Local). - Bidder is not black listed by any Public / Private Sector University / Government / Semi Government Organization (Provincial/Federal / Local). 	2
5.	Technical Staff	10
5.1	Diploma Engineers in relevant field duly trained by OEM for required equipment (2 mark for each)	4
5.2	Graduate Engineers in relevant field duly trained by OEM for required equipment (2 marks for each)	6
6.	Networking and Training	6
6.1	Networking setup across Pakistan (1 mark for each setup)	4
6.2	Certificate to affect that the firm will provide training in the use of equipment to the relevant technical staff. Training plan must be attached with certificate	2
7.	Delivery Schedule at consignees end	4
7.1	Up to 5 months or earlier (CFR / CNF/ C&F / CPT or DDP)	4
7.2	More than 6 months	0
8.	Past Experience / Performance of Last 3 years	5
8.1	Bidder's prior experience for supplying the quoted or better equipment to the Public / Private Sector Universities / Government / Semi-Government Organization (Provincial / Federal / Local) in Pakistan during the last 3 years . Documentary evidence in shape of Purchase Order and Installation Report / Satisfactory performance certificate must be attached. (1 mark for supply of each equipment / instrument)	5
9.	Average Annual Turnover during the last three (03) years (financial year 2015-16, 2016-17 & 2017-18) (In case of Joint Venture the financial information is required from the Lead Member only)	8
9.1	Turn over below 50 million	0
9.2	Turn over above 50 million	2
9.3	Turn over above 100 million	4
9.4	Turn over above 150 million	8

S#	PARAMETERS / SUB-PARAMETERS	Total Marks
10.	Financial Statements for financial year 2015-16, 2016-17 & 2017-18	4
10.1	Audited statement of Accounts, for last three years	2
10.2	Provision of copy of Income Tax Return Forms, for last three years	2
11.	Bonus points	5
11.1	Extended Warranty period free of cost (at least one year) (the bidder who offered greater period will get the marks)	5
	TOTAL BIDDER EVALUATION (B)	60
	GRAND TOTAL (A + B)	100

24.5 Only those item's Financial offer will be announced / considered which were technically qualify by the Committee. Bidders are advised to give separate sealed envelope (s) of every quoted item and should mention the name of the item and tender serial number on the front of the sealed envelope in **BOLD and legible letters** to avoid confusion, otherwise, the Financial Proposal Envelope will be opened on qualified item basis and it will not be challenged by the bidder that procuring agency has opened the Financial Proposal of the disqualified items besides qualified items.

24.6 **Litigation History**

The Bidder should not be involved in any litigation with the Public / Private Sector University / Government Organization (Provincial / Federal / Local), else their bid will be rejected.

25. CONTACTING THE PROCURING AGENCY

25.1 No bidder shall contact the Procuring Agency on any matter relating to its bid, from the time of the bid opening to the time the Contract is awarded. If any bidder wishes to bring additional information to the notice of the Procuring Agency, it may do so in writing.

25.2 Any direct or indirect effort by a bidding firm to influence the Procuring Agency during the process of selection of a bidder or award of contract may besides rejection of its bid result into its disqualification from participation in the Procuring Agency's future bids.

26. REJECTION OF BIDS

26.1 Notwithstanding anything stated here-before after the Procuring Agency may reject any or all bids at any time prior to the acceptance of a bid. The Procuring Agency may upon request, communicate to a bidder, the grounds for its rejection, but shall not be under obligation to justify those grounds.

27. RE-BIDDING

27.1 If the Procuring Agency has rejected all bids, it may move for a re-bidding or may seek any alternative method of procurement under the provisions of the prevailing Rules.

28. ANNOUNCEMENT OF EVALUATION REPORT

28.1 The Procuring Agency will announce the Evaluation Report and the resultant acceptance or rejection of bids at least seven days prior to the award of procurement contract.

25 AWARD OF CONTRACT

29. ACCEPTANCE OF BID AND AWARD CRITERIA

29.1 The bidder with lowest evaluated bid under clause 22, 23 & 24, if not in conflict with any other law, rules, regulations or policy of the Government, will be awarded the contract within the original or extended period of bid validity.

30. PROCURING AGENCY'S RIGHT TO VERY QUANTITIES

30.1 The Procuring Agency reserves the right to increase or decrease the quantity of stores originally specified in the Price Schedule and Schedule of Requirements without any change in unit price or other terms and conditions.

31. NOTIFICATION OF AWARD

31.1 Prior to the expiry of the original or extended period of bid validity, the successful bidder will be informed in writing of acceptance of its bid by the Procuring Agency.

32. SIGNING OF CONTRACT

33.1 While conveying acceptance of bid to the successful bidder, the Procuring Agency will send the bidder Contract Form provided in the bidding documents, incorporating all points of agreement between the Parties.

33.2 Ten days after the official announcement of the award, both the successful Bidder and the Procuring Agency will sign and date the Contract on legal stamp paper valuing 0.35% of the value of contract, (cost shall be borne by the bidder). In case the successful Bidder, after completion of all codal formalities, shows inability to sign the Contract, its Bid Security shall be forfeited. The firm may also be blacklisted from taking part in any future bidding of Procuring Agency for a period upto five Years. In such a situation, the Procuring Agency may make the award to the next lowest evaluated responsive bidder or move for re-bid.

33. PERFORMANCE SECURITY

34.1 The successful Bidder shall furnish Performance Security. Upon submission of Performance Security the Bid Security will be returned to the Bidder. The amount of Performance Security is specified at Bid Data Sheet.

34.2 Failure of the successful Bidder to comply with any of the requirements specified in this document shall be considered as sufficient grounds for the annulment of the award and forfeiture of the Bid Security, in which event the Procuring Agency may make the award to the next lowest evaluated Bidder at the risk and cost of the former.

34. CORRUPT OR FRAUDULENT PRACTICES

- 34.1 (a) the Procuring Agency and the Bidders / Manufacturers / Contractors are expected to observe the highest standard of ethics during the procurement and execution of the Contract. In pursuance of this policy, the relevant terms / phrases as may apply are defined below:
- (h) "corrupt practice" means the offering, giving, receiving or soliciting of anything of value to influence the action of a public official in the procurement process or in Contract execution; and
 - (ii) "fraudulent practice" means a misrepresentation of facts in order to influence a procurement process or the execution of a Contract to the detriment of the Procuring Agency, and includes collusive practice among Bidders (prior to or after bid submission) designed to establish bid prices at artificial noncompetitive levels and to deprive the Procuring Agency of the benefits of free and open competition;
- (b) the Procuring Agency will take all possible administrative / legal measures if it is found that the Bidder recommended for award was / is engaged in corrupt or fraudulent practice(s) before or after signing of the contract resulting into the conviction of the proprietor under criminal case besides blacklisting of the firm either indefinitely or for such period of time as may be determined by the Procuring Agency.
- (c) will declare a firm ineligible, either indefinitely or for a stated period of time, for the award of a Contract if it, at any time, determines that the firm has engaged in corrupt or fraudulent practices in competing for or in executing a Contract.

B: GENERAL CONDITIONS OF CONTRACT (GCC)

1. DEFINITIONS

1.1 In this Contract, the following terms shall be interpreted as indicated:

- (a) "The Contract" means the agreement entered into between the Procuring Agency and the Bidder, as recorded in the Contract Form signed by the Parties, including all attachments and appendices thereto and all documents incorporated by reference therein.
- (b) "The Contract Price" means the price payable to the Bidder under the Contract for the full and proper performance of its Contractual obligations.
- (c) "Goods" means all of the commodities, raw material, machinery and equipment, and/or other materials that the Supplier is required to supply to the Procuring Agency under the Contract.
- (d) "Related Services" means the services incidental to the supply of the goods, such as insurance, installation, training and initial maintenance, printing of special instructions on the label and packing, design and logo of the Procuring Agency, transportation of goods up to the desired destinations and other such obligations of the Bidder covered under the Contract.
- (e) "GCC" means the General Conditions of Contract contained in this section.
- (f) "SCC" means the Special Conditions of Contract.
- (g) "The Procuring Agency" means the Dow University of Health Sciences, Karachi.
- (h) "The Bidder" means the individual or firm supplying the goods under this Contract.
- (i) "Day" means official working day excluding national holidays.

2. APPLICATION

2.1 These General Conditions shall apply to the extent that they are not inconsistent with provisions of other parts of the Contract.

3. STANDARDS

3.1 The goods supplied under this Contract shall conform to the standards mentioned in the Technical Specifications goods eligibility criteria.

4. USE OF CONTRACT DOCUMENTS AND INFORMATION

4.1 The Bidder shall not without the Procuring Agency's prior written consent, disclose the Contract, or any provision thereof, or any specification, plan, drawing, pattern; sample, or information furnished by or on behalf of the Procuring Agency in connection therewith, to any person other than a person employed by the Bidder in the performance of the Contract. Disclosure to such employed person shall be made in confidence and shall extend only, as far as may be necessary, to such performance and not further or otherwise.

4.2 Any document, other than the Contract itself, shall remain the property of the Procuring Agency and shall be returned (all copies) on completion of the Bidder's performance under the Contract.

4.3 The Bidder shall permit the Procuring Agency to inspect the Bidder's accounts and records relating to the performance of the Supplies.

5. PATENT RIGHTS

5.1 The Bidder shall indemnify the Procuring Agency against all third-party claims of infringement of patent, trademark, or industrial design rights arising from use of the Goods or any part thereof in the country.

6. ENSURING STORAGE ARRANGEMENTS

6.1 To ensure storage arrangements for the intended supplies, the Bidder shall inform the Procuring Agency at least two weeks prior to the arrival of the consignments at its store/warehouse. However, in case no space is available at its store/warehouse at the time of supply, the Procuring Agency shall, seven days prior to such a situation, inform the Bidder, in writing, of the possible time-frame of availability of space by which the supplies could be made. In case the Bidder abides by the given time frame, he will not be penalized for delay.

7. INSPECTIONS, TESTS AND TRAINING

7.1 The Procuring Agency or its representative shall have the right to inspect and/or test the goods to confirm their conformity to the Contract specifications at the cost payable by the Bidder.

7.2 The Procuring Agency's right to inspect, test and, where necessary, reject the goods either at Bidder's premises or upon arrival at Procuring Agency's destinations shall in no way be limited or waived by reasons of the goods having previously been inspected, tested, and approved by the Procuring Agency or its representative prior to the goods shipment from the manufacturing point.

7.3 Any specialized training required for the smooth operation of the goods shall be the responsibility of the Bidder.

8. DELIVERY AND DOCUMENTS

8.1 The Bidder shall in accordance with the terms specified in the Schedule of Requirements make delivery of the goods. Details of documents to be furnished by the Bidder are specified in SCC.

9. INSURANCE

9.1 The goods supplied under the Contract shall be delivered to the Procuring Agency after the payment of all taxes and customs duty, cess, octroi charges etc. Risk will be transferred to the Procuring Agency only after the delivery of these goods has been made to the Procuring Agency. Hence, payment of insurance premium, if any, shall be the responsibility of the Bidder.

10. TRANSPORTATION

10.1 The Bidder shall arrange such transportation of the goods as is required to prevent them from damage or deterioration during transit to their final destination as indicated in the Schedule of Requirements.

10.2 The goods shall be supplied on "**D.D.P**" basis at the Dow University of Health Sciences, Karachi AND / OR "**CFR / CNF/ C&F / CPT**" Basis at Karachi Port as per Schedule of Requirements on the risk and cost of the Bidder. Transportation including loading/unloading of goods shall be the responsibility of Bidder.

11. INCIDENTAL SERVICES

11.1 The Bidder will be required to provide to the Procuring Agency incidental services the cost of which should be included in the total bid price.

12. WARRANTY / GUARANTEE

12.1 The term period of warranty / guarantee mean the period of twelve **(12) months or in accordance with extended warranty period** form the date on which the Stores have been put into operation and demonstrated to the University staff. In any case this period shall not exceed six months beyond the warranty expiration period from the date of taking-over of goods.

12.2 During the period of warranty / guarantee, the Contractor shall remedy, at his / her expense, all defects in design, materials, and workmanship that may develop or are revealed under normal use of the goods upon receiving written notice from the University; the notice shall indicate in what respect the goods are faulty.

12.3 The provisions of this Clause include all the expenses that the Contractor may have to incur for delivery and installation of such replacement parts, material and equipment as are needed for satisfactory operation of the goods at the University premises.

12.4 The contractor shall provide warranty / guarantee for supply of equipment's for at least 05 years (where applicable).

12.5 The contractor shall remain responsible for providing after sale services even after expiry of warranty / guarantee period and sign a Service Contract including Parts with Procuring Agency for 05 years (minimum). Bidder shall separately quote the price of service contract inclusive of parts.

12.6 The Procuring Agency shall promptly notify the Bidder in writing of any claims arising out of this warranty.

13. PAYMENT

13.1 The method and conditions of payment to be made to the Bidder under this Contract are specified in SCC.

14. ASSIGNMENT

14.1 The Bidder shall not assign, in whole or in part, its obligations to perform to another party under this Contract, except with the Procuring Agency's prior written consent.

15. DELAYS IN THE BIDDER'S PERFORMANCE

15.1 Delivery of the goods shall be made by the Bidder in accordance with the time schedule prescribed by the Procuring Agency in the Schedule of Requirements / Contract Award.

15.2 If at any time in the course of performance of the Contract, the Bidder encounters anything impeding timely delivery of the goods, he shall promptly notify the

Procuring Agency in writing of the causes of delay and its likely duration. As soon as practicable, after receipt of the Bidder's notice, the Procuring Agency shall evaluate the situation and may, depending on merits of the situation, extend the Bidder's time for performance, with or without liquidated damages, in which case the extension shall be ratified by the Parties by a supplementary Contract to be treated as an addendum to the original contract.

- 15.3 Any undue delay by the Bidder in the performance of its delivery obligations shall render it liable to the imposition of liquidated damages.

16. PENALTIES LIQUIDATED DAMAGES

- 16.1 In case of late delivery, even for reasons beyond control, penalty as specified in SCC will be imposed upon the Bidder / Manufacturer. The Procuring Agency may consider termination of the Contract in case there is an unusual delay in the delivery of the goods whereby the ongoing activity is likely to be affected seriously.

17. TERMINATION FOR DEFAULT

- 17.1 The Procuring Agency may, without prejudice to any other remedy for breach of Contract, by a written notice of default sent to the Bidder, terminate this Contract in whole or in part if:
- (a) the Bidder fails to deliver any or all installments of the goods within the period(s) specified in the Contract, or within any extension thereof granted by the Procuring Agency;
 - (b) the Bidder fails to perform any other obligation(s) under the Contract to the satisfaction of the Procuring Agency; and
 - (c) the Bidder, in the judgment of the Procuring Agency, has engaged itself in corrupt or fraudulent practices before or after executing the Contract.

18. FORCE MAJEURE

- 18.1 The Bidder shall not be liable for forfeiture of its Performance Guaranty/ Bid Security, or termination / blacklisting for default if and to the extent that this delay in performance or other failure to perform its obligations under the Contract is the result of an event of Force Majeure. For the purposes of this Clause Force Majeure means an act of God or an event beyond the control of the Bidder and not involving the Bidder's fault or negligence directly or indirectly purporting to mal-planning, mismanagement and /or lack of foresight to handle the situation. Such events may include but are not restricted to acts of the Procuring Agency in its sovereign capacity, wars or revolutions, fires, floods, earthquakes, strikes, epidemics, quarantine restrictions and freight embargoes. If a Force Majeure situation arises, the Bidder shall promptly notify the Procuring Agency in writing with sufficient and valid evidence of such condition and the cause thereof. The Committee, constituted for redressing grievances, will examine the pros and cons of the case and all reasonable alternative means for completion of purchase order under the Contract and will submit its recommendations to the competent authority. However, unless otherwise directed by the Procuring Agency in writing, the Bidder shall continue to perform its obligations under the Contract as far as is reasonably practical and shall seek reasonable' alternative means for performance not prevented by the Force Majeure event.

19. TERMINATION FOR INSOLVENCY

- 19.1 The Procuring Agency may at any time terminate the Contract by giving written notice of one month time to the Bidder if the Bidder becomes bankrupt or otherwise insolvent. In that event, termination will be without compensation to the Bidder, provided that such termination will not prejudice or affect any right or remedy which has accrued or will accrue thereafter to the Parties.

20. ARBITRATION AND RESOLUTION OF DISPUTES

- 20.1 The Procuring Agency and the Bidder shall make every effort to resolve amicably by direct informal negotiations any disagreement or dispute arising between them under or in connection with the Contract.
- 20.2 If, after thirty (30) days from the commencement of such informal negotiations, the Procuring Agency and the Bidder have been unable to resolve amicably a Contract dispute, either party may require that the dispute be referred to the Arbitrator for resolution through arbitration.
- 20.3 In case of any dispute concerning the interpretation and/or application of this Contract is to be settled through arbitration, the arbitrator to be appointed with the approval of the University's Syndicate. The decisions taken and/or award given by the sole arbitrator shall be final and binding on the Parties.

21. PACKING

- 21.1 The Bidder shall provide such packing of the Goods as is required to prevent their damage or deterioration during transit to their final destination, as indicated in the Contract. The packing shall be sufficient to withstand, without limitation, rough handling during transit and exposure to extreme temperatures, salt and precipitation during transit, and open storage. Packing case size and weights shall take into consideration, where appropriate, the remoteness of the Goods' final destination and the absence of heavy handling facilities at all points in transit.
- 21.2 The packing, marking, and documentation within and outside the packages shall comply strictly with such special requirements as shall be expressly provided for in the Contract, including additional requirements, if any, specified in SCC, and in any subsequent instructions ordered by the Procuring Agency.

22. GOVERNING LANGUAGE

- 22.1 The Contract shall be written in English language. All correspondence and other documents pertaining to the Contract, which are exchanged by the Parties, shall be written in English.

23. APPLICABLE LAW

- 23.1 This Contract shall be governed by the laws of Pakistan and the courts of Karachi - Pakistan shall have exclusive jurisdiction.

C: NOTICE INVITING TENDER (NIT)

DOW UNIVERSITY OF HEALTH SCIENCES



RE-RE-TENDER NOTICE

No. DUHS/W&S/2019/12

Dated: November 21, 2019

Dow University of Health Sciences, (DUHS), Karachi invites following bids from eligible Bidders/authorized Dealers / Distributors / Manufacturers, having registration with Federal Board of Revenue (FBR) for Income Tax, Sales Tax and Pakistan Engineering Council (PEC) in appropriate category if applicable for following work.

S. No.	NAME OF WORK	ESTIMATE COST	METHOD OF PROCUREMENT	COMPLETION PERIOD
1.	Supply / Fixing / Installation / Commissioning of HVAC for 3rd & 4th Floor of Serobiology Building on (Turnkey Basis) at Ojha Campus, DUHS, Karachi Ref No: DUHS/W&S/2019/59	Quoted Rate	Single Stage Two Envelope	06 Months

Tender Fee	Rs. 2,000/- (Rupees Two Thousand Only) Non-Refundable in shape of Pay Order / Demand Draft in favor of Dow University of Health Sciences, Karachi.
Bid Security	2.5% of the Total Bid Value.
Purchasing Date & Time	25-11-2019 to 14-12-2019 (11 a.m to 02 p.m)
Bids Delivery & Opening Date & Time	16-12-2019 at 11:00 a.m. & 11:30 a.m.

Detailed Specification are mentioned in the prescribed tender documents alongwith terms and conditions. Bidding documents can be obtained from the Office of the Project Director, Works & Services, 3rd Floor, Administration Block, Dow University of Health Sciences, Karachi and downloaded from SPPRA website or Dow University of Health Sciences, website. Conditional Bids, Telegraphic Bids, Bids not accompanied by Bid Security of required amount and form, bids received after specific date and time and bids of Black Listed firms will be rejected.

In case of any unforeseen situation or government holiday resulting in closure of office on the date of opening, bids shall be submitted / opened on next working day at the given time.

The Dow University of Health Sciences, Karachi (DUHS) reserves the right to reject any or all the bids subject to the relevant provisions of SPP Rules 2010 (Amended upto date).

PROJECT DIRECTOR

Works & Services Department,
Dow University of Health Sciences, Karachi

www.duhs.edu.pk

Baba-e-Urdu Road, Karachi - 74200 Pakistan.
Tel: 021-99216065 Fax: 021-99216065

PID(K) 1829

D: Bid Data Sheet

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

INTRODUCTION

ITB 1.1 Name of Procuring Agency: Dow University of Health Sciences, Karachi.

ITB 1.1 Name of Contract:
SUPPLY / FIXING / INSTALLATION / COMMISSIONING OF HVAC FOR 3RD & 4TH FLOOR OF SEROBIOLOGY BUILDING ON (TURNKEY BASIS) AT OJHA CAMPUS, DUHS, KARACHI

THE BIDDING PROCEDURE

ITB 4.1 Bids shall be accepted under the **Single Stage – Two Envelope Procedure**.

PREPARATION OF BIDS

ITB 7.1 Language of the bid shall be English

ITB 9.6 **For the Goods offered from Outside the Procuring Agency's Country:** the price quoted shall be on **CFR / CNF/ C&F / CPT Karachi Basis.**
(FOR GROUP-A)

For the Goods offered within the Procuring Agency's Country: the price quoted shall be on **delivered duty paid (DDP) Basis** at Consignee's End.
(FOR GROUP-B)

ITB 10.1 **For the Goods offered within the Procuring Agency's Country:** the price quoted shall be in **Pak Rupees.**

ITB 10.2 **For the Goods offered from Outside the Procuring Agency's Country:** the price quoted shall be in **Foreign Currency.**

ITB 13.1 The Bid Security shall not be less than **2.5%** of the total Bid price in Pak Rupees. If bidder elects to submit alternate bid / proposal(s), the Bid Security shall be attached for higher bid amount, otherwise both proposals / bids will be rejected.

ITB 14.1 Bid validity period shall be **90 days.**

ITB 15.1 **Alternate Bids shall not be allowed, if any bidder elects to submit alternative bid(s) / proposal(s), both bids viz. ORIGINAL and ALTERATIVE will be rejected straightaway.**

SUBMISSION OF BIDS

ITB 16.1 (b) The identification of this bidding process is:
**SUPPLY / FIXING / INSTALLATION / COMMISSIONING OF HVAC FOR
3RD & 4TH FLOOR OF SEROBIOLOGY BUILDING ON (TURNKEY
BASIS) AT OJHA CAMPUS, DUHS, KARACHI.
(REF NO: DUHS/W&S/2019/052)
NIT # DUHS/W&S/2019/12, DATED: 21-11-2019**

ITB 16.1 (c) Dow University of Health Sciences, Directorate of Works & Services,
Administration Block, Baba-e-Urdu Road, Karachi.

“Must bear the name of the bidder” and a warning **“Do Not Opened Before the
time and date of bid opening”**.

ITB 17.1 Deadline for bid submission: **16th December 2019 up to 11:00 a.m.**

OPENING & EVALUATION OF BIDS

ITB 20.1 The bid opening shall take place at:
Dow University of Health Sciences, Directorate of Works & Services,
Administration Block, Baba-e-Urdu Road, Karachi

Date: **DECEMBER 16, 2019**

Time: **11:30 a.m.**

CONTRACT AWARD

ITB 31.1 Qty. could be increased or decreased during the contract period (including
extended period) according to the actual requirement.

ITB 34.1 The successful Bidder shall furnish the Performance Security equivalent to **5%** of
the total Contract amount from any scheduled banks in shape of Pay Order /
Demand Draft / Call Deposit / Bank Guarantee. The Performance
Guarantee/Security Form is provided in the bidding documents. Upon submission
of Performance Security / Guarantee the Bid Security would be returned to the
Bidder.

E: Special Conditions of Contract (SCC)

1. DEFINITIONS (GCC CLAUSE 1)

GCC 1.1 (g) The Procuring Agency is the Dow University of Health Sciences, Karachi.

GCC 1.1 (h) The Bidder is: _____
(Name and address of the successful bidder)

2. BID SECURITY (ITB CLAUSE 13)

ITB 13.1 The Bidder shall furnish, as part of its financial proposal/bid, refundable Bid Security in Pak Rupees @ **2.5%** of the total bid value In the shape of Bank Draft / Pay Order / Call Deposit / Bank Guarantee in the name of the Dow University of Health Sciences, Karachi. The financial bid found deficient of the Bid Security will be rejected. No personal cheque in lieu thereof will be acceptable at any cost. The previous Bid Security, if any, will not be considered or carried forward. However, the Bid Security of the successful Bidder will be returned upon submission of Performance Security equal to **5%** of the Contract amount that will remain with the Dow University of Health Sciences, Karachi till satisfactory completion of the Contract period. After delivery and acceptance of the Goods, the performance security shall be reduced to two (2) percent of the Contract Price to cover the Supplier's warranty obligations

3. INSPECTIONS, TESTS AND TRAINING (GCC CLAUSE 7)

GCC 7.1, 7.2 & 7.3 The goods received in the Dow University of Health Services, Karachi from the Bidder will be thoroughly inspected and examine by a Committee to make sure that the goods received conform to the specifications laid down in the bid documents and which have been approved by the Procurement Committee for procurement. The Committee will submit its inspection report, any deficiency pointed out by the Committee shall have to be rectified by the Bidder free of cost. The Bidder will be responsible to provide the Foreign and or Local Training to the University Staff for the specialized Equipment.

4. DELIVERY AND DOCUMENTS (GCC CLAUSE 8)

GCC Clause 8.1 *(a) For Goods from within the Procuring Agency's country:*

The Bidder shall provide the following documents at the time of delivery of goods to the Store / Warehouse of the Dow University of Health Sciences, Karachi for verification duly completed in all respects:

- i. Original copies of Delivery Note (Delivery Challan) (in duplicate) showing item's description, make, model, quantity as well as Lot Number, Batch Number, Registration Number, manufacturing and expiry dates (if applicable).
- ii. Original copies of the Bidder's invoices (in duplicate) showing warranty, item's description, make, model as well as Lot Number, Batch Number, Registration Number, manufacturing and expiry dates (if applicable) per unit cost, and total amount.

- iii. Original copies of the Sales Tax Invoices (where applicable) in duplicate showing item's description, quantity, per unit cost (without GST), amount of GST and total amount (with GST).
- iv. Manufacturer's or Bidder's warranty certificate.
- v. Inspection certificate issued by the nominated inspection committee along with Bidder's factory inspection report.
- vi. Certificate of origin.

(b) For Goods supplied from abroad as per INCOTERM CFR / CNF/ C&F / CPT Karachi:

Details of shipping and documents to be furnished by the Bidder shall be:

Upon shipment, the Bidder shall notify the Procuring Agency and the Insurance Company by telex or fax or email the full details of the shipment, including Contract number, description of Goods, quantity, the vessel / flight, the Bill of Lading / Air Way Bill number and date, port of loading, date of shipment, port of discharge, etc. The Bidder shall send the following documents to the Procuring Agency, with a copy to the Insurance Company:

- i. 04 copies of the Bidder's invoice showing the description of the Goods, quantity, unit price, and total amount.
- ii. Original and 04 copies of the negotiable, clean, on-board bill of lading / air way bill marked "freight prepaid" and 04 copies of non-negotiable bill of lading / air way bill.
- iii. 04 copies of the packing list identifying contents of each package.
- iv. Insurance certificate.
- v. Manufacturer's or Bidder's warranty certificate.
- v. Inspection certificate, issued by the nominated inspection agency along with Bidder's factory inspection report.
- vi. Certificate of origin.

The Procuring Agency shall receive the above documents at least one week before arrival of the Goods at the port or place of arrival and, if not received, the Bidder will be responsible for any consequent expenses.

5. INSURANCE (GCC CLAUSE 9)

GCC 9.1 The goods supplied under the Contract shall be on DDP / CFR / CNF/ C&F / CPT basis at consignee's end under which risk will be transferred to the Procuring Agency only after it has taken delivery of the goods. Hence insurance coverage is Bidder's responsibility.

6. WARRANTY / GUARANTEE (GCC CLAUSE 12)

GCC 12.1 The goods shall be accompanied by manufacturer standard warranty / guarantee or 1 year or extended warranty, whichever is more.

GCC 12.2 The Procuring Agency shall promptly notify the Bidder in writing of any claims arising out of this warranty.

GCC 12.3 **The bidder shall separately quote the price of post warranty service contract inclusive of parts for 5 years (minimum) in term of %age for total contract value.**

7. PAYMENT (GCC CLAUSE 13)

GCC 13.1 The method and conditions of payment to be made to the Bidder under this Contract shall be as follows:

i. For Goods supplied from within the Procuring Agency's country:

- (a) Payment shall be made in Pak Rupees.
- (b) The payment will be made to the Bidder within 30 days of the receipt of original delivery Challan(s) and invoice(s) in duplicate duly completed in all respect and signed and stamped by the Chairman of the Inspection Committee. The Inspection Committee will prepare and submit a report of physical inspection with a certificate to the effect that the goods conform to the specifications laid down in the bidding documents.

OR

ii. For Goods supplied from outside the Procuring Agency's country:

- (a) The Procuring Agency shall pay the Bidder or its Principal through irrevocable letter of credit opened in favor of the Bidder or Its Principal in a bank in its country, upon submission of all the requisite documents.
- (b) Bidder will bear all the additional bank charges inside and outside the Procuring Agency country on account of Confirmation of L/C, if he desire to establish a Confirmed L/C etc.

OR

ii. For Goods supplied from outside the Procuring Agency's country:

- (a) The Procuring Agency shall pay the Bidder or its Principal through **3 years deferred payment** by irrevocable letter of credit opened in favor of the Bidder or Its Principal in a bank in its country, upon submission of all the requisite documents.
- (b) Bidder will bear all the additional bank charges inside and outside the Procuring Agency country on account of Confirmation of L/C, if he desire to establish a Confirmed L/C etc.

8. PENALTIES/ LIQUIDATED DAMAGES (GCC CLAUSE 16)

GCC 16.1 In case deliveries are not completed within the time frame specified in the schedule of requirements / contract, a Show Cause Notice will be served on the Bidder which will be following by cancellation of the Contract to the extent of non-delivered portion of installments. No supplies will be accepted and the amount of Performance Guarantee / Security to the extent of non-delivered portion of supplies of relevant installments will be forfeited. If the firm fails to supply the whole installments, the entire amount of Performance Guarantee/Security will be forfeited to the Government Account and the firm will be blacklisted at least for two years for future participation in bids:

The liquidated damage shall be 0.5 % per week or part thereof. The maximum amount of liquidated damages shall be 10% of the amount of contract. Once the cumulative amount of liquidated damages reaches ten percent (10%) of the amount

of the contract, the Procuring Agency shall rescind the contract, without prejudice to other courses of action and remedies open to it.

9. ARBITRATION" AND RESOLUTION OF DISPUTES (GCC CLAUSE 20)

GCC 20.3 Dispute resolution mechanism to be applied shall be as follows:

In case of any dispute concerning the interpretation and/or application of this Contract is to be settled through arbitration, the arbitrator to be appointed with the approval of the University's Syndicate. The decisions taken and/or award given by the sole arbitrator shall be final and binding on the Parties

10. PACKING (GCC CLAUSE 21)

GCC 21.1 The packing, marking and documentation within and outside the packages shall be as per manufacturer standards meeting the safety requirements of the goods.

12. GOVERNING LANGUAGE (GCC CLAUSE 22)

GCC 22.1 The language of this Contract shall be English.

11. APPLICABLE LAWS (GCC CLAUSE 23)

GCC 23.1 The Contract shall be governed by the Laws of Pakistan and the Courts of Pakistan shall have exclusive jurisdiction.

12. NOTICES

Procuring Agency's address for notice purposes:

Dow University of Health Sciences, Directorate of Works & Services,
Administration Block, Baba-e-Urdu Road, Karachi
Phone No. + 92-21-99216065
Email: rahim.khan@duhs.edu.pk

Bidder's address for notice purposes:

Name of Bidder: _____

Name of Contact Person & Designation: _____

Phone No. _____

Fax No. _____

Mobile Phone No. _____

Email Address _____

F: SCHEDULE OF REQUIREMENTS

1. SCHEDULE OF REQUIREMENTS

1.1 For Goods supplied from within the Procuring Agency's country (DDP Basis)

- i) The entire quantity of the ordered goods shall be delivered within **5 months** or earlier from the date of issuance of supply order / contract award.
- ii) The delivery period shall start from the date of contract signature.

1.2 For Goods supplied from outside the Procuring Agency's country (C&F / CFR / CNF / CPT Basis):

- i. The shipment of the items of Stores which are to be imported shall be started as early as possible (**goods must be delivered within the approved delivery period**); the shipment schedule shall be submitted along with the offer, and shall be negotiable and subject to approval by the University.
- ii. The bidder must indicate in his offer the port **from where** the Stores will be **shipped**.
- iii. The shipment period shall start from the date of opening of irrevocable letter of credit. The bidder must provide the Proforma Invoice and Marine Cover Note within 7 calendar days from the signing of contract agreement.

G: TECHNICAL SPECIFICATIONS

SUPPLY / FIXING / INSTALLATION / COMMISSIONING OF HVAC FOR 3RD & 4TH FLOOR OF SERO BIOLOGY BUILDING ON (TURNKEY BASIS) AT OJHA CAMPUS, DUHS, KARACHI

GROUP-A

S. No	DESCRIPTION	Units	QTY
1	2	3	4
1	<p>Supply of Centrifugal Oil Free Magnetic Bearing Water Cooled Chiller with VFD and Controls including supply of following essential spare parts as supplied with chiller.</p> <p>(a) Centrifugal Compressor (One No.) (b) Switchboard (One No.) (c) Graphical Panel (One No.)</p> <p>As shown on the drawings, as specified in equipment schedule and as per technical specification including all material and accessories, complete in all respect and to the satisfaction of Engineer incharge. ARI / AHRI Certification Required. Make: Europe / Japan / USA.</p>	Nos.	02
2	<p>Supply of Cross Flow Closed Type Cooling Towers, as shown on the drawings, as specified in equipment schedule and as per technical specifications including all material and accessories, complete in all respect and to the satisfaction of Engineer incharge. CTI / JIS / JCI Certification Required Make: Europe / Japan / USA.</p>	Nos.	02
3	<p>Supply of Air Handling Units as shown on the drawings, as specified in equipment schedule and as per technical specifications including all material, volume control dampers and accessories, complete in all respect and to the satisfaction of Engineer incharge. EUROVENT/AHRI Certification and Hygiene Certification Required (Mandatory) Make: Europe / Japan / USA.</p>	Nos.	04
4	<p>Supply of Fan Coil Units Cassette type, as shown on the drawings, as specified in equipment schedule and as per technical specifications including all material and accessories, complete in all respect and to the satisfaction of Engineer incharge. EUROVENT/AHRI Certification Required (Mandatory) Make: Europe / Japan / USA.</p>	Nos.	120

GROUP-B

S. NO	DESCRIPTION	UNITS	QTY
1	2	3	4
1	Installation & Commissioning of Centrifugal Oil Free Water Cooled Chiller with VFD and Controls , as shown on the drawings, as specified in equipment schedule and as per technical specification including all labour, material and accessories, complete in all respect and to the satisfaction of Engineer incharge. ARI / AHRI Certification Required Make: Europe / Japan / USA.	Nos.	02
2	Installation & Commissioning of Cross Flow Closed Type Cooling Towers , as shown on the drawings, as specified in equipment schedule and as per technical specifications including all labour, material and accessories, complete in all respect and to the satisfaction of Engineer incharge. CTI / JIS / JCI Certification Required. Make: Europe / Japan / USA.	Nos.	02
3	Installation & Commissioning of Air Handling Units as shown on the drawings, as specified in equipment schedule and as per technical specifications including all labour, material, volume control dampers and accessories, complete in all respect and to the satisfaction of Engineer incharge. EUROVENT/AHRI & Hygiene Certification Required (Mandatory) Make: Europe / Japan / USA.	Nos.	04
4	Installation & Commissioning of Fan Coil Units Cassette type , as shown on the drawings, as specified in equipment schedule and as per technical specifications including all labour, material and accessories, complete in all respect and to the satisfaction of Engineer incharge. EUROVENT/AHRI Certification Required (Mandatory) Make: Europe / Japan / USA.	Nos.	120
5	Supply, installation and commissioning of Chilled Water Pumps as shown on the drawings, as specified in equipment schedule and as per technical specifications including all labour, material, Vibration Isolators and accessories, complete in all respects. Make: KSB, Wilo Or Equivalent.	Nos.	3
6	Supply, installation and commissioning of Condensor Water Pumps as shown on the drawings, as specified in equipment schedule and as per technical specifications including all labour, material, Vibration Isolators and accessories, complete in all respects. Make: KSB, Wilo Or Equivalent.	Nos.	3
7	Supply, installation and commissioning of Chemical Dosing System for chilled and condenser water treatment as shown on the drawings and as specified in technical specifications including all labour, material and accessories, the cost of chemical feed pumps, chemical storage tank, all piping and fittings, control panel and chemicals for two year operation, complete in all respect and to the satisfaction of Engineer Incharge. Make: Arco Chemicals, Solutions Or Equivalent.	No.	1

8	Supply, installation and commissioning of Motor Control Center Panel (M.C.C) for operation of HVAC system, as shown on the drawings and as specified in technical specifications, in accordance with Pakistan Electrical Codes, including cost of all labour, material and accessories, complete in all respect. Make: Multitek Engineering, Park Engineering Company Or Equivalent	Nos.	2
9	Supply and installation of all electrical works for operation of HVAC system , as per technical specifications, including cables, conduits, dis-connect switches, wiring in accordance with Pakistan Electrical Codes, including cost of all labour and material, Cable Tray complete in all respects as per sample approved by site engineer. Make Conduite: Beta, Dadex Or Equivalent Cable: Newage, Fast Cable, GM Cable, Or Equivalent	Lot.	1
10	Supply, installation and commissioning of Exhaust air Fans , as per equipment schedule, as shown on the drawings and as specified in technical specifications including all labour, material and accessories, complete in all respect as per sample approved by site engineer. Make: Local.		
(a)	Centrifugal Type Exhaust Air Fans	Nos.	20
(b)	Propeller Type Exhaust Air Fans (Pak Fans)	Nos.	25
11	Supply and installation of seamless black steel schedule 40 chilled water piping, as shown on the drawings and as specified in technical specifications complete with elbows, tees, unions, reducers, flanges including the cost of all cleaning, painting with corrosion resistant paint, jointing and welding, guides / anchors sleeves, Clevis Hangers with Wooden Saddles and pressure testing, including all labour, material and accessories, complete in all respect and to the satisfaction of Engineer Incharge as per sample approved by site engineer. Make: 1/2" to 6" Huffaz Or Equivalent Make: 8" Imported		
(a)	8" dia	Rft.	240
(b)	6" dia	Rft.	360
(c)	5" dia	Rft.	460
(d)	4" dia	Rft.	680
(e)	3" dia	Rft.	460
(f)	2-1/2" dia	Rft.	380
(g)	1-1/2" dia	Rft.	280
(h)	1-1/4" dia	Rft.	430
(i)	1" dia	Rft.	640
(j)	3/4" dia	Rft.	800
12	Supply & Installation of BSS Medium weight black carbon steel piping for Condenser Water Complete with Specialties and Fitting as per sample approved by site engineer. Make: Imported		
(a)	10" dia	Rft.	160
(b)	8" dia	Rft.	260
(c)	6" dia	Rft.	320

13	Supply and installation of pre-formed molded fiberglass pipe insulation (density 64 kg/m ³) with aluminum foil kraft paper and canvas cloth as shown on the drawings and as specified in technical specifications, including all labour, material and accessories, complete in all respect as per sample approved by site engineer. Make: Knauf, Kimmco, Affico Or Equivalent		
13.1	Insulation 2" Thick (Chiller Plant & Ahu Rooms)		
(a)	8" dia	Rft.	240
(b)	6" dia	Rft.	360
(c)	5" dia	Rft.	460
(d)	4" dia	Rft.	680
(e)	3" dia	Rft.	460
(f)	2-1/2" dia	Rft.	380
9.2	Insulation 1-1/2" Thick		
(a)	1-1/2" dia	Rft.	280
(b)	1-1/4" dia	Rft.	430
(c)	1" dia	Rft.	640
(d)	3/4" dia	Rft.	800
14	Supply and installation of sheet metal cladding over all exposed ducting and piping on plant room & Ahu rooms , as shown on the drawings and as specified in technical specifications, including all labour, material and accessories, complete in all respect and to the satisfaction of Engineer Incharge as per sample approved by site engineer. Make: ISL Or Equivalent	Sq.Ft.	9,600
15	Supply and installation of Valves with matching flanges and gasket including G.I. cladding of all valves and filled with glass wool, as shown on the drawings and as specified in technical specifications, including all labour, material and accessories, complete in all respect.		
15.1	Gate Valve (1/2" TO 2" KITZ JAPAN OR EQUIVALENT 2-1/2" TO 10" IMPORTED)		
(a)	8" dia	Nos.	12
(b)	6" dia	Nos.	20
(c)	3" dia	Nos.	4
(d)	2-1/2" dia	Nos.	6
(e)	2" dia	Nos.	4
(f)	1-1/2" dia	Nos.	6
(g)	1" dia	Nos.	220
15.2	Strainer (1/2" TO 2" KITZ JAPAN OR EQUIVALENT 2-1/2" TO 10" IMPORTED)		
(a)	8" dia	Nos.	2
(b)	6" dia	Nos.	12
(c)	3" dia	Nos.	2
(d)	2-1/2" dia	Nos.	2
(e)	2" dia	Nos.	1
(f)	1-1/2" dia	Nos.	1
(g)	1" dia	Nos.	110

15.3	Combination Flow Regulating Valve (GALA USA OR EQUIVALENT)	Nos.	
(a)	3" dia	Nos.	3
(b)	2-1/2" dia	Nos.	2
(c)	2" dia	Nos.	2
(d)	1-1/2" dia	Nos.	3
(e)	1" dia	Nos.	110
15.4	Globe Valves (1/2" TO 2" KITZ JAPAN OR EQUIVALENT 2-1/2" TO 10" IMPORTED)		
(a)	8" Dia	Nos.	4
(b)	6" Dia	Nos.	6
(c)	4" Dia	Nos.	12
(d)	3" Dia	Nos.	6
15.5	Check Valves (1/2" TO 2" KITZ JAPAN OR EQUIVALENT 2-1/2" TO 10" IMPORTED)		
(a)	6" Dia	Nos.	6
(b)	8" Dia	Nos.	2
15.6	Flexible Connection (TOZEN OR EQUIVALENT)		
(a)	6" Dia	Nos.	16
(b)	8" Dia	Nos.	4
15.7	Pressure gauge (WIKA GERMANY OR EQUIVALENT) + Socket + Siphon + Ball Valve	Nos.	242
15.8	Thermometer (SIKA JAPAN OR EQUIVALENT) + Socket + Brass well	Nos.	132
16	Supply & Installation of Electric / Electronic type System Automatic controls system complete with Accessories as per Drawing. As per sample approved by site engineer		
16.1	Motorized Valve with Actuator (Make: Honey Well Or Equivalent)		
(a)	3" dia	Nos.	6
(b)	2-1/2" dia	Nos.	4
(c)	2" dia	Nos.	4
(d)	1-1/2" dia	Nos.	5
(e)	1" dia	Nos.	110
17	Supply, fabrication and installation of Sheet Metal handmade / machine fabricated Duct Work as shown on the drawings and as per technical specifications including all labour, material, accessories, tees, plenum, transition pieces, splitter dampers, special duct test holes, duct access doors, air deflector with antifungus paint, as where required complete in respect and to the satisfaction of Engineer incharge. Make: ISL Or Equivalent		
(a)	20 - Gauge	Sq.Ft.	6000
(b)	22 - Gauge	Sq.Ft.	25500
(c)	24 - Gauge	Sq.Ft.	9600
18	Supply and installation of Glass Wool Insulation including aluminum foil kraft paper and canvas cloth as shown on the drawings and as per technical specifications including all labour, material and accessories required for insulation work complete in respect and to the satisfaction of Engineer incharge. Make: Knauf, Kimmco, Affico Or Equivalent	Sq.Ft.	36100

19	Supply and installation of Duct Sound Liner as shown on the drawings and as per technical specifications including all labour, material and accessories, complete in respect and to the satisfaction of Engineer incharge. Make: Kimmco Or Equivalent	Sq.Ft.	3500
20	Supply and installation of Air Devices (Diffusers / Registers / Grilles) as shown on the drawings and as specified in technical specifications including all labour, material and accessories, complete in all respect and to the satisfaction of Engineer Incharge. Make: Choose Trading Company Or Equivalent	Sq.Ft.	850
21	Supply & installation of HEPA Filters complete with all accessories & fittings with filter and G.I Box etc. complete with RA grilles & aluco bond works as per sample approved by site engineer. Make: Imported USA Or Equivalent	Nos.	8
22	Supply and installation of Volume Control Dampers , as shown on the drawings and as specified in technical specifications including all labour, material and accessories, complete in all respect and to the satisfaction of Engineer Incharge. Make: Choose Trading Company Or Equivalent	Sq.Ft.	650
23	Supply and installation of Fire Dampers , as shown on the drawings and as specified in technical specifications including all labour, material and accessories, complete in all respect and to the satisfaction of Engineer Incharge. Make: Choose Trading Company Or Equivalent	Sq.Ft.	250
24	Supply, installation of Louvers for fresh and exhaust air , as shown on the drawings and as specified in technical specifications including all labour, material and accessories, complete in all respect and to the satisfaction of Engineer Incharge. Make: Choose Trading Company Or Equivalent	Sq.Ft.	23
25	Supply & installation of copper piping for FCu's with insulation, as specified in technical specifications complete with elbows, tees, unions, reducers, isolating valves including the cost of all jointing, brazing and , guides / anchors sleeves, including all labour, material and accessories, complete in all respect. Make: Muller USA Or Equivalent	Rft.	6000
26	Supply and installation of UPVC Condensate Drain Piping including insulation for all fcu's , Ahu's & all equipment's drain as shown on the drawings and as specified in technical specifications including all labour, material, accessories, complete in respect. Make: Dadex Or Equivalent		
(a)	2" dia	Rft.	630
(b)	1-1/2" dia	Rft.	360
(c)	1" dia	Rft.	920
(d)	3/4" dia	Rft.	220

27	Supply and installation of Galvanized Hanger and Supports for piping, ducting, all HVAC Equipment , as shown on the drawings and as specified in technical specifications, complete with angle iron, rawal bolts, threading rods, nuts and bolts, wooden pieces, including the cost of cleaning, painting with corrosion resistant paint, jointing and welding, including all labour, material and accessories, complete in all respects. Make: Fischer, Index, Mungo, Or Equivalent	Ton's	18
28	Supply & installation of 90% Efficiency dust spot test ASHRE standard 52-76 Air filters complete in all respects. As per sample approved by site engineer. Make: Imported USA	Nos.	8
29	Supply & installation of 65% Efficiency dust spot test ASHRE standard 52-76 Air filters complete in all respects. As per sample approved by site engineer. Make: Imported USA	Nos.	8
30	Supply & installation of Insulated Pressurized Expansion Tank complete with all fittings and accessories as per sample approved by site engineer. Make: Choose Trading Company Or Equivalent	No.	1
	Air Separator For Chilled Water Complete with accessories and controls (As per sample approved by site engineers) Make: Self Manufactured)		
31	Air Balancing	Job	1
32	Water Balancing	Job	1
33	Making all cutting in walls, slabs and preparation of RCC foundation for Chillers, Cooling Towers plate form, AHU's, Pumps, Fans and other HVAC equipment's in plant room and Ahu rooms in all other areas and all other work such as Openings, Penetrations, Fire stopping, Acoustic Cork sheet, Wooden Frame Sleeves and Pipe Sleeves, plaster finish etc as directed by Engineer Incharge, complete in all respect.	Job	1
34	Testing, Adjusting, Balancing and commissioning of pipe and duct work of the air and water side flow rates and control setting, as specified in the technical specifications, including the cost of all labour, material, replacements, repair etc. required to be carried out by a separate PEC authorized /registered agency and the result and test data to be submitted to the Engineer Incharge for approval prior starting maintenance period, complete in all respect.	Job	1
35	Providing Shop Drawings Coordination Drawings as per Reflected Ceiling plan and As Built Drawings in A1 size with Electronic Copies, as specified in technical specifications, as advised by the Consultant, complete in all respect.	Set	4
36	Providing spare parts for chiller, cooling tower, FCU, AHU, Fans and pumps as specified in technical specification and as per manufacturer recommendation for 2 years operation, contractor shall submit the list of spare parts.	Job	1
37	Providing Painting and Finishing including stenciling and identification tags as specified in technical specifications and as directed by the Engineer Incharge, complete in all respect.	Job	1

38	Providing manufacturers operation and maintenance manuals of all HVAC Equipment and standard operating procedures, as specified in technical specifications, complete in all respect.	Job	1
39	Providing imported superior quality Maintenance Tools / Instruments as specified in technical specifications including cost of all labour, material and accessories, complete in all respect and to the satisfaction of Engineer Incharge.	Job	1
40	Providing Operation and Maintenance for HVAC System for 36 months period, as specified in technical specification.	Job	1
41	Viscous oil 2" thick cleanable aluminum air filter complete with all respects.	Job	1
42	Charts and Tags.	Job	1
43	Any other items to complete the system	Job	1

SPECIAL NOTE:

- i. **Item-wise product compliance / deviation statement must be attached.**
- ii. **Confirm delivery period must be provided.**
- iii. **The “Origin” means the place where the “goods” are mined, grown, or produced. Hence, clearly mention country of origin of company and country of origin of manufacturing of offered equipment.**
- iv. Port of Shipment and Country of origin of “MAJOR PART(S) OF THE EQUIPMENT” must be clearly reflected separately in the Technical and Financial bids.
- v. **The above specifications are only for widest possible competition and not for favor any single contractor or supplier nor put others at a disadvantage. However, the brand name, catalogue No. / Name etc. has only been used for the reference purpose. Goods offered “AT LEAST EQUIVALENT OR BETTER QUALITY” to requisite specifications shall also be considered.**
- vi. Equipment must be quoted with all the standard accessories.
- vii. Quoted equipment should be of latest Model.
- viii. UPS/Power protection for the equipment shall be incorporated in the systems, otherwise prices must be quoted separately.
- ix. All the civil works and support services will be carried-out by the Dow University of Health Sciences, Karachi with the consultation of the responsive bidder.
- x. The bidder shall separately quote the price of service contract inclusive of parts as well as excluding the parts for 5 years (minimum) in term of %age for total contract value.
- xi. **COUNTRY OF ORIGIN: UK / USA / Japan / Europe / valid free sale certificate for the quoted items(s) duly attested by the Pakistani Embassy in the Country of Origin / Valid free sales certificate for quoted items(s) duly attested by the Embassy of the Country of Origin in Pakistan.**
- xii. **No alternate bid allowed.**
- xiii. **The Financial bid will be evaluated on the aggregated amount Group-A + Group-B in Pak Rupees.**
- xiv. **Conversion Rate should 7 (Seven) working days prior to open of bid date issue by NBP / SBP.**

2. MANUFACTURER'S AUTHORIZATION FORM
[SEE CLAUSE 11.1 (A) OF THE INSTRUCTION TO BIDDERS]

To: The Dow University of Health Sciences
Karachi.

WHEREAS **[name of the Manufacturer]** who are established and reputable Manufacturers of **[name and /or description of the goods]** having factories at **[address of factory]** do hereby authorize **[name and address of Bidder / Agent]** to submit a bid, and subsequently follow-up / negotiate and sign the Contract with you against Invitation for Bids (IFB) / Tender Notice for the goods manufactured, by us, under the patent name of for performance of the contract.

We hereby commit and assure our full guarantee and warranty / guarantee as per Clause 12 of the General Conditions of Contract for the goods offered for supply by the above mentioned firm against this Invitation for Bids.

[Signature for and on behalf of Manufacturer]

Note:

This letter of authority should be on the letterhead of the Manufacturer and should be signed by a person competent and having the power of attorney to bind the Manufacturer. It should be included by the Bidder in its bid.

3. CONTRACT FORM

THIS AGREEMENT made the _____ day of _____ 2019 between *Dow University of Health Sciences, Karachi of Islamic Republic of Pakistan* (hereinafter called “the Procuring Agency”) of the one part and _____ [Name of Bidder] of _____ [city and country of Bidder] (hereinafter called “the Bidder”) of the other part:

WHEREAS the Procuring Agency invited bids for certain goods and ancillary services, viz., _____ [brief description of goods and services] and has accepted a bid by the Bidder for the supply of those goods and services in the sum of _____ [contract price in words and figures] (hereinafter called “the Contract Price”).

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 referred to.
2. The following documents shall be deemed to form and be read and construed as part of this Agreement, viz.:
 - (a) the Bid Form and the Price Schedule submitted by the Bidder;
 - (b) the Schedule of Requirements;
 - (c) the Technical Specifications;
 - (d) the General Conditions of Contract;
 - (e) the Special Conditions of Contract; and
 - (f) the Procuring Agency’s Notification of Award.
3. In consideration of the payments to be made by the Procuring Agency to the Bidder as hereinafter mentioned, the Bidder hereby covenants with the Procuring Agency to provide the goods and services and to remedy defects therein in conformity in all respects with the provisions of the Contract
4. The Procuring Agency hereby covenants to pay the Bidder in consideration of the provision of the goods and services and the remedying of defects therein, the Contract Price or such other sum as may become payable under the provisions of the contract at the times and in the manner prescribed by the contract.

IN WITNESS whereof the parties hereto have caused this Agreement to be executed in accordance with their respective laws the day and year first above written.

Signed / Sealed by the Manufacturer /
Authorized Bidder / Authorized Agent

Signed / Sealed by Procuring Agency

I: BID FORM & PRICE SCHEDULE

1. BID FORM

To: The Dow University of Health Sciences
Karachi

Dear Sir,

Having examined the Bidding Documents, the receipt of which is hereby duly acknowledged, we, the undersigned, offer to supply and deliver the goods specified in the said Bidding Documents for the sum of **[Total Bid Amount Rs. _____]**, **[Bid Amount in words _____ only]** or such other sums as may be ascertained in accordance with the Schedule of Prices attached herewith and made part of this bid.

2. The free of cost / donation / discounts offered and the methodology for their application are: .

3. We undertake, if our bid is accepted, to deliver the goods in accordance with the delivery schedule specified in the Schedule of Requirements.

4. If our bid is accepted, we shall obtain an unconditional guarantee of a bank in the sum of 5% of the Contract Price for the due performance of the Contract, in the form prescribed by the Procuring Agency.

5. We agree to the validity of this bid for 90 days from the date fixed for financial bid opening and it shall remain binding upon us and may be accepted at any time before the expiration of that period.

6. Until a formal Contract is prepared and executed, this bid, together with the written acceptance thereof and notification of award, by the Procuring Agency, shall constitute a binding Contract between us.

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

In the capacity of _____

Signed _____

Duly authorized to sign the Bid for and on behalf of _____

Date _____

2. (A) **PRICE SCHEDULE IN FOREIGN CURRENCY (FOR GROUP-A)**
(CFR / CNF/ C&F / CPT BASIS)

FOR GOODS OFFERED FROM OUTSIDE THE PROCURING AGENCY’S COUNTRY

S#	Detailed Specification of Goods	Model / Cat No.	Name of Manufacturer	Country of Origin	Port of Shipment	Quantity of Stores	Unit	Currency	Rate Per Unit	Total Price
1	2	3	4	5	6	7	8	9	10	11
Total Amount in Foreign Currency										

Name _____

In the capacity of _____

Signed _____

Duly authorized to sign the Bid for and on behalf of _____

Date _____

NOTE:

Port of Shipment and Country of origin of “MAJOR PART(S) OF THE EQUIPMENT” must be clearly reflected separately in the Technical and Financial bids. The “Origin” means the place where the “goods” are mined, grown, or produced.

2. (B) **PRICE SCHEDULE IN PAK RUPEES delivered duty paid (DDP BASIS)
(FOR GROUP-B)**

FOR GOODS OFFERED WITHIN THE PROCURING AGENCY’S COUNTRY

S#	Detailed Specification of Goods	Model / Cat No.	Name of Manufacturer	Country of Origin	Port of Shipment	Quantity of Stores	Unit	Rate Per Unit	Total Price
1	2	3	4	5	6	7	8	9	10
TOTAL AMOUNT IN PAK RS.									

GRAND TOTAL

	GROUP-A	
	GROUP-B	
	TOTAL	

Name _____

In the capacity of _____

Signed _____

Duly authorized to sign the Bid for and on behalf of _____

Date _____

NOTE:

Port of Shipment and Country of origin of “MAJOR PART(S) OF THE EQUIPMENT” must be clearly reflected separately in the Technical and Financial bids. The “Origin” means the place where the “goods” are mined, grown, or produced.

The Financial bid will be evaluated on the aggregated amount Group-A + Group-B in Pak Rupees. Conversion Rate should 7 (Seven) working days prior to open of bid date issue by NBP / SBP.

DETAIL TECHNICAL SPECIFICATION - HVAC WORKS

1.0 GENERAL:

The contract drawings indicate the extent and general arrangement of the air-conditioning system. Equipment, ductwork and piping shall fit into the space allotted and shall allow adequate and acceptable clearance for entry, servicing and maintenance. Where component parts of equipment or system cannot be serviced without distributing adjacent work resulting from original installation of other work, corrective action satisfactory to the Consultant shall be taken, without any additional cost to the Owner.

- (a) Capacities of equipment and materials shall not be less than those indicated.
- (b) Conformance with Agency requirements: Where materials or equipment are specified to conform to requirements of Underwriter's laboratory, Inc., Air-conditioning and Refrigeration Institute of Heating, Refrigeration and Air-conditioning Engineers, etc., the Contractor shall submit proof of conformance. The label or listing of the specified agency will be acceptable evidence.
- (c) Nameplates: Each major item of equipment shall have the manufacturer's name, address serial and model numbers on a plate securely attached to the item.
- (d) Protective and Access requirements: Belts, pulleys, chains, gears, coupling, projecting set-screws, keys and other rotating parts are so located that any person in close proximity shall be fully enclosed or properly guarded. High temperature equipment and piping so located as to endanger personnel or create a fire hazard shall be properly guarded or covered with insulation of a type specified in Clause - THERMAL INSULATION. Items such as catwalk ladders and quadrails shall be provided where indicated for safe operation and maintenance of equipment.
- (e) Verification of dimensions: The Contractor shall visit the premises to thoroughly familiarize himself with all details of the work and working conditions and verify all dimensions in the field, and shall advise the Consultant of any discrepancy before performing any work. The Contractor shall be specifically responsible for the co-ordination and proper relation of his work to the building structure and to the work of all trades.
- (f) Cost of wooden frame at all duct penetration: The cost of 25-mm thick termite treated deodar wood frame equal to opening width shall be deemed to have been included in the relevant items.
- (g) Pipes and ducts crossing fire rated wall, the gap between wall and pipe/duct shall be filled with soft packing like mineral wool, the ends shall be closed with gauge 16 duct sleeves or approved sealant shall be deemed to have been included in the relevant items.
- (h) The heating, ventilation, cooling and air conditioning systems shall be in accordance with ASHRAE, SMACNA, ASME and NFPA except as modified by rules, regulations and by-laws of authorities having jurisdiction.

1.1 EQUIPMENT AND MATERIAL:

- (a) General:
These shall conform to the respective publications and other requirements specified herein, and as shown on the drawings and shall be the products of the

manufacturers regularly engaged in the manufacture of such products. Items of equipment shall essentially be duplicate of equipment that has been in satisfactory use at least 5 years prior to bid opening and shall be supported by a service organization that is, in the opinion of the Consultant, reasonably convenient to the site. It shall be solely the Contractor's responsibility to ensure that the equipment supplied by him shall fit into the space allotted for the purpose. If at any stage it is detected that the equipment supplied by him cannot fit into the space provided for the equipment, then the Contractor shall be responsible for supplying other equipment of suitable size, without incurring any additional cost to the Owner.

(b) Approval of Equipment and Material:

Before starting installation of any material or equipment, the Contractor shall submit to the Consultant for approval working drawings of all areas and lists of materials and equipment to be incorporated in the work. The layout drawings shall include a plan and elevations of the proposed piping, ductwork and equipment to establish that the equipment will fit in the allotted space with clearances for installation and maintenance. The drawings shall show proposed details for attachment anchoring, and hanging to structural framing of the building; vibration isolation units; foundation and support; location and size of sleeves and prepared openings for passage of pipes and ducts. If departures from the contract drawings are deemed necessary by the Contractor, details of such departures including changes in related portions of the project and the reasons thereof shall be submitted with the drawings. Approved departures shall be made at no additional cost to the Owner. A complete electrical connection diagram, for each electrically controlled component having more than automatic or manual control device, shall be submitted to the Consultant for approval in addition to the automatic temperature control diagram required hereinafter. Wiring diagrams shall identify each component and one diagram shall show all interconnected or interlocked components. The lists of materials and equipment shall be supported by sufficient descriptive material, such as catalogs, diagrams, performance curves, charts, layout drawings and other data published by the manufacturer, to demonstrate conformance to the specification requirements; model numbers alone will not be acceptable. The data shall also include the name and address of the nearest service and maintenance organization that regularly stock repair parts. Listings of items that function as parts of an integrated system shall be furnished at one time. One copy of the layout drawings, wiring diagrams and lists will be returned, marked to indicate approval. All material shall be submitted to the Consultants for approval and only approved material shall be supplied to the site.

1.2 SAMPLES:

The contract shall provide at his cost, samples of material, instruments, gauges and electrical items, for approval by the Engineer before order is placed for the same. Engineer may waive this requirement, if detailed published catalogues submitted by the contractor provide sufficient information for approval. These samples shall include but not limited to:

1. G.I Sheet, each gauge to be used

2. Pipes and Fittings
3. Valves (all types), Control Valves, Strainer, Air Vents, Pressure Gauges and Thermometers etc.
4. Duct Insulation, Liner and Covering
5. Pipe Insulation and Covering
6. Insulation Adhesive and Tapes
7. Air devices (Diffusers, Grilles, Registers, VAV, CAV)
8. OA / EA Louvers
9. All types of Dampers
10. Power and Control Cables
11. Electrical Items, Push Buttons, HOA & Toggle Switches, Pilot Lamps, Contractor, Relays, Circuit Breakers and Isolating Switches
12. Vibration Isolating Springs, Pipe Hangers, Duct Hangers and Rollers
13. MS Piping, Copper Piping, Condensate Drain Piping, GI Piping

1.3 FACTORY INSPECTION OF EQUIPMENT AND MATERIALS:

All major equipment listed below to be supplied under this Contract which has been manufactured or shop assembled in or outside Pakistan shall be subject to inspection by the Employer's two numbers authorized representatives for each equipment at manufacturer's factory of origin before its dispatch to site. The Contractor shall make necessary arrangements and provide all the facilities required for such inspection. The Contractor to arrange travel, boarding and lodging for 02 persons on his expense.

The following equipment shall be inspected and tested at the manufacturer's place:

1. Chillers
2. AHU, FCU and FAHU
3. Motor Control Centre (MCC)

2.0 WATER COOLED CENTRIFUGAL CHILLERS, OIL-FREE:

2.1 GENERAL:

The Contractor shall furnish and install water cooled high efficiency Centrifugal Oil Free chillers with VFD of the capacity called for at the design Conditions listed in the drawings. The unit shall be complete in all respects with microprocessor based controls, motor controller, vibration isolators, Refrigerant and accessories and suitable for continuous operation. Evaporator and condenser fouling factor shall be 0.088 m².K /kW.

The machine shall be AHRI certified. The cooler and condenser refrigerant side shall include "U" stamp and name plate certifying with ASME section VIII Division-1 code. The machine shall be constructed to comply with the material and workmanship requirements of the ASME Codes. The minimum COP of chiller shall be 4.9.

Unit shall be delivered to job site fully assembled with all interconnecting refrigerant piping and internal wiring ready for field installation and charged with refrigerant by the manufacturer.

Chillers shall be an imported item and shall be as per List of Approved Manufacturer's.

2.1.1 SUBMITTALS:

- A. Manufacturer shall submit the complete set of certified prints of water chiller assemblies, control panels, sections, and elevations, and unit isolation. Include the following:
 - 1. Assembled unit dimensions.
 - 2. Operating weight and load distribution.
 - 3. Required clearances for maintenance and operation.
 - 4. Size and location of piping and wiring connections.
 - 5. Power, signal, and control wiring, diagrams.
 - 6. Detailed selection with all required parameters.
 - 7. Operation and maintenance manual for each chiller.
 - 8. Vibration isolation calculations and details.
 - 9. Sound power or sound pressure level data in decibels (dB) at full load and part load conditions.

2.1.2 QUALITY ASSURANCE:

- A. ARI Certification: Signed by manufacturer certifying compliance with requirements in ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."
- B. ASHRAE Certification: Signed by manufacturer certifying compliance with ASHRAE 15 for safety code for mechanical refrigeration. Comply with ASHRAE Guideline 3 for refrigerant leaks, recovery, and handling and storage requirements.
- C. ASME Compliance: Fabricate and label water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. Comply with NFPA 70.
- E. Comply with UL 1995.
- F. Green Seal Certification: Signed by (manufacturer) (Green Seal) certifying with Green Seal's GS-31.

2.1.3 WARRANTY:

- A. Manufacturer shall warrant all supplied equipment and material in standard form in which manufacturer agrees to repair or replace components of water chillers that fail in materials or workmanship.

2.2 PACKAGED WATER CHILLER:

Furnish, install and commission factory assembled, charged, and operational run tested, water-cooled Centrifugal compressor chiller as specified herein and shown on the drawings

Chillers will be installed in an indoor location and shall be capable of operating in room temperatures between 42°F and 115°F (6°C and 46°C). The capacity control system capable of reducing unit capacity to 20% of full load. Compressor shall start in unloaded condition.

Chiller shall be completely factory-packaged including evaporator, condenser, compressor, motor, control center and all interconnecting unit piping and wiring. Unit shall ship in one piece.

2.3 COMPRESSORS:

Compressors shall be centrifugal, oil free with magnetic bearing. Design working pressure of entire compressor, suction to discharge, shall be 450 psig (31 barg) or higher. Compressor shall be U.L. recognized.

Compressor Motor shall be refrigerant suction-gas cooled, with inherent internal thermal protection and external current overload on all three phases.

AHRI listing shall be provided on the chillers.

Compressors shall start at minimum load. Provide microprocessor control to command compressor capacity to balance compressor capacity with cooling load.

2.4 REFRIGERANT CIRCUIT COMPONENTS:

Refrigerant shall be R-134a. Classified as Safety Group A1 according to ASHRAE 34.

Each refrigerant circuit shall incorporate an electronic expansion valve controlled by the control center to meter refrigerant flow to the evaporator to accommodate varying head and load conditions.

Each refrigerant circuit shall incorporate all components necessary for the designed operation. Chiller shall provide with an independent circuit for each compressor to provide maximum redundancy during chiller operation. Refrigerant isolation valves shall be provided to isolate the referent into the condenser.

2.5 HEAT EXCHANGERS:

2.5.1 Evaporator: evaporator shall be shell and tube, material shall be carbon steel and copper tube. Tubes shall be high-efficiency, internally and externally enhanced type copper tubes with 0.035" (0.89 mm) minimum wall thickness at all intermediate tube supports to provide maximum tube wall thickness at the support area. Each tube shall be roller expanded into the tube sheets providing a leak proof seal, and be individually replaceable. Independent refrigerant circuits shall be provided per compressor.

Constructed, tested, and stamped in accordance with ASME pressure vessel code Section VIII, Division-1, for minimum 235 psig (16 barg) refrigerant side design working pressure and 150 psig (10 barg) liquid side design working pressure.

Water boxes with design working pressure of 150 Psig shall be removable to permit tube cleaning and replacement. Liquid nozzle connections shall be ANSI/AWWA C-606.

2.5.2 Condenser: Condenser shall be shell and tube type, with a discharge gas baffle to prevent direct high velocity impingement on the tubes and to distribute the refrigerant gas flow evenly over the tubes. An integral sub-cooler shall be located at the bottom of the condenser shell providing highly effective liquid refrigerant sub cooling and highest cycle efficiency.

Constructed, tested, and stamped in accordance with ASME pressure vessel code Section VIII, Division-1, for minimum 388 psig (26.8 barg) refrigerant side design working pressure and 150 psig (10 barg) liquid side design working pressure.

Water boxes with design working pressure of 150 Psig shall be removable to permit tube cleaning and replacement. Liquid nozzle connections shall be ANSI/AWWA C-606.

2.6 INSULATION:

Thermal insulation on cold surfaces shall be Closed-cell, flexible, UV protected, minimum 1-1/2" (38mm) thickness complying with ASTM C 534 Type 2 (Sheet) for preformed flexible elastomeric cellular thermal insulation in sheet and tabular form.

Maximum Thermal conductivity shall be 0.26 (BTU/HR-Ft²-°F/in) at 75°F mean temperature.

Insulation shall be over cold surfaces of liquid chiller components including evaporator shell and suction line.

Apply adhesive to 100 percent of insulation contact surface including all seams and joints.

All insulated surface shall be properly cladding with aluminum sheet 26 SWG as directed by the engineer.

2.7 POWER AND ELECTRICAL REQUIREMENTS:

Factory installed and wired NEMA 1, powder painted steel cabinets with tool lockable, hinged, latched, and gasket sealed outer doors equipped with door latch. Provide main power connection, compressor starters, current overloads, and factory wiring.

Single point power connection to chiller, shall be 3 phase of scheduled voltage.

Terminal Block connections shall be provided at the point of incoming single point connection for field connection and interconnecting wiring to the compressors.

A non-fused disconnects and lockable external handle shall be supplied to isolate the unit power voltage for servicing.

Power panel shall be supplied with a factory mounted and wired control transformer that will supply all unit control voltage from the main unit power supply. Transformer shall utilize scheduled line voltage on the primary side and provide 115V/1Ø on secondary.

Short Circuit Withstand rating of the chiller electrical enclosure shall be minimum of 30,000Amps. Rating shall be published in accordance with UL508.

Motor starters shall be zero electrical inrush current (Variable Frequency Drives) or reduced inrush type (Closed transition Wye-Delta or Solid State) for minimum electrical inrush. Open transition Wye-Delta and Across the Line type starters will not be acceptable.

Provide equipment with power factor correction capacitors as required to maintain a displacement power factor of 95% at all load conditions.

All exposed power wiring shall be routed through liquid-tight conduit.

2.8 CONTROLS:

Provide standalone microprocessor based automatic control of chiller operation including compressor start/stop and load/unload anti-recycle timer, evaporator pump, condenser pump, unit alarm contacts and run signal contacts.

Chiller shall automatically reset to normal chiller operation after power failure.

Alarm controls shall be provided to remote alert for any unit or system safety fault.

Display and Keypad:

1. Provide multiple character liquid crystal display or light emitting diodes.
2. Provide one keypad and display panel per chiller.
3. Display and keypad shall be accessible without opening main control /electrical cabinet doors.
4. Display shall provide a minimum of unit set points, status, electrical data, temperature data, pressures, safety lockouts and diagnostics without the use of a coded display.
5. Descriptions in English, numeric data in English.

Programmable Set points shall be display language, chilled liquid cooling mode, local/remote control mode, display unit mode, system lead/lag control mode, remote temperature reset, remote current limit, leaving chilled liquid set point and range, maximum remote temperature reset, leaving condenser liquid set point.

Display Data shall be Chilled liquid leaving and entering temperatures; lead system; flow switch status; evaporator/condenser pump status; active remote control; evaporator pressure, discharge, and oil pressures, condenser pressures; compressor discharge temperature, motor temperatures, compressor speed, oil pump status; compressor number of starts; run time; operating hours; history data for faults and normal shutdowns, Condenser liquid leaving and entering temperatures.

Unit controls shall avoid safety shutdown when operating outside design conditions by optimizing the chiller controls and cooling load output to stay online and avoid safety limits being reached. The system shall monitor the following parameters and maintain the maximum cooling output possible without shutdown of the equipment: motor current, evaporator pressure, condenser pressure, discharge pressure, starter internal ambient temperature, and starter baseplate temperature.

Unit shall cause individual compressor systems to perform auto-reset shut down if high discharge pressure or temperature, low evaporator pressure, low motor current, high/low differential oil pressure, low oil level, high motor temperature, system control voltage.

Unit shall be automatic reset and cause compressors to shut down if low leaving chilled liquid temperature, under voltage, flow switch operation.

Manufacturer shall provide any controls not listed above, necessary for automatic chiller operation.

2.9 ACCESSORIES AND OPTIONS:

Chiller shall accept 4 to 20mA or 0 to 10 VDC input from Building management system to reset the leaving chilled liquid temperature or load limit set point or both.

Chiller shall communicate with Building Management System, including BACnet (MS/TP), Modbus, N2, and LON.

Manufacturer shall provide the elastomeric vibration isolators for chillers.

2.10 SPARE PARTS:

The Contractor shall provide the following list essential spare parts at the time of bidding and with the submittal of Chillers.

- a) **CENTRIFUGAL COMPRESSOR:** Totally oil free compressor, which include magnetic bearing, variable-speed centrifugal compressor and digital electronic controls.
- b) **SWITCHBOARD:** The switchboard must be completely wired inside a watertight steel box IP54 produced according to the strictest European norms.
- c) **GRAPHICAL PANEL:** From the hardware point of view, the Graphical Panel must have a touch screen of 7" to 10" and is able to offer excellent performance and low power consumption. Software must be user-friendly and is able to collect and analyse the data provided by the system in order to optimize the operation of the chiller when connected to the system.

2.11 INSTALLATION:

2.11.1 General:

The Contractor shall install water cooled Centrifugal, oil-free Chillers as shown on drawings. Installation shall take into account all manufacturer's recommendations and specifications.

Chiller shall be installed on concrete housekeeping pad at minimum of 100 mm above the floor. Concrete base shall be 100 mm larger in both directions than overall dimensions of supported unit.

A Factory Trained Engineer, Duly Authorized by the Unit Manufacturer, shall supervise the Commissioning of the Unit and give instructions to the Employer's Operating Personnel for Operation and Maintenance of the units for a period of at least two weeks at Site.

The Contractor shall be responsible for supply and installation of all auxiliary devices and accessories required for fully operational chillers including flanged or Victaulic

connections for chilled and condenser water piping, flow switch and wiring per chiller requirement, field control wiring necessary to interface sensors to the chiller control system, vibration isolators, Insulation on the cold areas of machine including liquid nozzles and water boxes, vent pipe line from relief valves to outside the building. The insulation shall be finished with cladding of appropriate thickness.

The Contractor shall be responsible for making all water, drain and electrical connections and finish painting of equipment. All necessary material, labour, supervision in this respect shall be supplied by the contractor.

2.11.2 Commissioning & testing:

The Contractor shall be required to commission the chillers as per manufacturer's procedure. The chiller shall be subjected to recommend/specified tests to determine their capacity and performance. The test reports shall be submitted to the Client and Consultants in suitable test forms. It is the intent of these specifications that a completely functional chiller shall be supplied by the Contractor.

2.12 DEMONSTRATION:

- a) The contractor shall train the Owner's maintenance personnel to adjust, operate, and maintain Chillers.

3.0 COOLING TOWERS:

3.1 GENERAL:

The Contractor shall furnish and install Cooling Tower as shown on the drawings. The cooling tower shall be factory-Fabricated, cross-flow, vertical air discharge, mechanical induced draft type as indicated on the drawings, deck filled, complete with casing, basin, hot water distribution, frame, air inlet, float valve assembly, fans, drain, drain, over-flow and bleed connections. Rated capacity shall be based on 25% extra heat dissipation per ton of refrigeration. Tower shall be structurally designed to withstand a 30 Lbs/ft² (147 Kg/m²) wind load. All joints shall be water tight and arranged to shed water inward. The Contractor is required to submit manufacturer's noise generation data of the cooling tower for the Engineers/Consultants approval. The noise level from the cooling tower shall not be more than 60 dB (decibel) at a radius of 10m (33ft). Means of access shall be provided to all parts of the cooling tower for servicing and maintenance.

The cooling tower shall be of low noise type. Cooling towers shall be tested, rated, and certified in accordance with cooling tower institute (CTI) standard 201, and shall bear the CTI certification label, and listed in the CTI directory of certified cooling towers, equivalent JIS / JCI standards. Additionally the cooling tower manufacturer shall guarantee the performance of the tower as installed according to the plans. If, because of a suspected thermal performance deficiency. The owner chooses to conduct an on-site thermal performance test under the supervision of a qualified, independent third party, and witnessed by the manufacturer, in accordance with CTI or ASME standards during the first year of operation at the Contractor Cost, and if the tower fails to perform within the limits of test tolerance, then the cooling tower manufacturer will pay for the

cost of the test and with make such corrections as are appropriate and agreeable to the owner to compensate for the performance deficiency. Cooling tower shall be an imported item manufacturer of cooling tower shall be as per List of Approved Manufacturer's. Cooling tower shall be closed type with copper pipes as heat transfer medium.

3.2 CASING:

Casing shall be of UV-resistant Rubber Form insulated. Construction shall be bolted with stainless steel, hot dip galvanized steel bolts, or cadmium plated bolts. Legs shall be of aluminum.

3.3 AIR INLET:

Air inlet shall be designed to prevent back-splash at any rate of water flow upto the specified capacity.

3.4 FILL:

Fill shall be polyvinyl chloride sheets having a minimum thickness of 0.0051-inch (0.13-mm). Fill shall be free to expand or contract without warping, and shall be adequately supported so that no sagging or warping will occur. Fill shall be of the interlocking type.

3.5 FANS:

Fans shall be fixed pitch, heavy-duty cast or formed aluminum with a minimum of 4 blades (FRP fan blades not acceptable). It shall discharge through an FRP fan cylinder designed for streamlined air entry and minimum loss for maximum fan efficiency.

Fan and shaft shall be supported by heavy duty, relubricatable ball bearings, with special moisture seals, slingers and housing to prevent moisture accumulation.

Fan shall be directly coupled to the motor. Fan motor shall be totally enclosed, reversible squirrel cage, ball bearing type, designed specifically for cooling tower service. Motor shall be furnished with special moisture protection on winding, shafts and bearings. Fan cover of galvanized wire shall be provided.

3.6 COLD WATER BASIN:

Cold Water Basin shall be watertight, constructed of FRP or heavy gauge type 304 stainless steel panel and structural members. The basin shall be adequately supported to prevent sagging or buckling. Cold water basin shall be provided with accessible float valve assembly, overflow, capped drain, and screen non-activating pump suction or sump with strainer.

3.7 DISTRIBUTION SYSTEM:

Hot water distribution basins shall be open gravity type water distribution made of FRP resin or 304 stainless steel. Distribution weirs and brass metering orifices shall be provided to ensure even distribution of water over wet deck surface.

3.8 DRIFT ELIMINATORS:

Drift Eliminators shall be constructed of PVC/FRP and shall limit drift loss to less than 0.2% of the total water circulated.

3.9 STRUCTURAL SUPPORTS:

In addition to supports indicated on the contract documents, additional supports shall be provided as necessary to support the tower in accordance with the recommendations of the manufacturer of the tower proposed for the project.

3.10 LADDER:

The tower shall be provided with a galvanized steel ladder for inspection of the tower.

3.11 SPARE PARTS:

The minimum spare parts required shall be as listed below. However, Contractor shall provide Manufacturer's Recommended List of spare parts at time of bidding and with the submittal of Cooling Towers.

- a) Fills 10% of total for each Tower.
- b) Set of motor belt for each Tower.
- c) Fan Assembly.
- d) Set of bearings.

3.12 INSTALLATION:

3.12.1 General:

The Contractor shall be responsible for the installation of the cooling tower(s) complete in all respects as called for in the project plans and specifications. All accessories required for the installation of the cooling tower in a complete operational state shall be supplied and installed by the Supplier. This shall include all make-up piping with complete fittings, drain piping, condenser water inlet and outlet connections, electrical wiring and accessories complete in all respects.

Contractor shall install the cooling tower on concrete pad in accordance with drawing, manufacturer's instructions and site condition. The Contractor shall also provide the platform and ladder where required for servicing of cooling tower.

3.12.2 Assembly:

The cooling tower shall be supplied in a knocked down and disassembled state. The contractor shall be responsible for the complete assembly of the cooling.

3.12.3 A Factory Trained Engineer, Duly Authorized by the Unit Manufacturer, shall supervise the Commissioning of the Unit and give instructions at site to the Employer's Operating Personnel for Operation and Maintenance of the units for a period of at least two weeks at site.

3.12.4 Commissioning & Testing:

The contractor shall be responsible for the commissioning and testing of the cooling tower to the satisfaction of the Consultants.

4.0 END SUCTION & IN-LINE CENTRIFUGAL PUMPS:

4.1 SCOPE:

Specifications covers vertical split case end suction and in-line centrifugal pumps for hydraulic applications. Pump curves certifying pump operation, BHP & NPSH curves shall be submitted to the Consultant for approval. The manufacturer of Pumps shall be as per List of Approved Manufacturer's.

- a) Each pump shall be factory tested as per hydraulic institute standards. It shall then be thoroughly cleaned and painted with at least one coat of high grade machinery enamel prior to shipment and motor shall be meet NEMA and IEE specification.
- b) Primary chilled water pumps shall be constant speed.
- c) Secondary chilled water pumps shall be variable speed, suitable for VFD operation.
- d) Pump and motor shall be connected through a flexible coupling supplied with the pump. A coupling guard shall be provided.

4.2 SERVICE CONDITIONS:

Pumps shall be designed and constructed to operate satisfactorily in a typical hydraulic application. Pump shall be the product of a manufacturer regularly engaged in the production and marketing of these pumps.

4.3 OPERATING CONDITIONS:

The flow rate and pump head required is indicated in the Selection Data and the pump supplied shall conform to these requirements for continuous duty for 24 hours. The Contractor is required to ensure non-overloading selection of motor for parallel pumping operation. NPSH required by the pump shall be stated. The pump RPM shall be as specified in the Schedule Sheet. Each pump casing shall be designed to withstand the discharge specified on the Schedule Sheet plus the static head on the system, plus 50% of the total head, but not less than 150 psi (10 bars).

Pump's head given in the schedule are indicative and for guidance only. The Contractor is required to calculate the pump head based on site condition, installed equipment, piping connection, and approved shop drawings and submit for Engineer review and approval, before ordering the pumps. Required pumps and motors shall be provided without any additional cost and no variation or claim shall be entertained in this regard.

4.4 END SUCTION PUMP CONSTRUCTION:

4.4.1 Pump Construction: Details of End Suction Pump construction shall be as follows:

- a) Casing: shall be vertical split with centerline discharge, foot-supported and made of cast iron. Casings shall be provided with tapped and plugged holes for priming, vent and drain.

- b) Casing Connections: shall be ANSI B16.1, 150 Psi (10 bars) ASA Standard flat face flanges.
- c) Casing Wearing Rings: Easily replaceable casing wearing rings of suitable material for service shall be provided in front and rear of impeller.
- d) Casing Joint Gasket: An O-ring shall be provided at the casing joint to prevent leakage.
- e) Impeller: shall be the single section enclosed type of bronze. Impeller shall be statically and hydraulically balanced. Drilled holes shall be provided through the impeller hub to balance axial thrust loads and keep positive pressure on the stuffing box. Impeller shall be keyed & locked to the shaft with a hex head impeller nut, and shall be easily removable without the use of special tools.
- f) Shaft: Pump shaft shall be high strength stainless steel sized to provide a minimum amount of deflection. Shaft shall be protected in the stuffing box area by a replaceable shaft sleeve.
- g) Mechanical Seal: Shaft seal shall be mechanical seal type.
- h) Bearing Frame: shall be rigid, one-piece cast iron construction. Frame shall be provided with catch basin reservoir with tapped drain hole to collect and pipe away stuffing box leakage.
- i) Bearings: shall be ball type on both ends of the frame. Both bearings shall be locked in place and be sized to provide long life under thrust loads encountered. Both bearings shall be enclosed by replaceable box.
- j) Bearing lubrication: Ball bearings shall be grease lubricated with provisions for the addition & relief of grease.
- k) Deflector: A replaceable shaft deflector of non-corrosive material shall be provided to prevent the entrance of contaminants into the pump bearings at the inboard end of the bearing frame.

4.4.2 Base Plate & Coupling:

- a) Base plate: shall be fabricated steel center drain or cast iron drip lip sufficiently rigid to support the pump and the driving motor with tap hole to pipe away leakage and condensation.
- b) Coupling: Shall be spacer type.
- c) Coupling Guard: shall be all metal and fastened to base plate and conform to the requirement and conform to the requirements of ANSI B.15.1.

4.4.3 Motor Driver: It shall be selected in accordance with the pumps non-overloading performance characteristics. Motors shall be squirrel cage induction, TEFC type for exposed installation and drip-proof type for enclosed installation. Motors shall be mounted with pump on common base plate in manufacturer's plant and shipped as one

unit. Motor starters shall be Star-delta Starter and for operation on 400 Volts, 3-phase, 50 cycle electric supply.

4.5 IN-LINE PUMP CONSTRUCTION:

4.5.1 Pump Construction: Details of In-line Pump construction shall be as follows:

- a) Casing: shall be in-line type, radial split, back pull-out type with bottom support pads and made of iron.
- b) Flanges: shall be flat faced, to ANSI 150 lbs. Standard.
- c) Casing Wearing Rings: Easily replaceable, of suitable material, shall be provided.
- d) Casing Joint Gasket: An O-ring shall be provided at the casing joint to prevent leakage.
- e) Impeller: shall be of single section enclosed type, suitably fastened to the Shaft, hydraulically and dynamically balanced.
- f) Shaft: shall be stainless steel and protected in the stuffing box area by a replaceable shaft sleeve.
- g) Stuffing Box: shall be packed with at least five rings of graphite asbestos packing or four rings of asbestos packing and a seal cage. Ample space shall be provided for re-packing and other normal stuffing box maintenance.
- h) Bearing Frame: shall be of vertical design, with easy access for coupling and stuffing box cover removal.
- i) Bearings: shall be thrust type and shall have provision for lubrication.

4.5.2 Motor Driver: shall be of bolted coupling design, with thrust bearings, and selected for non-overloading performance. Motor shall be connected to the pump at manufacture's plant.

4.6 INSTALLATION:

4.6.1 General: The Contractor shall be responsible for the installation of centrifugal pumps as shown on the drawings. All additional items required for a complete installation shall be supplied and installed by the Contractor. During installation, the pump shall be properly leveled, grouted in and realigned before operation in accordance with the Manufacturer's recommendations. Suction and discharge connections shall be installed through flexible connectors, and electrical wiring shall be done. Drain lines from pump base plate at dip pocket shall be installed equals to the size of the opening.

- a) All pumps are on BMS system. It is contractor's responsibility to coordinate with electrical trade to ensure that all MCC panels have all suitable arrangements/hardware for directly hooking up with BMS.
- b) Install pumps as per manufacturer's recommendations.

- c) Manufacturer representative to certify that pumps are installed and commissioned as per manufacturer's recommendation and to be present to assist during testing and commissioning.
- d) Pump manufacturer to certify that VFD's supplied are suitable and fully compatible for driving pump schedules.

4.6.2 Foundation: Construction of pump foundation, complete in all respect including inertia block and vibration isolator is in the scope of the Contractor. The Contractor is required to provide calculation for inertia block and vibration isolator selection. For pump, foundation shall be 1:2:4 concrete, sized to provide an inertia block having a mass equal to 3 times the weight of the pump and motor. The foundation shall be isolated from the structure and plant room floor by using 2" (50 mm) thick higher density cork. Edges of the foundation shall be chamfered and the same shall be provided with two coats of oil paint.

4.6.3 Commissioning & Testing: The pump shall be commissioned and tested by the Contractor, in accordance with the manufacturer's recommendations. The pump operational curve shall be charted on the pump curve. Operational point at full flow shall be identified and submitted to the Consultant. Tests shall be conducted and test reports submitted to the Consultants and approval is obtained.

5.0 AIR HANDLING UNITS:

5.1 GENERAL:

The Contractor shall furnish and install Central Station Air Handling Units as given in the Schedule Sheet. The units shall be supplied in strict accordance with these specifications. All units shall be tested, rated and certified as complete units in accordance with Eurovent or ARI Standard 430-66, and shall bear the ARI seal, or equivalent certification. The Air Handling Unit shall be consist of inlet mixing box, pre-filter section, final filter, cooling coil, Fan & discharge section as bare minimum. The units shall be provided as per List of Approved Manufacturer's.

Air handling units shall be low pressure or high-pressure single zone draw-through type as indicated on the Schedule Sheet. Units shall be complete with airtight insulated fan coil section, waterproof drain pan, cooling coils, piping, fans, motor, adjustable V-belt drive, belt guard, bag & flat filters, air inlet / outlet dampers if required for stable fan operation, removable panels, access doors, wherever required for servicing, combination filter/mixing box, spring vibration isolators, and any other appurtenances necessary for satisfactory operation. Contractor shall be duly responsible for verifying the dimensional suitability of the air-handling unit in the space allocated, as shown on the drawings.

External static pressure given in the schedule are indicative and for guidance only. The Contractor shall calculate the external and total static pressure for all air handler fans and shall submit the same for Engineer's review and approval before ordering the units. Required fan and motor shall be provided without any additional cost and no variation or claim shall be entertained in this regard.

5.2 UNIT CASING:

Unit Casing shall be product of a Standard Manufacturer. Unit casing shall be of double skin design, with an insulation panel sandwiched between two galvanized steel sheets, of quality construction, braced and reinforced for smooth operation. The minimum thickness of inner and outer sheet shall be 1.0 mm and 0.8 mm. Fan and coil section shall be constructed of not lighter than 18 gauge, 0.0516 inch (1.31 mm) nominal thickness, galvanized steel Removable panels shall provide access to all internal parts. An insulated drain pan shall be provided under the fan & coil section and shall be coated with waterproofing material. Drain pan shall have drain connections on both sides. The unit casing shall be of double-skin type, with the outer and inner skins fabricated of hot-dip galvanized steel and with the outer skin powder coated after manufacture and shall be enamel baked. The panels shall be supplied in 50-mm thickness.

The panels shall be insulated with a rigid factory injected polyurethane insulation layer of at least 45 kg/m³ density, meeting the NFPA-90A Flame speed and smoke generation requirements.

5.3 FANS:

All fans shall be fully enclosed centrifugal, single width single inlet or double width, double inlet, class I, II or III as required or indicated for the design system pressure. Fans shall be capable of discharging the required volume of air against the duct work system resistance plus the resistance through the unit itself. Contractor shall add the resistance through the unit to the external static pressure indicated on the Schedule Sheet for selecting the fans. Impeller wheels shall be of the non-overloading type, shall be rigidly constructed, accurately balanced both statically & dynamically and shall be free from objectionable noise or vibration. Fan blades may be forward curved, design. The fan shall bear AMCA certified sound rating seal.

Fan wheels 36 inches (910 mm) or less in dia may have one or more extra-long bearing between the fan wheel and the drive.

The bearings shall be permanently lubricated, sleeve type, self-aligning and self-oiling with adequate reservoir, or self-aligning ball type with accessible grease fittings. The fan shaft shall be of steel, accurately finished. Fans shall not pass through their first critical speed at any catalogue RPM. Motors shall be mounted on an adjustable mount furnished by the unit manufacturer.

Motors up to and including 1 HP shall be 220/50/1, motors larger than 1 HP shall be 400V/50/3. Drive shall be selected at a service factor of 1.2 MHP.

5.4 MIXING BOXES:

Medium capacity combination filter mixing box shall be furnished for all air handling units not operating on 100% fresh air, such that the filter velocity is in accordance with the velocity specified. Access to the filter shall be provided on both sides. Filter shall be fit a snugly to prevent air by passing. Damper arrangement shall be parallel type and set up for merging of air streams inside the box. Damper blade rods shall rotate on rustproof bushings. Each box shall be equipped with duct connection flanges and necessary fastener holes. Mixing box shall be the manufacturer's standard product.

5.5 ELECTRICAL MOTORS:

The electric motors shall be of the type and sizes as specified for air-conditioning equipment and should comply with rules of electrical machines as stated in the VDE0530/59 and BS 2613:1957 specifications. The motors offered should have output rating as specified & should meet system requirements. Motors shall be of acceptable manufacturer.

Adjustment in motor HP or speed must be allowed on this account. Generally all motors shall be constant speed, 3 phase, squirrel cage induction type unless otherwise specifically noted and remarked in schedules and drawings.

The motors offered should be for a supply of 400 Volts, 3 phase, 50 Hertz, and should be able of giving the rated output at + 5% the rated voltage and frequency.

The motors shall be suitable for and able to give the required output under site conditions i.e. maximum ambient temperature or 120°F. (50°C.) and altitude 1700 feet (518 meters).

The motors, where specified to be single phase, should be suitable for operation on 220 + 5% Volts, 50 Hertz AC System.

The motors shall have tropicalized Class 'F' insulation and fungus proof. Unless otherwise specified the motor shall have drip proof construction for indoor installation, and totally enclosed weatherproof, fan cooled construction for outdoor installation.

All motors should be arranged for quiet operation and guaranteed to give the required output and fulfil the requirements of the machinery without producing any sound audible outside the AHU / Machine Room.

5.6 COILS:

The Contractor shall ensure proper selection of all coils to provide the required heat transfer capacity, and shall submit selection data as proof of the same.

Coils shall be removable from the unit without dismantling the entire unit. Provision for removing the coil from unit top shall also be provided. Coils shall have continuous plate fin surface, with seamless copper tubes expanded into or positively bounded to aluminum fin collars. Casings shall be of galvanized steel. Each coil shall leak-tested before shipment.

Coils shall be selected as per manufacturer's recommendations and shall be capable of providing the indicated capacity. Tubes shall be correctly circuited for proper water velocity, without excessive pressure drop.

All coils shall be of the cleanable and drainable type with removable gasketed headers for complete access to the tubes for mechanical cleaning. Each coil shall be leak tested before shipment at 250 Psi (17.5 bars) and shall be suitable for working pressure and temperature up to 250 Psi (17.5 bars) and 220°F. (105°C.) Air velocity across the unit at design flow shall not exceed 500 fpm. (2.5 m/sec).

5.7 AIR FILTERS:

The following types of filters shall be installed where indicated on the air handling units and specified herein:

Sectional Cleanable Filters shall be 2 inch (50 mm) thick, permanent, viscous impingement, washable, all metal, and panel type. Media shall be 14 mesh (0.6 mm pitch) Aluminum screen arranged in alternate layers of flat and crimp screens, four layers of each per inch, 1/8 inch (3mm) reinforcing rod for positive media support, and enclosed in a frame of 16gauge (1.6 mm) Aluminum Sheeting with flush mitered corners. Resistance to airflow of a clean filter shall not exceed 0.12 inch w.g. (30 Pg) at 3.6 CFM per sq. inch (0.011 m³/sec/sq. Cm.) of net face area.

Holding frames shall be factory built of 16 gauge (1.6 mm) steel 'T' section construction with felt air seal, inter-locking edges and filter locking device. Viscous adhesive shall be provided in 5 gallon containers in sufficient quantity for 12 cleaning operations. One washing and charging tank shall be provided for every 100 filter section or fraction thereof. Each washing and charging unit shall consist of a tank and rock mounted on legs. The drain rack shall be provided with dividers and partitions to properly support the filter in the draining position.

Bag filters shall not be less than, +95% against ASHRAE Standard 52-76/ EN 779/ atmospheric Dust SPOT test method average efficiency. Bag Filters shall be extended surface pocket type filter inserts having long service life with high and constant dust extraction efficiencies, high stability of filter bags and low pressure loss even under large air flows. Filter media shall be manufactured from 100% endless fiber synthetic spun bonded polypropylene, which shall be ultrasonically bonded to form an impermeable seal. The media shall be sealed to longitude internal separator strips and sealed around the edge of each pocket.

5.8 NOISE LEVEL:

All air handling units shall be selected to provide noise level of not more than NC 40 in the air-conditioned space. The Contractor shall be responsible for evaluation of the noise level of the AHU and to incorporate sound attenuators, if required, to provide the noise level specified in the space, no additional cost and no variation or claim shall be entertained in this regard. The Contractor is directed to refer to specifications for "ACOUSTIC DUCT LINING", and to ensure the inclusion of all necessary acoustic attenuators to achieve the desired performance.

5.9 CONTROL & VALVE PACKAGE:

Following valve assembly (not in AHU supplier scope) shall be followed for all AHUs:

- A. Air-Handling Units (AHU):
 - a. Gate Valves on supply and return lines
 - b. 1 Calibrates Balancing valve on return line
 - c. 1 No. 2-way motorized modulating valve
 - d. 1 No. Automatic air vent
 - e. 1 No. Strainer on supply line

- B. Fresh Air-Handling Units (FAHU):
 - a. Gate Valves on supply and return lines
 - b. 1 Calibrates Balancing valve on return line
 - c. 1 No. 3-way motorized modulating valve.
 - d. 1 No. Automatic air vent
 - e. 1 No. Strainer on supply line

Control package shall be suitable for operation on 220V/1 phase/50 Hertz A.C power.

5.10 THERMAL HEAT WHEEL (ENTHALPY WHEEL):

- A. Each fresh air handling units shall have enthalpy heat recovery wheel.
- B. Wheel matrix should be only from pure aluminum foil to allow for quick and efficient uptake of thermal energy, sufficient mass for optimum heat transfer, maximum sensible heat recovery during low rotational speed of 20 to 25 rpm.
- C. The Desiccant for Enthalpy wheel should be water molecule selective and non-migratory. The Desiccant should be molecular sieve 3Å, so as to keep the cross contamination to absolute minimum and also ensure the exclusion of contaminants from the air streams, while transferring the water vapor molecule. The desiccant should be of sufficient mass, and should be coated with non-masking porous binder adhesive on the aluminum substrate (matrix) so as to allow quick and easy uptake and release of water vapor. The weight of desiccant coating and the mass of aluminum foil shall be in a ratio so as to ensure equal recovery of both sensible and latent heat over the operating range.
The Rotor/Wheel matrix shall have Equal sensible and latent recovery in the range of 60 to 80%.
- D. The Rotor shall be made of alternate flat and corrugated aluminum foil of uniform width. The Rotor honeycomb matrix foil should be so wound and adhered as to make a structurally very strong and rigid media un-affected by temperature and humidity changes.
Subject to wheel size, sectioned wheel with pie segments, capable of being assembled at site can be acceptable as an option.
The surface of the wheel/rotor should be highly polished to ensure that the vertical run out does not exceed ± 1 mm for every 1 meter diameter, ensuring negligible leakage.
The number of wraps (of alternative corrugated and flat foil) of the rotor over the radii shall be very consistent so as to ensure uniform air flow and performance over the entire face in the air stream. Flute height and pitch will be consistent to a very tight tolerance to ensure uniform pressure drop and uniform airflow across the rotor face.
The rotor shall be non-clogging aluminum media, having a multitude of narrow aluminum channels, thus ensuring a laminar flow and will allow particles up to 800 microns to pass through it.
The rotor should rotate at a speed lower than 20 to 25 rpm, ensuring long life of belts and reduce wear and tear of seals.
The media shall be cleanable with compressed air, or low pressure steam or light detergent, without degrading the latent recovery.
- E. The recovery wheel cassette/casing shall be manufactured from tubular construction to provide a self-supporting rigid structure, complete with access panels, purge sector, rotor, bearings, seals, drive mechanism complete with belts. The cassette/ casing shall be finished weather proof painting.
- F. The rotor shall have a field adjustable purge mechanism to provide definite separation of air flow minimizing the carryover of bacteria, dust and other pollutants, from the exhaust air to supply air. With proper adjustments the cross contamination shall be limited to less than 0.04% of the exhaust air concentration.
- G. The face and radial seals shall be 4 pass non-contact labyrinth seals for effective sealing and also for minimum wear and tear.

- H. The rotor shall be made from epoxy coated sheet aluminum.
- I. All thermal wheels sensible and enthalpy shall be supplied with electronic speed control center. The electronic speed control center shall be fully integrated to BAS (building automation system).
- J. Wheel supplier/manufacturer shall insure full compatibility of the electronic speed center with BMS system and shall provide all necessary hardware and software to ensure full integration and compatibility with BMS system.

5.11 SPARE PARTS:

The minimum spare parts required shall be as listed below. However, Contractor shall provide Manufacturer's Recommended List of spare parts at time of bidding and with the submittal of Air Handling Units.

- a) Set of bearings for each Air Handler.
- b) Set of filters for each Air Handler.
- c) Set of motor belt for each Air Handler.
- d) Spare motor of each type of kW.

5.12 INSTALLATION:

5.12.1 General: The Contractor shall be responsible for installation of the Air Handling Units, as shown on the drawings, complete in all respects and as per satisfaction of the Consultants. The installation shall be carried out complete in all respects as per recommendations of the manufacturer and as specified herein. Pipe connections, duct connections, flexible connections, electrical connections, drain connections, etc. shall be done by the Contractor, complete in all respects.

5.12.2 Foundation: Foundation shall consist of 6" (150 mm) concrete pads constructed of 1:2:4 cement concrete. The foundation shall be isolated from the structure and AHU / machine room floor by using 2" (50 mm) thick higher density cork sheet. The foundation shall be finished with 3/16" thick cement plaster, edges shall be chamfered.

5.12.3 Commissioning & Testing: The unit shall be commissioned and tested as per the Manufacturer's recommendations. Drives shall be adjusted to provide the required airflow rate and valves shall be adjusted for the proper water flows, etc.

6.0 FAN COIL UNITS:

6.1 GENERAL:

The Contractor shall supply and install Fan Coil Units as specified herein. Fan coil units shall be skin exposed or double skin concealed standard type, suitable for either horizontal ceiling suspension or high static fan coil units as specified below and shown on drawings. All units shall be suitable for operation at 220V/1 phase/50 Hertz A.C. power. The units shall be provided as per List of Approved Manufacturer's.

External static pressure given in the schedule are indicative and for guidance only. The Contractor shall calculate the external and total static pressure for all fan coil units and shall submit the same for Engineer's review and approval before ordering the units.

6.2 HORIZONTAL CONCEALED STANDARD MODEL:

shall consist of coil in an enclosed cabinet, a fan, an auxiliary and main drain pan, ½ inch (13 mm) thick cleanable expanded aluminum filters, and controls and piping package, all as specified below. All Fan Coil Units shall include a factory installed return air plenum that encloses the fan section. The plenum shall be lined with minimum ½ inch (13mm) thick glass fiber insulation. Provide access door to serve fan motor assembly.

6.3 HORIZONTAL CABINET STANDARD MODEL:

shall consist of an enclosure, enclosing coils, fan, main and auxiliary drain pan, ½ inch (13 mm) thick cleanable expanded aluminum filter and controls and piping package.

6.4 DUCTED FAN COIL UNITS:

shall be suitable for air distribution through ducts and shall be capable of handling a minimum external static pressure of ¾ inch of WC (190 Pa).

6.5 SOUND LEVELS:

The sound power levels, in decibels reference 10⁻¹² watts ft² at the fan operating speed selected to meet specified capacity shall not exceed the following values in each octave band, at the mid frequency (Hertz):

		Unit Capacity in CFM					
		Octave Band –	3	4	5	6	7
		Mid Frequency, Hertz –	250	500	1000	2000	4000
200	–	54	54	51	42	36
300	–	60	56	55	45	39
400	–	60	55	51	45	39
600	–	64	60	57	48	41
800	–	61	59	58	48	41
1000	–	60	60	59	48	42
1200	–	62	60	59	50	44

The sound power level data values for these units shall be obtained in accordance with the test procedure specified in ARI Standard 443 based on ASHRAE Standard 36. The power sound values apply to units provided with factory fabricated cabinet enclosures and standard size grilles.

6.6 ENCLOSURE:

Shall be constructed of not lighter than 18 gauge 0.0478 inch (1.21 mm) in normal thickness, steel properly reinforced and braced. Front panel of enclosure for cabinet model shall be removable and provided with ½ inch (13 mm) thick-coated glass fiber insulation. Discharge grilles for cabinet model shall be adjustable and shall be of such design as to properly distribute air throughout conditioned space. All ferrous metal surfaces shall be galvanized treated with a rust inhibitor. Access doors shall be provided for all piping and control components.

6.7 CASING:

Shall be acoustically and thermally insulated internally with not less than ½ inch (13 mm) thick ¾ Lbs/ft³ (12 Kg/m³) density, coated glass fiber insulation, fastened with waterproof and fiber resistant adhesive. Duct discharge collars shall be provided for concealed models.

6.8 FANS:

Shall be galvanized steel or aluminum, multi-blade centrifugal type, dynamically and statically balanced at the factory after assembly in the fan coil units.

All surfaces shall be smooth. Assemblies shall be accessible for maintenance. Disassembly & re-assembly shall be by means of mechanical fastening devices & not by epoxies & cements.

6.9 WATER COILS:

Shall be constructed of not less than 3/8 inch (9.5 mm) outside diameter seamless copper tubing with copper or aluminum fins, mechanically bounded or soldered to the tubes, provided with not less than ½ inch (13 mm) outside diameter flare or sweat connectors. Coils shall be hydraulically tested at 250 Psi (17.5 bars) or under water at 250 Psi (17.5 bars) air pressure and suitable for 200 Psi (14 bars) working pressure. Provision shall be available for easy coil removal.

6.10 DRAIN PANS:

Shall be sized and located properly to collect all water condensed on and dripping from any item within the unit enclosure. Drain pans shall be constructed of not less than 18 gauge, 0.0516 inch (1.31 mm) nominal thickness, galvanized steel, thermally insulated with 1/2 inch (13 mm) thick closed cell fire retardant foam, to prevent condensation. The insulation shall be coated with a waterproofing material. Drain pans may be constructed of 20 gauge, 0.0396 inch (1.0 mm) nominal thickness and galvanized steel die-formed from a single sheet and insulated and coated as for the 18 gauge material. Drain pans shall be properly pitched to ensure condensate runoff.

Not less than ¾ inch (20 mm) NPT or 5/8 inch (15mm) OD Copper drain connection shall be provided in drain pan. Auxiliary drain pan shall be provided for piping and control package.

6.11 FILTERS:

Shall be provided for each unit and shall be of expanded aluminium permanent washable type, ½ inch (13 mm) nominal thickness. Filter shall be removable without the use of tools.

6.12 MOTOR:

Shall be split capacitor or shaded pole, 3 speed, overload protected type, directly connected to unit fans, and suitable for operation on 220 volts, 1phase, 50 Hertz A.C. power.

6.13 **JUNCTIN BOX:**

Fan coil shall be provided with a junction box. The fan motor, electric valve, thermostat, OFF-HIGH-MEDIUM-LOW switch shall all be wired to the junction box, which shall be easily accessible.

6.14 **FAN SWITCH AND THERMOSTAT:**

All units shall be provided an OFF-HIGH-MEDIUM-LOW fan speed switch with integral thermostat. The thermostat shall be of Honeywell or approved equal.

6.15 **CONTROL AND VALVE PACKAGE:**

Following valve assembly (not in FCU supplier scope) shall be followed for all FCUs:

- a) Gate Valves on supply and return lines
- b) 1 Calibrated Balancing Valve on return line
- c) 1 No. 2-way motorized modulating valve
- d) 1 No. Automatic air vent
- e) 1 No. Strainer on supply line

Control package shall be suitable for operation on 220V/1 phase/50 Hertz A.C. power. All piping shall be provided with 1½-inch (40 mm) premolded Rubber form insulation.

6.16 **SPARE PARTS:**

The minimum spare parts required shall be as listed below. However, Contractor shall provide Manufacturer's Recommended List of spare parts at time of bidding and with the submittal of Fan Coil Units.

- e) Set of filters for each Fan Coil.
- f) Spare motor of each type of kW.

6.17 **INSTALLATION:**

6.17.1 General: The Contractor shall install Fan Coil Units as specified and shown on drawings. The unit shall be installed with neoprene vibration isolator of durometer rating 70. The installation shall be carried out complete in all respects as per recommendations of the manufacturer and specified herein. FCU have been specified to be provided with a complete piping and controls package. It shall be the Contractor's responsibility to ensure that the same is as required. He shall connect Chilled Water Lines to the units and outlet connections of the Fan Coil Units. Complete power and control wiring and earthing as required to obtain a fully installed, completely operational system. The unit shall be thoroughly cleaned, filters washed, any defective paint work touched up to obtain a finish as per manufacturer's original finish. All piping shall be installed to ensure condensate discharge into the auxiliary drain pain.

6.17.2 Commissioning & Testing: The Contractor shall be required to commission and test the fan coil units to ensure specified results. Water flows shall be balanced and report be provided to the Consultants for approval.

7.0 SUPPLY AND EXHAUST FANS:

7.1 GENERAL:

The contractor shall supply and install fans of the type and capacity specified in Schedule Sheet and conforming to the specifications given herein. The contractor shall be responsible for the proper selection of the fans so that the specified operating conditions are obtained. Motor shall be sized to provide the required BHP for meeting the specified conditions without overloading. The Fans shall be provided as per List of Approved Manufacturer's.

External static pressure given in the schedule are indicative and for guidance only. The Contractor shall calculate the external and total static pressure for all fans and shall submit the same for Engineer's review and approval before ordering the fans. Required fan and motor shall be provided without any additional cost and no variation or claim shall be entertained in this regard.

7.2 PROPELLER FANS:

Shall be supplied of the quality indicated on the drawings. Propeller fans shall operate on 220V/1 phase/50 Hertz A.C. current. Fans shall be directly mounted on the motor, and shall operate without disturbing noise, during normal operation. The discharge side of the fan shall be provided with self-closing shutters. Propeller fans shall be as manufactured by National Japan or approved equal local brand.

7.3 CENTRIFUGAL FANS:

Shall be capable of delivering the specified capacity against the specified static pressure. Scroll shall be fabricated of heavy gauge steel, completely welded for maximum duty and leak proof construction. Fan wheel shall be of aluminum and have backward curved blades, rigidly constructed with non-overloading characteristics, and shall be balanced both statically and dynamically, and shall be free from objectionable noises and vibration. Sealed permanently lubricated, sleeve, roller or ball bearings shall be provided. Spring type vibration isolators shall be provided. Fan shall be provided with 1450 rpm motor with weather proof enclosure, suitable for 400V, 3 phase, 50 Hertz. Fan shall be driven through an adjustable speed belt drive, rated for 1.5 times motor H.P. Fans shall be provided with inlet and outlet flanges/screen. Motor and belt drive shall be provided with a baked enamel finish.

7.4 ROOF EXTRACTORS:

Shall be capable of delivering the specified capacity against the specified static pressure. Inlets and unit bases shall be one piece with spun aluminum.

Fan wheel shall be aluminum backward-inclined and shall be statically and dynamically balanced. Fans with 10" or smaller wheel diameters shall be direct-drive units, and larger units shall be belt-driven. Belt-drive units shall have motors mounted on adjustable motor base. Base shall have provision for positive, accurate belt alignment and adjustment. V-belt drive shall be of variable pitch type and shall prevent overloading of motor at rated maximum speed. Motor and fan drive shaft (on belt-driven models) shall have

permanently lubricated bearings. Vibration isolators shall be provided at all metal-to-metal contact points. Safety disconnect shall be provided on all units.

7.5 AXIAL FANS:

Each fan shall be supplied with a suitably rated contactor/ starter/ isolator of approved pattern.

Fan casings shall be constructed of mild steel plates with angle stiffeners, with the casing hot dip galvanized after manufacture. The inlets and outlets of the axial flow fans shall be flanged for connection to the system. A drain plug shall be fitted and the casing designed to permit removal of the impeller.

An access door is to be provided on the casings of all fans. Casings shall cover both impeller and motor so that fans can be removed without disturbing adjacent ductwork or other components of the system. A flameproof external terminal box shall be fitted on the casing.

All lubrication points are to be extended to the outside of the casing and in a position that will permit access in relation to the adjacent plant, services or building structure.

Impellers shall be die cast in Aluminum alloy and X-rayed during manufacture. The impellers shall be capable of running continuously at 20% in excess of the rated speed. The impeller shall be keyed and locked onto the shaft, which shall be statically and dynamically balanced and tested at over speed before dispatch from the Manufacturer's works.

Flexible connections shall be supplied and installed at both inlet and outlet of each fan.

The fan bearings shall be of the sleeve type wherever possible. The bearings are to be truly aligned and rigidly mounted on to the casing.

Blade angle shall be adjustable over at least a 30 degree range, with markings at the root to indicate the blade angle.

Axial flow fans are to be driven by electric motors of commercially silent pattern carrying a Makers guarantee in this respect. The motors shall be totally enclosed, fan cooled.

All motors are to be positioned to permit effective ventilation of the motor and all component parts of the fan and motor are to be suitable to withstand the temperature conditions expected in the fan.

Electrical connections to the motors shall be in a totally enclosed terminal box secured to the exterior of the casing. Wiring within the axial flow fans shall be suitable for the conditions within the casings.

A suitable steel support is to be provided for each fan, and the frame is to be fabricated from rolled steel channel with adequate cross members for bolting the fan into position. The frame shall be of welded construction with anti-vibration mountings.

The anti-vibration mountings are to be rubber in shear pattern and of a type that are bolted to both the fan and the support.

All fans should be provided with lifting eyes, speed control, non- return dampen and wire guards.

7.6 SMOKE EXTRACT FANS:

In general the construction of smoke extract fan shall be as per specification for standard centrifugal fan.

Units shall be designed to permit operation at extreme temperatures for a known time period under smoke operation. Fans shall be capable of withstanding temperatures of up to 300°C generally for up to 1 hour duration. Roof units shall include a cowl of fire resistant material. Units casings shall be heavy gauge, mild sheet steel, rolled formed and welded. Hubs shall be die cast aluminium alloy. Wheel shall be single width single inlet pressure die cast aluminium alloy or polyester powder coated steel.

Motors shall be base mounted totally enclosed metric type to IP55, with sealed for life bearings, standard industrial paint finish and Class H insulation, suitable for operating at high temperatures.

7.7 CAR PARK JET FANS:

Car Park Jet Fans shall consist of bell mouth inlet, 50mm thick double wall silencers on the fan inlet and outlet. Airfoil axial flow jet fan and motor. Mounting bracket shall be provided to support the fan from the ceiling, in general construction of fans shall be as per specification for standard axial fans. Fan motor shall be sized to have the power to allow the fan to handle air at normal ambient temperature. Fan motor that de-rated the power required to handle the hot fire smoke are not acceptable. Fan motor must be capable of handling both cool smoke and hot smoke (cool smoke during the early stage of the fire) without overloading the motor. Fans shall be rated for once only operation of 300°C for 1 hour. Fans shall be driven by 2 speed class 'H' motors. The quantity and location of jet fans shown in the drawings are indicative, the actual quantity and location shall be provided by jet fan supplier after CFD study. The Contractor shall submit the CFD study to the Consultant for review and approval.

7.8 STAIR CASE PRESSURIZATION FANS:

In general the construction of stair case pressurization fan shall be as per specification for standard centrifugal fan. Blowers shall be efficient, double inlet, forward curved design. Units casings shall be heavy gauge, mild sheet steel, rolled formed and welded. Hubs shall be die cast aluminium alloy. Wheel shall be double width double inlet pressure die cast aluminium alloy or polyester powder coated steel.

The housings louvered sides shall permit a direct air path. Cleanable, permanent filters back up each louvered side to prevent airborne contaminants from entering. Filters shall be easily removed for cleaning. Motors shall be totally enclosed with class 'F' insulation.

7.9 INSTALLATION:

- 8.9.1 General: Fans as shown on drawings shall be installed by the Contractor, complete in all respects and as per satisfaction of the Consultants. Fans shall be rigidly secured so that

they operate without vibration and transmission of vibration to the structure shall be through isolated. Connection to ducting shall be through flexible connectors. Ducting connection to fan shall ensure lowest turbulence and smooth transition of sizes. All supporting arrangements of the fans shall be drawn up by the Contractor and submitted to the Engineer for approval.

Floor mounted fans shall be installed on concrete housekeeping pad at minimum of 100 mm above the floor, fan shall be mounted on vibration isolator. Structural suspended fans shall be installed using threaded rods and vibration isolator.

8.9.2 Commission & Testing: The fans shall be commissioned and tested by the Contractor.

8.0 WATER TREATMENT EQUIPMENT AND CHEMICALS:

The following water treatment equipment and chemicals shall be supplied and installed by the contractor. The quantities of chilled and condenser water treatment chemicals should be for two years, based on 12 hours per day plant operation at 75% average load. Sufficient chemicals for preliminary tests, balancing commissioning and reliability test shall be separately provided by the contractor.

Water treatment equipment and chemical shall be provided as per List of Approved Manufacturer's in original along with the submittal.

8.1 CHILLED WATER SYSTEM:

Water treatment for this System shall be by means of adding chemicals into the system by using Bypass Feeders. Bypass Feeders shall be of steel/cast iron construction, tapped for a one-inch feed line. The feeders shall be supplied complete with close nipples, reducer coupling, reducing bush, gauge glass, gauge glass holder, gate and globe valves and flow regulator. Feeder volume shall be at least 5 gallons. Bypass feeders manufactured shall be as per list of approved manufacturers.

Water Treatment Chemicals for Chilled Water Circuit

One of the following closed system corrosion inhibitor shall be supplied:

CWT-110 Nitrite base corrosion inhibitor or Drewgard-315 Molybdate base corrosion inhibitor manufactured by as per approved list of Manufacturers.

8.2 CONDENSER WATER SYSTEM:

a) Automatic Conductivity Controller: Provide a microprocessor based control system that will automatically perform the following functions:

- i) Control the level of dissolved solids in re-circulating cooling water at a preset maximum limit through a solenoid bleed valve installed in the bleed-off line, to control concentration of salts beyond maximum permissible limits to control scale and corrosion and to prevent loss of system water due to excessive bleed-off. The conductivity control range shall be 0-6000 micro Siemens/cm.
- ii) Feed inhibitor chemical through user selectable either of the following programmable feed options:

- a. Simultaneous “feed and bleed” to allow inhibitor feed during bleed cycle with maximum feed time adjustable from 1-99 minutes.
- b. “Feed after bleed” to allow inhibitor feed after the bleed cycle is over. Maximum feed cycle shall be adjustable from 1-99 minutes.
- iii) Two independently programmable 7-day biocide feed programs to allow alternate feeding of two biocides on weekly basis.
- iv) Pre-bleed program to allow bleed-off from 0-99 minutes before biocide addition begin, regardless of the system water conductivity.
- v) A biocide lockout function to inhibit all controllers functions during biocide addition and during the soak cycle from 1-300 minutes.
- vi) It should provide a 4 mA to 20 mA isolated signal for Interface with Control System.

The controller shall be complete with temperature compensated, quick disconnect type conductivity probe rated for 150 psi pressure and 140 F temperatures and a flow switch with back check valve and shall be mounted in NEMA 4X Rubber form insulation.

LED type display lamps for inhibitor and biocide feed and bleed with outputs for alarms shall be provided. Controller shall be similar to Liquitron DC1000 of LMI make or approved equal.

- b) Inhibitor and Biocide Feed Pumps: One inhibitor and two biocide pumps shall be provided. Pumps shall be positive displacement electronic types with suitable liquid handling components. Pump output shall be adjustable by readily accessible dial knobs for stroke length and frequency. Pumps housing shall be totally enclosed; corrosion proof glass fiber reinforced polypropylene.

Pump capacities and pressure ratings shall be appropriate for the system application. Pumps shall be as manufactured by LMI of approved equal.

- c) Bleed-off Valve: The bleed-off valve shall be electrically operated, normally closed solenoid valve.

The system shall be complete in all respects with pumps, controllers, solenoid bleed valves, mounting brackets, timers, all plumbing and wiring etc.

- d) Chemicals for Condenser Water Circuit:
 - i) Scale/corrosion inhibitor chemicals similar to Drewgard 300 of Drew Ameroid make.
 - ii) Biocide similar to Biosperse-250 of Drew Ameroid makes.
 - iii) Biocide similar to Biosperse-280 of Drew Ameroid makes.

8.3 WATER ANALYSIS:

The contractor shall be responsible for obtaining a water sample of the water to be used for makeup and having it chemically analyzed to calculate the rate of addition of various

chemicals. Chemically analyzed report shall be submitted to the Consultant for review and approval.

8.4 WATER TREATMENT PROGRAM:

The contractor shall be responsible for obtaining a complete water treatment program for the water circuits. The program shall indicate the testing procedures, the rate of addition of chemicals, and the concentration of chemicals to be maintained in the system, and type and frequency of service. All this information shall be submitted in an approved format bound in hard cover. Suitable test kits for testing water by operating personnel shall be supplied.

8.5 INSTALLATION:

9.5.1 Water Analysis: The Contractor shall be responsible for obtaining a water sample of the water to be used for make-up and having it chemically analyzed to calculate the rate of addition of various chemicals. Water treatment equipment shall be installed by the contractor, complete in all respects. All necessary equipment and material required for a complete installation shall be supplied and installed by the contractor within the quoted cost. It is the intent of these specifications to obtain a complete operational system and the Contractor shall be responsible for providing the same.

9.5.2 Water Treatment Program: The Contractor shall be responsible for preparing a complete water treatment program for the chilled water. The program shall indicate the testing procedures, the rate of addition of chemicals, and the concentration of chemicals to be maintained in the system. Type and frequency of service. All this information shall be submitted in an approved format bound in hard cover.

9.5.3 Commissioning & Testing: The water treatment system for the chilled water shall be commissioned and tested by the contractor to the satisfaction of the Consultants. Test reports shall be submitted by the Contractor and approval obtained. During the maintenance period, the Contractor shall be responsible for making monthly service calls, conduct water analysis of the makeup and re-circulating systems and submit a report of the findings to the Client/Consultants.

9.0 SHEET METAL DUCTWORK AND ACCESSORIES:

9.1 SHEET METAL:

Sheet metal ductwork shall be constructed of galvanized sheet steel conforming to ASTM A653 and zinc coating shall conform to G90. Sheet Metal shall be provided per List of Approved Manufacturer's.

Galvanized sheet metal shall be lock forming quality (LFQ) and duct fabrication should be as per SMACNA standard or DW-144.

Galvanized sheet steel shall be confirming to BS2989 or ASTM A653A, 653M, G90 (Z275).

Rectangular Ducting shall be fabricated according to the following dimensions:

LARGEST NOMINAL DIMENSIONS OF DUCTING MM (INCHES)		U.S.S. GAUGE.	THICKNESS MM	
Up to 675 (27")	....	24	....	0.70
700-1275 (28"-51")	....	22	....	0.85
1300-2025 (52"-81")	....	20	....	1.00
Above 2025 (81")	....	18	....	1.31
Flue Duct	....	12	....	2.50

9.2 SPLITTER DAMPER:

Shall be fabricated of sheet metal, two gauges heavier than the duct gauge in which the damper is installed. Damper shall be fabricated of wood of an aero foil shape; over which sheet metal shall be formed to completely cover the wood. Damper shall be operated by a 3/8 inch (10 mm) dia rod brought through the side of the duct with brass locking set screw and bushing. Two operators shall be required on splitters over 200 mm (8 inches) wide. For insulated ducts, bushing shall be of thickness equal to the thickness of the duct insulation. Locking set screw shall be ¼ inch ø, arranged for easy locking of the damper operator at the desired position. Damper shall be installed with full-length hinge. Rubber gaskets shall be installed to minimize air leakage. Damper operator shall be galvanized and shall be designed for convenience of operation.

9.3 QUADRANT VOLUME DAMPER:

Shall be multi-leaf opposed blade type, with a maximum blade width of 200 mm (8 inches). Dampers shall be constructed of sheet metal two gauges heavier than the duct gauge. They shall be operated by quadrant operators manufactured of brass. Operators shall be provided with standoff mountings on thermally insulated ducts to provide clearance between the ducts surface and operator, equal to the thickness of the insulation. Quadrant operator shall be heavy duty, capable of being locked at desired position conveniently. Damper after fabrication shall be provided with baked enamel finish.

9.4 AIR DEFLECTORS:

Shall be provided in all square elbows, duct mounted supply outlets, take-off or extension collars to supply outlets and tap-in-branch take-off connections. Air deflectors will be factory-fabricated units consisting of curved turning vanes or louver blades for uniform air distribution and change of direction with minimum turbulence and pressure loss. Square elbows shall be provided with curved vanes.

9.5 SOUND ATTENUATOR:

All silencers shall be completely pre-fabricated of noncombustible materials and shall have a minimum insertion loss to suit equipment and required terminal noise levels and a maximum air pressure drop of 62 pa.

Acoustic media shall be packed under compression and protected from air erosion by minimum 22 U.S. ga. Perforated galvanized sheet metal.

Silencers with internal air velocities above 22.86 m/s shall have acoustic media additionally protected from erosion by glass fiber cloth.

Silencers shall have 50 mm slip connections unless specified otherwise. Silencers shall be painted with anti-rust prime coat. Supply lighting lugs on units with cross sectional dimensions larger than 600 mm.

Silencers of rectangular construction shall have an outer sheet of 16 U.S. ga. Galvanized sheet metal, with continuous welded seams and painted with one anti-rust prime coat. Splitter shall be reinforced with formed channels. End connections shall be steel galvanized angle flanges. They shall be used in ducts over 1000 Pa.

The certification of the pressure drop, insertion loss and generated noise data shall be based upon tests of the same silencer for all measurements.

Provide silencers as required to achieve noise levels specified.

9.6 VARIABLE AIR VOLUME (VAV) TERMINAL UNITS:

The contractor shall supply and install variable air volume terminals of the sizes and capacities shown on the plans. space limitations shall be reviewed carefully to ensure that all terminals will fit the available space.

The variable air volume box assemblies shall be pressure independent and shall reset to any air flow between zero and the maximum scheduled figures.

Each air distribution assembly shall be designed to maintain essentially constant flow regardless of inlet flow deflection. A hard duct elbow of any angle upto 90 deg. shall not alter the maximum or minimum factory air flow setting by more than 5 %.

The air flow sensor and controller shall be designed to prevent contamination and stoppage by building dust.

The air flow sensor shall amplify the sensed air flow signal having a center averaging chamber.

The digital controller shall operate the electric damper actuator through the full scheduled capacity range.

The actuator and its controller shall be calibrated and factory set for the maximum and minimum flow rates as scheduled.

Each VAV box shall be supplied with its own digital controller and shall be pressure independent VAV controller complete with electronic flow transducer. All control components shall be mounted inside a protective metal shroud.

The VAV box and components shall safely withstand an internal air pressure up to 1245 Pa (5" WG)

The damper shall have heavy gauge blades pivoted in self-lubricating bearings. The blades shall seat against closed cell foam gasketed stops, with less than 20% leakage at 747 pa (3"W.G) inlet SP, as rated by ARI standard 880.

The controller shall be field adjustable for minimum and maximum l/s (cfm) settings.

9.7 CONSTANT AIR VOLUME (CAV) TERMINAL UNITS:

The contractor shall supply and install constant air volume units. The CAV units shall be pressure independent type, having low pressure loss, low sound level to provide content air flow with a percentage deviation not exceeding 2.5 %.

Units shall be galvanized steel sheet construction with casing leakage rate to Class II in accordance with DIN24194. Damper blades shall be of aluminum with neoprene seals, aero foil profile to control air flow. Damper spindle shall be supported on self-lubricating nylon bearings.

The CAV unit shall be equipped with a factory installed "Flo-cross" type averaging and signal amplifying air flow sensor to maintain constant air flow even with irregular duct approach.

Units shall be complete with factory installed DDC controllers. Units shall be present at factory for the scheduled airflow. It shall also be possible to carry out field resetting of airflows when necessary. Units shall be selected so as not to exceed specified noise levels for the respective zone.

9.8 FIRE DOORS AND FIRE DAMPERS:

Shall be provided on all supply/Return duct crossing AHU rooms. Fire doors and fire dampers shall be fusible link curtain type approved for the protection of openings in one, two and four hour fire rated walls and partitions and shall be installed in accordance with the Consultant's directives. Suitable hand-hole openings with tightly fitted access covers or doors shall be provided in the ducts to make all fire doors and fire dampers accessible for inspection and maintenance. Unless otherwise shown, the installation details given in NFPA 91 for fire doors and SMACNA Fire Damper Guide for fire dampers shall be followed except minimum thickness metal for all sleeves provided for the fire dampers shall not be lighter than 14 gauge. All necessary items associated with the fire doors and fire dampers such as retaining angles, sleeves, break-way connections and access doors shall be provided.

Fire dampers shall meet all UL and NFPA Standards and criteria for primary fire dampers in walls and floors with fire resistance rating of 4 hours and less.

9.9 DUCT ACCESS DOORS:

Hinged doors shall be provided at all automatic dampers, fire dampers, coils, thermostats, plenums, filters and other apparatus requiring services and inspection in the duct system. Doors shall be of 450 x 450 mm (18" x 18") unless otherwise required. Where size of duct will not accommodate this size, the doors shall be done as large as practical. Doors shall be rigid and provided with airtight felt gaskets. Doors shall be provided with galvanized hinges with bronze pins and two approved brass fasteners. Doors 600 x 600 mm (24" x 24") or larger shall be provided with fasteners operable from both sides. Doors in insulated ducts shall be of the insulated type. Unless otherwise indicated, doors shall also swing those fan pressure or suction holds the door closed.

9.10 DUCT TEST HOLES:

Holes with patches or threaded plugs in duct and plenums shall be provided where directed or necessary for using pitot tubes for taking air measurements to balance the air systems. At each of these locations where ducts or plenums are insulated, extensions shall be provided with plug fittings.

9.11 FLEXIBLE DUCT WORK:

Flexible duct shall be lightweight aluminum laminated duct suitable for low and medium pressure system. The aluminum laminated construction shall encapsulate a high tensile steel wire helix between two layers of 0.9 micron thick plus 12 micron thick polyester. Flexible ducts shall be with factory applied thermal insulation and vapor barrier. Insulation shall be 25mm thick 16 kg / m³ density.

9.12 BACKDRAFT DAMPER:

Backdraft dampers shall be low leakage with parallel blades and neoprene edge seals.

Dampers frames shall be constructed from galvanized sheet steel with Aluminum blades. Blade stub shafts shall be brass with PVC bearings. Sealing strips on blades shall be polyester foam.

Pressure relief dampers shall be multi-parallel blade with weighted arm closing assist. The frame shall be anodized Aluminum channel sections with formed Aluminum blades. Maximum blade length shall be 100 mm, and polyester foam seating strips shall be incorporated on blade edges. Bearings shall be in PVC with non-corrodible shafts.

9.13 INSTALLATION:

10.13.1 General: Sheet metal ductwork shall be constructed have galvanized sheet steel conforming to ASTM A-366-B2T. Unless otherwise approved ducts shall conform accurately to the dimensions indicated and shall be straight and smooth on the inside, with joints neatly finished. Ducts shall be secured to the structural slab in the building, and the method of anchoring and/or fastening is as detailed on the drawings. Ducts shall be constructed and installed so as to be completely free from vibrations under all conditions of operation. Layout drawings required under the clause APPROVAL OF MATERIALS AND EQUIPMENT shall show, for suspended ductwork, the location of all supports typical details for anchorage and details for special anchorage.

10.13.2 Duct Construction:

- (a). Curved elbows shall have a centerline radius not less than 1.5 times the width or diameter of the duct.
- (b). Joints for low velocity ducts shall be made substantially airtight, and no duct marks from air leaks shall show at duct joints, or connections to grills, registers and diffusers.
- (c). Laps at the joints for low velocity systems shall be made in the direction of airflow. Button punch or bolt connections in standing seams shall be spaced at fixed centers not greater than 150 mm (6"). Horizontal locks or seams of the type known as Button Punch Snap Lock, may be used in lieu of Pittsburgh Lock on low velocity systems.
- (d). Transformations shall be made with sides pitched not to exceed a maximum of 20°, 40° included angle, for diverging air flow, and 30°, 60° included angle, for converging air flow, or as indicated on the drawings.
- (e). Square elbows, fittings and branch take-off for low velocity shall be designed, constructed and installed as per recommendations in SMACNA Publications, "Low Velocity Duct Construction Standards".
- (f). Splitter dampers, Quadrant Volume Dampers, Air deflectors, fire doors and fire dampers, duct access doors and duct test holes shall be installed where shown on the drawings and where required for the proper operation of the system even though not shown on the drawings.

Other details for duct construction: Casing construction, access doors, hangers and supports, duct joints, volume dampers, penetration of casing, casing curb detail, and hood construction shall be as indicated on the drawings or as indicated by the Consultant. Ducts shall be connected to intake and exhaust louvers, rain-hoods or goosenecks. Details of connections shall be as indicated, or directed by the Consultant. All connections of ducting to air handling units, dampers, plenums, rotary heat exchangers, etc. shall be through removable flanges. Installation of items not shown in detail or not covered by detailed specification shall be as set forth in the SMACNA Publications "Low Velocity Duct Construction Standards".

Bracing and jointing shall be done as per following table:

Ducting Dimensions – Inches	Size of Bracing Angle	Duct joint (Low Pressure)	Duct joint (medium Pressure)
Up to 23" larger dimensions	None	Hemmed " S" Slip bar	1 ½ "standing seam, 1 3/8 "welded flange, 1 1/8" Pocket lock.
24" – 30" larger dimensions	Joints at 4 ft. centre without bracing or joints at 8 ft. center with 1" x 1/8" bracing between joint.	Hemmed " S" Slip bar 10 ' centers	1 ½ "standing seam, 1 ½ "Pocket lock.
31" – 42" larger dimensions	1" x 1" x 1/8" – 4 ft. Centre	Reinforced 1" x 1/8" bar slip 10' centers	2 "standing seam, 2" Flanged Joint.
43" – 72" larger dimensions	1.5" x 1.5" x 1/8" – 4 ft. Centre	Reinforced 1 1/2" x 1/8" bar slip 4' centers	2 "standing seam, 1.5"Flanged Joint with tie rod In center.
73" – 84" larger dimensions	1.5" x 1.5" x 1/8" – 4 ft. Centre	Reinforced 1 1/2" x 1/8" bar slip 4' centers	2 "standing seam, 1.5"Flanged Joint with tie rod In center.
85" – 96" larger dimensions	1.5" x 1.5" x 3/16" – 4 ft. Centre	Companion Angles 1 ½" x 1 ½" x 1/8" at 4' centers	2 "standing seam, 1.5"Flanged Joint with tie rod In center.

10.13.3 Flue Duct: The Contractor shall install flue duct using steel sheet of U.S. Gauge 12 (2.5 mm) thickness, with flanged joints sealed with gasket Longitudinal joints shall be welded.

10.13.4 Duct Hangers: Duct hangers shall be installed as per the table given below:

Larger Duct Dimension Spacing	Angle Size	Maximum	Hanger Rod Size
Up to 30" 10' – 0"	Dia. 3/8"		1" x 1" x 1/8"
31" – 60" 10' – 0"			1" x 1" x 1/8"
61" – 84" 8' – 0"	2"	x	2" x 2" x 1/8" Dia. 3/8"
85" – 96" 8' – 0"			2" x 2" x 1/4" Dia. 1/2"

The above table shows the maximum spacing of hangers. Hangers shall however be installed at every change of direction, at volume control damper, at other duct mounted accessories location and where necessary to support the duct suitably.

10.13.5 Flexible Duct Connections (Expansion Joint):

Flexible duct connections as specified elsewhere shall be fitted wherever ducts cross building expansion joints, at suction and discharge end of Air Handling Units and Fans where ducts are connected to such unit, and or wherever shown on the drawings. Flexible duct connection shall be high grade woven fire-resisting cloth of minimum 250 lbs tensile strength and 100 lbs tear strength.

Details of flexible connections and bases shall be submitted to the engineer for approval.

10.0 DIFFUSERS, REGISTERS AND GRILLES:

10.1 GENERAL:

These shall be factory fabricated of anodized Aluminum extruded sections and shall distribute the specified quantity of air evenly over space intended, without causing noticeable drafts, or dead spots anywhere in the conditioned area. The Contractor shall confirm with the Architect regarding the interior color scheme of the building to match the colors and type of the diffusers and grills. The Contractor shall be responsible for diffusion, spread, drop and throw. If, according to the certified data of the manufacturer of the proposed units, the sizes indicated on the drawings will not perform satisfactory, the units shall be re-selected to perform quietly and effectively in accordance with the manufacturer's recommendations as approved by the Consultant.

A schedule of all air inlets and outlets shall be submitted to the Consultant, indicating location, types, specified air quantity, neck or face velocity, sound power level values, pressure drop, throw and drop for registers and maximum and minimum diffusion range, prior to ordering. Diffusers and registers shall be provided with opposed blade volume controller with accessible key operator. The manufacturer of these units shall be as per list of approved manufacturers.

1. The cutting of false ceiling (tiles) shall be the responsibility of the HVAC contractor.
2. All air inlet and outlets shall be manufactured as per turtle & belly standards of air inlets / outlets.
3. Diffusers connected to VAV systems shall be the non-dumping type.
4. The interior of all grilles and diffusers is to be factory painted matt black.
5. All grilles, diffusers and registers shall be tested to the requirements of ASHRAE and ADC and ARI.

All grilles and diffusers supplied on this project shall be tested and rated in accordance with ASHRAE standard 70-72, ADC Test code 1062-GRD and ISO 3741.

Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing for Rating the Air flow performance of outlets and inlets" and ARI 650 "Standard for air outlets and inlets" Test and rate louvers in accordance with AMCA 500 "Test Method for louvers, dampers, and shutters"

10.2 DIFFUSERS:

Shall be square, rectangular, slot, strip shape or perforated type with fixed or adjustable air discharge pattern, as indicated in the drawings. Ceiling mounted units shall be furnished with anti-smudge device, unless the diffuser unit minimizes ceiling smudging through design features. Diffusers shall be provided with air deflectors specified herein. Ceiling mounted units shall be installed with trims tight against ceiling whether flush, recessed or surface mounted. Sponge rubber gasket shall be provided between ceiling and surface mounted diffusers, when necessary for air leaking-control. Suitable trim shall be provided for flush mounted diffusers.

10.3 REGISTERS:

Shall be four-way directional-control type except that return and exhaust registers may be fixed horizontal or vertical louver type similar in appearance to the supply registers face.

Registers shall be provided with sponge rubber gaskets between flanges and walls or ceilings. Wall supply registers shall be installed at least 150 mm (6") below the ceiling unless otherwise indicated. Type of registers shall be as indicated on the drawings or approved.

10.4 RETURN GRILLES:

Shall be of sizes shown on the drawings and shall consist of fixed louvers at 40° angle along the longer side and shall not be provided with control dampers unless otherwise indicated on drawings.

10.5 LINEAR SLOT DIFFUSERS:

Shall be of continuous ¾ inch width slot/s with adjustable control vanes and volume control dampers. It shall be fully adjustable from the face of the diffuser, to any horizontal, vertical or any intermediate setting of air flow pattern to satisfy needed throw. Linear slot diffusers complete with accessories shall be of extruded aluminum construction with lengths and numbers of slots as shown on the drawings. Finish and color to be approved by the Engineer. Provide concealed mounting brackets fit in a hemmed duct collar or frame to positively hold the diffuser in ceiling or sidewall installations. Provide diffusers with galvanized steel sheet plenum as required, internally lined with 1 (one) inch thick acoustic insulation. Circular spigots are provided and fitted with volume control dampers.

10.6 LOUVERS:

Louvers shall be extruded aluminum frame with aluminum blades of not less than 2 mm thickness, and shall be firmly fixed so as not to vibrate. Unsupported blade width shall not exceed 1800mm. behind each louver there shall be an insect mesh screen 76 x 6 mm made from 2 mm diameter stainless steel wire. The screen will be clamped by a 20 mm frame and will be firmly fixed to the outer edges of the louver. The frame shall be hot dip galvanized after fabrication. The connection to the louver shall be flexible and shall ensure no duct load is transmitted to the louver. Louvers shall be provided with powder coated finish to the approval of the engineer.

10.7 INSTALLATION:

Installation shall ensure that all lines are perpendicular and parallel to the building walls and other surfaces and properly centered so that complete symmetry is obtained.

All diffusers shall be installed directly to the supply air ducting, so that the weight of the diffusers is not transferred to the ceiling. Diffusers shall be so installed that the collar is flush with the ceiling. Gaskets shall be used to prevent leakage.

Registers and grills on sidewalls shall be fixed on deodar wooden frames. Frame thickness shall be 3 mm (1/8") less than the register/grill collar and shall cover the full width of the wall. Perfect alignment and symmetry shall be maintained.

After the system is in operation, if drafts, dead spots, or excessive noise are noticeable in the conditioned areas due to improper selection or construction of the air outlet, the grill/diffuser/register shall be changed to the proper type to remove the defect, without additional cost to the owner.

11.0 THERMAL INSULATION:

11.1 GENERAL:

The Contractor shall install the insulation on ducting, piping, etc., as specified below. Installation shall be done as per the following specification. The insulation shall be provided as per List of Approved Manufacturer's or equivalent make subject to the approval of Consultant.

11.2 CHILLED WATER, REFRIGERANT AND CONDENSATE DRAIN PIPING INSULATION:

- (a) Chilled water piping: insulation shall consist of preformed sections of long fine fiber glass, bounded with a temperature resistant, light in weight easy to handle, cut and fit with the product complying with the requirements of BS 3958: part-4, 1968. The density of the Rubber Form Insulation shall be 4 lb/ft³ (64 kg/m³) and thermal conductivity of 0.22 Btu.in/hr.ft².°F at 75°F (0.032 W/m °C at 24°C). Insulation shall be factory provided with fire resistant jacket, consisting of a laminate of white kraft paper on the outside and aluminum foil on the inside, reinforced with strong glass yarns, laminated with flame snuffing adhesive. Sealing of all longitudinal and circumferential joints shall be done by using laminated aluminum and white kraft paper self-sealing tape. All overlaps shall be 50mm at the joints. Insulation thickness shall be as follows:
- | | | |
|------|-------------------------------------|------------------|
| (i) | Pipe size upto 40 mm (1½") ∅ | - 50mm thickness |
| (ii) | Pipe size upto 50 mm (2") ∅ & above | - 75mm thickness |
- (b) Valves and Fittings and other specifications shall be insulated with preformed adjoining insulation, cut to suitable shapes and sections, to closely fit around valves and fittings. Insulation thickness shall not be less than the adjoining straight pipe insulation thickness. The adjoining insulation near these fittings shall be metered and trimmed into suitable sections to tailor fit closely around the valves, flanges and fittings. All trimmed sections shall be secured by wrapping of approved type of self-adhesive tape to form a complete vapor seal. Insulation at valves, unions, flanges and any other pipe line mounted at component shall be done in such a way that if the insulation of the components is required to be removed the adjoining pipeline insulation shall not be damaged. A clear line of demarcation shall be inherent between the pipeline insulation and pipeline mounted components.
- (c) Canvas Cloth Protection: All internal and external pipe insulation shall be provided with 1 Lbs. /sq. yd. (0.54 Kg/m²) water proof canvas. The canvas shall be stretched tight over the insulation-using adhesive, which shall cover 50% area and the edges sewer with nylon thread. Cut edges shall not be visible. All longitudinal joints shall be on top for horizontal pipes and hidden from view. Circumferential joints shall be equally distant and equal to the width of the canvas roll. Patches shall not be permitted.
- (d) Cladding: All chilled water piping in the plant room and where expose to atmosphere shall be provided with cladding of 26 U.S. Gage (0.55 mm) thick galvanized steel or aluminum sheet: Cladding at valves, strainers, flanges, unions and other de-mountable pipe line components shall be provided with quick release toggles with the case made in two or more pieces to allow for easy dismantling. The cladding shall be painted with one coat of primer and two coats of finish paint.
- (e) Copper Pipes: shall be insulated with 1-1/4" (32 mm) thick closed cells synthetic elastomeric foam insulation and wrapped with self-adhesive waterproofing tape and provide G.I cladding in the plant room and where expose to atmosphere.

- (f) Condensate Drains: shall be insulated with 3/8" (10mm) thick closed cell synthetic elastomeric foam insulation such as Aero flex-Europe or equivalent.

11.3 DUCT INSULATION:

- (a) Duct Insulation: All indoor supply, fresh & return air ducting shall be insulated with 40-mm thick, 1.5 lb/cu.ft. (24 Kg/m³) density Rubber form insulation. All exposed supply, fresh & return ducts shall be insulated with 50-mm thick 48 Kg/m³ density Rubber form insulation. The insulation shall be applied to the duct surface with MOWLITH adhesive by CLARIANT. All joints shall be sealed with self-adhesive aluminum foil faced tapes 50mm wide.

Insulation shall be continuous and no gaps, crevices and other discontinuities shall be acceptable. All gaps shall cover 100% surface area of the duct and insulation and joint shall be overlapped 50mm.

All exhaust air duct heading toward energy recovery wheel or passing through plenum in the Air-conditioned areas shall also be insulated with 25-mm insulation to avoid any condensation.

- (b) Jacketing: The complete insulation shall be provided with 1 Lbs./sq.yd. (0.54 Kg/m²) water proof canvas. The canvas shall be stretched tight over the insulation-using anti-fungus (Foster) adhesive, which shall cover 50% area and the edges sewer with nylon thread. Cut edges shall not be visible. All Longitudinal joints shall be on top for horizontal ducts and hidden from view for vertical ducts. Circumferential joints shall be equally distant and equal to the width of the canvas roll. Patches shall not be permitted.

All supply, return, exhaust (up to FAHU) and fresh air (conditioned) ducting in the plant room and where exposed to atmosphere shall be cladded with 26 gauge G.I. sheet metal after proper insulation.

The cladding shall be painted with one coat of primer and two coats of finish paint.

- (c) Flue Duct: shall be completely insulated with spun mineral fiber or rock wool, at least 100 mm (4") thick, having a thermal conductivity of 0.55 Btu.in/hr.ft².°F at 600°F. Insulation shall be jacketed with galvanized iron mesh on one side and copper clad wire on the other side, and provided with an outer jacket of 26 gauge G.I. Sheet.

11.4 EQUIPMENT INSULATION:

- a) Air separator, expansion tank and chilled water pumps shall be insulated with minimum 25 mm (1") thick cellular glass insulation with cladding and painting.

11.5 INSULATION SCHEDULE

S.No	SERVICE	THICKNESS mm	DENSITY Kg/m ³	THERMAL CONDUCTIVITY w/m.°C	MATERIAL	PROTECTION	CLADDING
1	Chilled water pipe Up to 40 mm dia.	50	64	0.032 @ 24 °C	Preformed section of fiber glass insulation with factory applied glass reinforced aluminium foil.	Canvas Cloth	26 Gauge G.I sheet in plant room and where expose to atmosphere
	Chilled water pipe 50 mm & above dia.	75	64				
2	Duct - Supply, Return and Fresh air - air conditioned space/ air conditioned ceiling cavity.	40	24	0.032 @ 24 °C	Fiber glass insulation with factory applied glass reinforced aluminium foil.	Canvas Cloth	26 Gauge G.I sheet in plant room and where expose to atmosphere
	Duct - Supply, Return and Fresh air duct - non air conditioned space.	50	48				
	Exhaust air duct.	25	24				
3	Copper Tubes	32	70	0.04 @ 24 °C	Closed cell synthetic elastomeric foam insulation	Self - adhesive waterproofing tape	26 Gauge G.I sheet in plant room where expose to atmosphere
4	Condensate Drain Pipe	10	70	0.04 @ 24 °C	Closed cell synthetic elastomeric foam insulation	Self - adhesive waterproofing tape	-
5	EQUIPMENTS						
	Air Separator	25	120	0.042 @ 24 °C	Cellular glass	Canvas Cloth	26 Gauge G.I sheet
	Expansion Tank	25	120				-
Chilled water pumps	25	120	-				
6	Flue Duct	100	145	0.075 @ 300 °C	Rockwool	G.I mesh	26 Gauge G.I sheet

11.6 INSTALLATION:

12.6.1 Duct insulation: The insulation shall be fixed to the duct with a good quality fire-resistant, approved adhesive. Adhesive shall cover at least 75% of duct area. Sheet metal hooks only will not be allowed. At all elbows, tees or turnings insulation shall be applied in such a way as to allow the insulation to be installed flush with the duct. Insulation shall be continuous, and no gaps, crevices, or other discontinuities shall be acceptable. All gaps remaining shall be filled up with fiber glass scrim.

(a) Vapor barrier shall be fixed to the insulation with a good quality, fiber resistant adhesive, approved by the Consultant. All circumferential and longitudinal joints shall be lapped at least 1.5 inches. Vapor barrier shall be completely continuous. All scratches, tears, etc. shall be made good by pasting fresh layers of Kraft paper on the discontinuity. Adhesive shall cover at least 75% of the insulation area.

(b) Jacketing & cladding shall be done, on exposed to atmosphere ductwork.

12.6.2 Pipe Insulation: No insulation shall be applied to any system of piping until all pipe work has been tested, cleaned out and made tight. All insulation shall be applied in a manner consistent with good practice and methods. All longitudinal joints of pipe shall be at the top and bottom. Insulation shall be continuous through walls, floors, ceiling and partitions etc.

Chilled Water Piping: shall be insulated with preformed sectional Rubber form insulation. All insulation shall be fixed to the pipe with a good quality, fire resistant, approved adhesive. Insulation shall be continuous and gaps if any shall be filled up with insulation yarn scrim and bounded with twine. Circumferential and longitudinal joints of vapor barrier and jacket shall be overlapped at least 50 mm. Soft aluminum bands shall be installed at every 450 mm.

12.6.3 Cladding: All insulated pipes in the central plant room and where expose to atmosphere shall be provided with a cladding of 26 gauge G.I. sheet metal. At all flanges and Valves shall be provided with valve boxes with quick opening clamps.

The cladding shall be painted with one coat of primer and two coats of finish paint.

12.0 ACOUSTICAL DUCT LINING:

12.1 GENERAL:

Acoustical duct lining for low velocity system shall be fibrous glass designed exclusively for lining duct. The air side surface of the liner shall be capable of withstanding air velocity of 4,000 feet per minute without delamination or erosion for service in low velocity duct systems. Sound absorption coefficient for the thickness provided shall not less than indicated below as determined by procedures of the Acoustical & Insulating Materials Association, Mounting No. 6:

OCTAVE PASS BANDS	2	3	4	5	6	7
Mid frequency, Hertz	125	250	500	1000	2000	4000
Sound Absorption Coefficient						
	Type I .23	.50	.49	.63	.73	.82
	Type II .13	.44	.63	.90	.83	.76

The density of the lining including any surface coating or facing shall not be less than 21.6 kg/m³ not greater than 52.82 kg/m³. The Acoustical duct lining shall be as provided as per List of Approved Manufacturer's.

The liner shall be coated on the airside with neoprene cloth. Lining shall be not less than 1 inch thick, nominal. Duct sizes shown on the drawings shall be increased to compensate for the thickness of the lining used. Acoustic liner shall be provided upto a length of 5 m (15 ft.) downstream of all the Air Handling Units. For Fan Coil Units provide Acoustic Lining in supply air duct upto first air outlet.

12.2 APPLICATION:

The lining shall be applied in cut-to-size pieces attached to the interior of the duct with fire-resistant adhesive. Top and bottom pieces shall lap the side pieces and in addition shall be secured with welded pins, adhered clips, metal, nylon high impact plastic, and speed washers or welding cup-head pins or adhered clips shall not distort the duct, burn through or mar the finish or the surface of the duct. Pins and washers shall be flushed with the surface of the duct liner and all breaks and punctures of the duct lining coating shall be sealed with fire resistant adhesive.

All exposed edges of the liner at the duct ends and at other joints where the lining will be subject to erosion shall be coated with a heavy brush coat of fire-resistant adhesive, to prevent delamination of the glass fibers.

12.3 INSTALLATION:

General: It is the intent of this specification that noise levels due to air conditioning and/or ventilating equipment, ducts, grilles, registers, diffusers, dampers, etc., will permit attaining sound pressure levels in occupied spaces conforming to the following NC (Noise Criteria) curves as explained in the latest issue of the ASHRAE Handbook and Product Directory – Systems:

All spaces shall be NC-35 except the following:

- (a) Lobby, Toilets, Corridors: NC-40
- (b) Space within 10' (3m) of local floor fan room: NC-42 to 45
 - (i) On the discharge side: NC-45
 - (ii) On the return side: NC-42

12.3.1 Air Distribution System: Maximum permissible sound power in octave bands of airborne transmission through the combination of grilles, registers and diffusers when operated in installed condition per plans and specifications shall be as follows:

Octave Band

Noise Criteria	1	2	3	4	5	6	7	8
NC-35	62	56	49	46	43	42	41	42
NC-40	66	60	54	51	48	47	46	47
NC-45	68	63	58	56	53	52	51	52

12.3.2 Acoustical Performance within Equipment Spaces: Equipment room noise levels and noise transmission to adjacent buildings shall comply with all applicable Noise Ordinances.

13.0 ELECTRICAL WORKS:

13.1 ELECTRICAL WIRING:

The Contractor shall be responsible for the complete power and control electric wiring of the required of the HVAC and BMS Works and other areas as required for the system. A 3 phase and neutral, 4 wire Electric Supply with earthing continuity conductors where indicated on the drawings will be available for the Contractor. Wiring onwards from this supply point to all motors, controls, etc., shall be the responsibility of the Contractor.

The Contractor shall verify the electric power given in motor control center drawings at the time of bidding. No additional cost and no variation or claim shall be entertained if Contractor supplied higher electric power equipment's.

For remotely located equipment, a power point shall be supplied near each unit, or where indicated on the drawings and wiring onwards shall be the responsibility of the air-conditioning contractor.

The electrification work shall be carried out by a licensed workman, authorized to undertake such a work under the provision of Pakistan Electricity Act and Rules and the latest edition of I.E.E. Wiring Regulations.

Any special requirements of the local Electric Supply Company shall be complied with.

13.2 CABLES:

All the cables listed, except otherwise specified, are four cores PVC insulated PVC sheathed cables 600/1000 volts grade as per British Standard B.S. 6004:1969. The conductors shall be of high conductivity annealed copper wires of 99.97% purity heavily insulate with PVC compound and sheathed overall with PVC compound. The insulation

color identification will be as red, yellow, blue and black for neutral. In general all the cables, except otherwise specified in the cable schedule will be non-armored types. All cables shall be selected at 45°C.

13.3 ELECTRIC MOTORS:

The electric motors shall be of the type and sizes required for driving all air-conditioning equipment and should comply with the rules of Electrical Machines as stated in the VDE0530 and the BS 2613: 1957 specifications. The motors offered should have output rating as specified and should meet the system requirements.

Adjustments on motor horsepower or speed will be allowed on this account. Generally all motors shall be constant speed, three phase squirrel cage induction type, unless otherwise specifically noted.

The motors offered should be designed and rated for 400V, 3 phase, 50 cycles A.C. system and should be able to give their rated output at + 5% the rated voltage and frequency.

The motors shall be suitable and be able to give required output under site conditions i.e. maximum ambient temperature of 120°F and altitude 1000 meters.

The motor where specified as of single phase should be suitable for operation on 220 + 5% volts, 50 cycles A.C. system.

The motor shall be tropicalized class 'F' insulation and fungus proof. Unless otherwise specified the motors shall have drip proof construction for indoor installation and totally enclosed weatherproof; fan cooled construction for outdoor installation.

All motors shall be arranged for quiet operation and guaranteed to give the required output and fulfill the requirements of the machinery without producing any sound audible outside the machine room.

13.4 MOTOR CONTROL CENTER CONSTRUCTION AND COMPONENTS:

- (a) General: The central control panel shall be located as indicated in drawings. It shall be floor-mounted, free standing and front access design.

Each piece of equipment on the part shall be identified by a nameplate.

Nameplate may be plastic or metal and attached to the surface of the panel or integral with it.

Painting or lettering, directly on the panel will not be permitted. Control instruments, wiring and terminals shall be within the panel, except that switches pilot lights, and push buttons shall be mounted on the panel front. The front panel shall be hinged for front access. The Motor control centers shall be from Standard manufacturers and shall be provided as per List of Approved Manufacturer's or equivalent make subject to the approval of Consultant.

Cable and breaker sizes and other components of MCC shown in the drawings are indicative and for guidance only. The Contractor shall submit all MCC based

on approved equipment's and get approval before ordering. Any change in approved MCC's shall be provided without any additional cost.

- (b) Construction: The control center shall be consisted of 90 inches high and approximately 12-18 inches deep. The external panels shall be of flanged 14-gauge sheet steel. Side, top, back and full floor plates shall be rigidly joined by cross members and angle iron brackets.
Removable floor channels 1.5" x 3" shall be provided to support and mount the entire control center.
- (c) Unit Compartments: provide each compartment with an individual front door.
- (d) Bus: Power shall be distributed horizontally within the control center by a three phase electrolytic imported copper bus (99.7% purity), rated for the required Amperes continuous current and braced for minimum 40,000 ampere RMS asymmetrical short circuit current or as indicated on drawings. The bus shall be efficiently isolated from all wiring troughs and other working areas. Power within vertical sections shall be distributed by vertical copper bus bars. Bus bars shall be painted red, yellow and blue.

All the bus bars, internal wiring cables and other equipment shall be rated for 45°C ambient and bus bar end temperature of 65°C.

Provide copper ground bus of the required amperage but having not less than 200 amperes capacity in the base of the control center permanently grounding the structure. Provide lugs as required for ground wire attachment.

- (e) Incoming & Outgoing Cable Termination: Provide 12" or more of wiring space just below the main bus for incoming cable. Provide space for outgoing cables through either top or bottom of all standard vertical sections.
- (f) Main Protective Device: The incoming line protection device unless otherwise specified shall be a circuit breaker of the frame size and ampere rating required for the power supply to the plant.
- (g) Motor Starters: All starters for single phased motors shall be automatic magnet direct-on-line types with adjustable overload cutout start/reset push button. Where electrical interlocking is required the starters shall be additionally provided with hand/off/auto switch and at least two auxiliary contacts for electric or electronic interlocking or as specified.

All three phase motor starters up to 7.5 HP shall be automatic magnetic direct-on-line type, with three adjustable overload cut-outs, Ammeter low voltage cut-out, single phasing preventer, stop-reset push button, HAND-OFF-AUTO switch and at least one auxiliary contact for electrical interlocking circuit or as specified.

The squirrel cage induction motors above 7.5 HP shall have star-delta type reduced voltage starters. The automatic starter shall have hand/off/auto switch, wherever electrical interlocking is required or where shown on the drawings. All starters should have three adjustable overload cutouts, Ammeter low voltage

cutout, single phasing preventer, stop-reset push button, at least two auxiliary contacts for electrical interlocking circuit.

All starters control circuit and magnetic coils to be suitable for 220 volt, 1 phase A.C. For motors requiring electrical interlocking or remote control or sequence starting control or any other such feature, starters should have necessary auxiliary contacts providing the desired control arrangement.

A separate set of terminals is required for each control circuit. All motors and starters provided under this contract should be of one manufacturer except for the equipment where special motors and starters are provided as standard components.

- (h) Unit Nameplate: Each unit shall be identified by a ½" x 4" engraved nameplate.
- (i) Motor Protection: Furnish and install all starters, overload heaters, as well as fuses unless specifically noted otherwise on the drawings. The selection of the overload heaters shall be based on the motor nameplate data. Fuses shall be of the dual element type, unless specifically noted otherwise. They shall be properly coordinated and in general sized according to fuse manufacturer's recommendations for the loads served.
- (j) Air Break Contractors: The contractors shall be suitably rated according to the motor output rating if not specified in the drawings and having rupturing capacity of 25 kA. Backup fuses to be provided if rupturing capacity is lower than the required.

The contractors should have sturdy magnets and bearings and should have bouncing, easily replaceable contacts of silver alloy and long contact life.

- (k) Time Relays: Time relays used in Automatic star-delta starter can be motor driven or electronic type but should have a high timing accuracy independent of voltage and temperature fluctuations.

The relays should generally have operating time range between 0.5 to 20 seconds. However in cases of motors having longer starting periods the Contractor will check their starting time and use matched time relays accordingly.

- (l) Selector Switches, Pilot Lamps, Relays, etc.: In general, where motors are to be automatically controlled a "HAND-OFF-AUTO" selector switch shall be provided and mounted in the enclosure cover. Selector switches shall be equipped with Voltmeter and Ammeter. Provide motors that are to be started manually with "START-STOP" buttons mounted in the enclosure cover.

For all motors installed in the plant room, pilot lights, for ON-OFF-OVERLOAD status indication shall be provided on this panel, or specifically as shown on drawings.

Necessary relays etc. for interlocking starters, LEAD-LAG Switch, etc., shall also be provided.

The overload relays shall be of the soldered ratchet type.

Starters used on 400 volts circuits shall have a 220 volt step-down control transformer included in the enclosure of 350 volt amperes.

Provide each starter with a blank plastic nameplate with the equipment identification marked thereon.

13.5 MOTOR CONTROL CENTER CONFIGURATION:

Motor control centers shall have the configuration as shown on the drawings.

13.6 CABLE TRAYS:

The cable tray system shall be of one manufacturer and shall include factory made trays, tray fittings, connections and necessary accessories and supports to form a complete tray support system.

The cable tray system shall include the following factory made tray elements. Straight trays and ladders, fittings and horizontal and vertical bends of various angle crosses, tees, wyes, reducers, vertical riser elements, connectors and all necessary fixing accessories.

Cable trays shall be constructed from mild steel of minimum thickness 16 gauge (1.5 mm). Trays in excess of 300 mm width shall be of minimum thickness 14 gauge (2.0mm).

Insert elements, bolts, screws, pins etc., shall be mild steel cadmium plated.

- a. Tray work shall have oval perforations. Ladder type trays shall be used as required and/or approved by the Engineer.
- b. All trays (straight and fittings) to be heavy duty returned flanged type unless specified otherwise.
- c. Tray component are to be accurately rolled or formed to close tolerance and all edges rounded. Flanges are to have full round smooth edges.
- d. Ladder racks of widths up to and including 300mm shall be constructed from rolled steel sections of minimum thickness 16 gauge (1.5 mm). Ladders in excess of 300 mm width shall be C Section construction with a minimum thickness of 14 gauge (2.0mm). the rungs shall be spaced at a maximum 300 mm.
- e. Unless indicated otherwise on drawings, cable trays shall be used in the range 150 mm to 900 mm wide, in fire preferred standard sizes: 150, 300, 450, 600 and 900 mm.
- f. Other sizes shall be used where specified or previously agreed with the Engineer.
- g. Flanges shall be a minimum of 50 mm deep.
- h. Minimum radius at side rails, horizontal and vertical tees and crosses shall be in accordance with the Manufacturer's standard.

Perforated, heavy duty, return flange type, in 2.5m nominal lengths Hot dip galvanized after completion of bending and drilling, complete with all necessary purpose made bends, tees, supports and the like. Width shall be such as to permit adequate access for installation and maintenance of cables and per the requirements of KESC regulations.

13.7 STEEL CONDUIT AND ACCESSORIES:

All conduits shall be of heavy gauge 16 SWG steel, manufactured and tested in accordance with latest relevant standards.

The conduit shall be protected by two base coats of red oxide anti-rust paint and finished in first quality black enamel paint. The coating shall be of heavy enamel, which shall not flake or crack during installation and handling. Each conduit length shall be furnished with threaded ends and a threaded coupling at one end. Soft metal bushes shall be provided at conduit termination to prevent damage to cable during pulling operation.

Junction boxes shall be 100 mm square, having minimum depths of 38 mm or 65 mm as required for accommodating the number of wires. The junction box shall be 16 SWG sheet steel provided with anti-rust paint and finished in heavy black enamel paint. The cast Iron outlet boxes for light points shall be round having 50 mm diameter and 63 mm depth. The above dimensions are given as minimum only, and the exact size shall be determined by the Contractor keeping in view the ease of Installation and maintenance. All outlet boxes and junction boxes shall be provided with one piece bake lite cover plate of suitable design.

13.8 GALVANIZED IRON PIPES AND ACCESSORIES:

The G.I. pipes shall be galvanized from inside and outside by hot dip galvanizing method. The pipes shall be free from stains, burrs or any other defect. The accessories for G.I. pipes shall be galvanized from inside and outside. The conduit shall be NPT threaded, with at least 5 complete threads and assembled with TEFLON tape.

13.9 INSTALLATION:

13.9.1 General: The Contractor shall be responsible for the complete power and control electric wiring of the HVAC and BMS Works. A 3 phase and neutral, 4 wire Electric Supply with earthing continuity conductors where indicated on the drawings will be available for the Contractor. Wiring onwards from this supply point to all motors, controls, etc., shall be the responsibility of the Contractor.

13.9.2 Electric Wiring & Earthing: The electrification work shall be carried out by a Licensed Electrician, authorized to undertake such work under the provision of Pakistan Electricity Act & Rules. The installation shall be carried out in conformity with Pakistan Electricity Act & Rules and the latest edition of I.E.E. Wiring Regulations. Any special requirements of the local Electricity Supply Company shall be complied with.

All power and control wiring shall be duly tagged/ numbered on circuit for the ease of trouble shooting on wiring diagram and on circuits in MCC. All wiring in Plant Room shall be run in approval rigid and flexible steel conduits from the MCC to the motors, on the surface of walls, roofs & columns. Galvanized steel saddle and clamps of minimum 16 SWG, approved by the Consultants, shall be fixed to the surface using nylon plugs and galvanized steel screw, with a maximum distance of 3 ft. between clamps. Pull boxes, having sized of 4' x 4" & 2" deep and constructed of 18 SWG sheet steel shall be installed wherever required to limit the pulling length and shall be in a flexible steel conduit, provided with suitable brass glands and check nuts.

Earthing continuity conductors shall be hard drawn base electrolytic copper wires of the recommended size for the motor being served and shall be run along the cables. Earthing to each motor of 1 HP and above shall be with 2 conductors. The minimum size for the earthing shall be 10 SWG.

13.9.3 Steel and G.I Conduit

The minimum size of conduit shall be 20 mm.

The use of solid or inspection elbows, bends or tees will not be permitted and 120 degree bends shall be limited to one between any two drawn-in boxes. Conduit coupling joint shall not be used where conduit enter spout entry boxes. Conduit running, joints shall not be used where conduit enter conduit boxes or spout entry boxes.

Equipment that is required to be removed for maintenance shall be provided with conduit unions in all conduits that enter such equipment. The use of conduit nipples shall be avoided as far as practicable.

All conduits shall be cut square and reamed at the end. All conduit ends and the inside of conduits shall be clean and free from burrs.

Where bushed spouts or tapped holes are not provided at conduit termination, the conduit shall be terminated in a flanged socket and a smooth bore brass hexagon bush, with a lead washer fitted between the flanged socket and the equipment or box.

All exposed threads and parts where the galvanizing has become damaged shall be thoroughly cleaned and painted with galvanized paint. the exposed conduit ends shall be capped to protect threads from being damaged before installing cables.

Repair painting shall take place before any making good on site or buildings is carried out. The entire conduit system shall be checked for continuity. Any observation found shall be removed without damaging the installation.

The conduit system shall be installed empty with an 16 SWG steel wire drawn through the conduits for pulling of cables. Joints in underground conduits shall be avoided or reduced to the absolute minimum.

Where adjustable dies are used they shall be so adjusted that threads cut with them shall be the same depths as machine made threads.

The use of manufactured bends shall be avoided and instead smooth bends shall be provided by using approved type of bending tools.

Flexible steel conduits shall be installed at all points locations where flexible connection is required, as directed by the Engineer. The flexible conduits when used, shall be protected by external PVC sheath, resistant to oil damages.

G.I. pipes for underground installation shall be given bituminous paint coating and wrapped with suitable paper or cloth before installation.

13.9.4 Testing:

- (a) General: Upon completion of installation and carrying out physical inspection of works, the Contractor shall perform field tests on all equipment and material before commissioning. All tests shall be performed in the presence of the Consultant's and client representatives for the purpose of demonstrating the equipment or system compliance with specifications, and that each component shall electrically and mechanically function properly as intended. In general the tests shall be carried out in accordance with Section 'E' of Regulations for the Electrical Equipment of Buildings. The Contractor shall however insure that the requirements of the Local Electrical Inspector are met with, and the installation is duly approved by the Electrical Inspector. Proper regards to manufacturer's instructions for testing procedures shall be given for equipment.

The Contractor shall furnish, install and maintain all tools, instruments, test equipment, material, etc., including all personnel required for carrying out the setting, adjustment and recording associated with the testing procedures. All tests shall be made with due consideration to the protection of installation and personnel carrying out the tests. Adequately qualified and trained staff shall supervise the tests. The procedure and sequence of testing shall be furnished to the Consultant at least 48 hours before starting of tests. The Contractor shall systematically keep a record of results of all tests carried out. Two copies of all test data and complied results duly initialed by Engineer Incharge/Authorized Representative present during the tests shall be supplied to the Consultant for record purposes and approval obtained.

- (b) Insulation Resistance Test: Insulation Resistance tests shall be carried out on all electrical equipment and wiring, using a self-contained instrument such as direct indicating Ohmmeter of generator type. Only direct current potential shall be used for such testing; voltage range for the same areas under:

Circuits up to 250 volts: 500 volts D.C.

Circuits above 250 volts
and up to 500 volts: 1000 volts D.C.

All cables before connection at switchgear of equipment shall be tested for insulation resistance. The test shall be carried out individually between each cable in circuit and also between cable and earth. The minimum acceptable value of insulation resistance shall be 1 Megohm.

Before making any connection all switchgear shall be tested for insulation resistance between live parts and earth. Insulation tests on circuit breakers between each phase and earth. The minimum acceptable value of insulation shall be 5 Meg. Ohms. If the Insulation resistance of any circuit or equipment under test is less than the specified values, the cause of low reading shall be determined and necessary corrective measures carried out. Tests shall be repeated after rectification of defective section for ensuring correct value of insulation resistance before commissioning.

(c) Operational Tests:

All equipment power feeders shall be tested for operation under load conditions.

Each switch shall be carried to ensure that the operating mechanisms are working. Nameplates are also to be checked for proper designation with respect to the equipment connected. The Contractor shall identify the phases of incoming supply and all equipment, to ascertain that each circuit is connected in proper phase sequence. Wherever required phase identification markings or labelling shall be provided on switchgear and cables. Motors must be tested for proper rotation and stroboscopic effect.

14.0 PIPING, FITTING AND FLANGES:

All chilled water & condenser water piping shall be Seamless Black Steel Schedule 40 conforming to ASTM A53 and shall be provided as per List of Approved Manufacturer's.

Fittings for steel pipes through 2 inches shall be screwed conforming ANSI B16.3 and larger than 2 inches shall be flanged conforming ANSI B 16.9. Welded fittings shall be seam-less, butt welding type, compatible to the schedule of the pipes.

Flanges shall be slip on with raised neck type and shall confirm to ANSI B16.5. All fittings & flanges shall be suitable for 150 Lbs. SWP. Piping shall be provided as per List of Approved Manufacturer's.

1. Welding flanges for pipe 65 mm larger shall be forged steel ASTM A181, class 150, ANSI B 16.5.
2. Gasket, cloth inserted rubber ring.
3. Bolts, square head machine with hexagonal nut, galvanized steel ASTM A307, ANSI 818.2
4. All valves shall be with matching flanges and gasket from the valves manufacturer.

Condensate drain piping shall be uPVC class E ASTM D1785 or BS3505 with solvent welded fitting for installation not expose to view and GI pipe class B (medium) BS1387 with threaded fittings for installation on roof and within plant room.

Copper piping shall be seamless pipe ASTM B88 type K plain ends with wrought copper fitting ANSI B16.22

15.1 INSTALLATION:

- (a) General: Chilled water piping shall include all piping and connections between water chillers, pumps and terminal units.

All stop valves, check valves, globe valves, (calibrated balancing valves) control valves, drain cocks, expansion joints, compensators, automatic air vents, thermometers, pressure gages, strainers and other specialties required for proper operation of the whole system shall be provided, even if not indicated on the drawings.

Pipes shall be cut accurately to measurements established at the job site and worked into place without springing or forcing, properly clearing all windows, doors and other openings. Excessive cutting or other weakening of the building structure to facilitate piping insulation will not be permitted without written approval. Layout drawings required under the title of “**APPROVAL OF MATERIAL AND EQUIPMENT**” shall show locations of all supports, the load imposed on each fastening or anchor, typical details for special anchorage, and details for special anchorage for supports attached to metal roof decking, for suspended piping, valves, tank, pumps, converters, and other mechanical equipment. Supports shall be attached to metal decking. Where supports are required between structural framing shall be provided and detailed. Pipe shall have burrs removed by reaming and shall be installed to permit free expansion and contraction without damage to joints and hangers. Changes in direction shall be made with fittings, except that bending of pipe bender is used and wide sweep bends are formed. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks wrinkles, flattening or other mal-formations will not be accepted. All piping shall be installed with sufficient pitch to ensure adequate drainage and venting. Piping connections to equipment shall be provided with unions or flanges. Open ends of pipelines or equipment shall be properly capped or plugged during installation to keep dirt and other foreign matters out of the system.

- (b) Screwed joints shall be used on pipes of diameter 2” and below. Screwed joints shall be made with tampered threads properly cut. Joints shall be made tight with a stiff mixture of litharge and glycerin, or polytetrafluoroethylene tape, or approved thread joint compound applied to the male thread only. Not more than three threads shall show after the joint is made up.
- (c) Welded joints shall be used on pipes of diameter above 2” Welded joints shall be fusion-welded by metal arc welding method unless otherwise required. Changes in direction of piping shall be made with welding fittings only. Mitering or notching pipe to form elbows and tees or other similar construction will not be permitted. Branch connections shall be made with welding tees or forged welding tees or forged welding outlets.

Field and shop bevels shall be in accordance with the recognized standards and shall be done mechanically by means of flame cutting. Where beveling is done by flame cutting, surfaces shall be cleaned of scale and oxidation prior to welding.

Before welding, the component parts to be welded shall be aligned so that no strain is placed on the weld when finally positioned. Height shall be so aligned that no part of the pipe wall is offset by more than 29% of the wall thickness. Flanges and branches shall be set true. This alignment shall be preserved during the welding operation.

Removing and replacing defective welds shall be at no additional cost to the Owner. Repairing of defective welds by adding new material over the defects or by penning will not be permitted. Electrodes shall be stored in a dry heated area

and shall be kept free of moisture or dampness during fabrication operations. Electrodes that have lost part of their coating shall be discarded.

- (d) Flanges and Unions shall be faced true. Flanges shall be provided with compressed fiber gasket, and made square and tight. Except where copper tubing is used, unions or flanged joints shall be provided in each line immediately preceding the connection to each piece of equipment such as coils, pumps, control valves and other similar items.
- (e) All Anchors, nuts, bolts, screws, fasteners and rivets shall be of HILTI make.

15.1.1 Pipe Supports:

- (a) General: pipe hangers, brackets, saddles, inserts, clamps and pipe rolls including rods, bolts, turn buckles, bases and protection shields shall conform to standard recommended engineering practice, using stock or production parts wherever possible. Chain, wire, strap or other makeshift devices will not be permitted as hangers or supports.

Accurate weight balance calculations shall be made to determine the required supporting force at each hanger location and pipe weight load at each equipment connection. Pipe hangers shall be capable of supporting the pipe in all conditions of operations. They shall allow free expansion and contraction of the piping, and prevent extra stress resulting from transferred weight being included in the pipe or connected equipment. Hangers shall be supported from beams, clamps, concrete inserts Phillips concrete fasteners, and power actuated drive pins. Concrete inserts when used shall be installed in the exact location prior to the pouring of the concrete.

- (b) Suspended Horizontal Piping: shall be supported by adjustable hangers or supports, which shall provide a means of vertical adjustment after erection. Unless otherwise indicated on drawings maximum spacing between pipe supports for straight runs of pipe shall be in accordance with recommended spacing shown in accordance with recommended spacing shown in the table given below:

Nominal Pipe Size	0.5	0.75	1	1.5	2	2.5	3	4	5	6	8	10
Inches (mm)	-13	-20	-25	-40	-50	-65	-75	-100	-	-	-200	-
									125	150		250
Maximum Span Feet	5	6	7	9	10	11	12	14	16	17	19	22
(Meters)	-	-1.8	-	-	-3	-	-	-4.2	-4.8	-5.2	-5.8	-6.7
	1.5		2.1	2.7		3.3	3.6					
Rod Size dia mm.	10	10	10	10	10	13	13	16	16	19	22	22

Pipe hangers and supports shall be spaced not over 5 feet (1.5m) apart at heavy fittings and valves.

A hanger shall be installed not over 1 foot (0.3m) from each change in direction of piping. Where necessary to prevent vibration transmission, the support closest to the sources of vibration shall be spring cushion, or other approved type of isolation hanger. Where the piping system is subject to shock loads, such as thrusts imposed by the actuation of safety valves, hanger design shall include provision of shock absorbing devices of approved design. Hangers shall be designed so that they cannot become disengaged by movements of the supported pipe.

- (c) Vertical Piping: shall be guided or supported in the center of each riser but not over 15 feet on center and shall be supported at the base of the riser on a base elbow or tee with a pipe stand only where required. For un-insulated brass or copper pipe or tubing, the riser clamp shall be compatible nonferrous or electrolytic ally coated steel as for hangers.
- (d) Piping in trenches: Pipes shall rest on suitable wall floor supports with rollers.
- (e) Pipe Sleeves: Pipes passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction or afterwards if necessary. Each sleeve shall extend through its respective wall, floor or roof and shall be cut flush with each surface. Sleeves shall be of such size as to provide a minimum of 1/4" all around clearance between bare pipe and sleeve or between jacket over insulation and sleeve. Sleeves in bearing walls shall be steel or cast iron pipe. Sleeves in non-bearing walls, floors, or ceiling may be steel pipe, cast iron pipe or G.I. sheet metal gauge 14, with lock type longitudinal seam. Sleeves in bearing walls shall be steel or cast iron pipe.

16.0 GATE VALVES:

Gate valves upto 2 inches shall be with threaded ends, bronze body, with union bonnet, non-rising stem and wedge disc. Hand wheel nut, packing nut, gland, stuffing box, bonnet, bonnet ring, disc and body shall be of bronze. Hand wheel shall be of malleable iron. Packing shall be graphite asbestos. Stem shall be manganese bronze.

Gate valves 2.5 inches and above shall be cast iron body bronze mounted with flanges ends.

These shall be of solid wedge disc type, with outside screw and yoke. Body and bonnet shall be of cast iron. Wedge shall be of cast iron with bronze disc. Seat rings shall be bronze. Packing gland shall be cast iron. Yoke shall be of cast iron and yoke nuts shall be of bronze. Hand wheel shall be of cast iron.

All valves shall be rated for 150 Lbs. SWP & 250°F, and shall be provided as per List of Approved Manufacturer's.

All valves shall be provided with manufacturer's matching flanges and gaskets.

All valves shall be brand new / unused. Any defected / used / re-painted material shall be rejected. Contractor shall provide pressure test certificate, certificate of origin, MTC and warranty certificate for all valves at the time of site inspection.

17.0 GLOBE VALVES:

Globe valves up to 2 inches shall be bronze with threaded ends. Body, bonnet, disc holder, stems lock nut; packing nut and disc lock nut shall be of bronze. Hand wheel shall be malleable iron with stem of manganese bronze. Renewable composition disc shall be provided suitable for water & steam. Packing shall be graphite asbestos.

Globe valves 2.5 inches and above shall be cast iron body; bronze faced disc and yoke bonnet, and shall be flanged. Hand wheel, gland, bonnet and body shall be of cast iron. Stem shall be of manganese bronze. Packing shall be graphite asbestos. Stem lock nut, disc and seat ring shall be of bronze. Disc shall be renewable composition type.

All valves shall be suitable for 150 Lbs. SWP service and shall be provided as per List of Approved Manufacturer's.

All valves shall be provided with manufacturer's matching flanges and gaskets.

All valves shall be brand new / unused. Any defected / used / re-painted material shall be rejected. Contractor shall provide pressure test certificate, certificate of origin, MTC and warranty certificate for all valves at the time of site inspection.

18.0 CHECK VALVES:

Check valves up to 2 inches shall be swing type with threaded ends Cap, hinge pin, body, hinge, disc nut and disc shall be of bronze.

Check valves larger than 2 inches shall be wafer type, cast iron body, including valve cap and disc. Hinge pin, seat ring and disc ring shall be of bronze. Ends shall be flanged.

All valves shall be suitable for 150 Psi SWP & 250°F and shall be provided as per List of Approved Manufacturer's.

All valves shall be provided with manufacturer's matching flanges and gaskets.

All valves shall be brand new / unused. Any defected / used / re-painted material shall be rejected. Contractor shall provide pressure test certificate, certificate of origin, MTC and warranty certificate for all valves at the time of site inspection.

19.0 BUTTERFLY VALVE

Butterfly valves shall be used for shutoff purpose for all sizes from 8 inch and above in place of gate valves. Use gate valves only up to and including 6 inch.

Valves shall be raised face class 150 flanges. Body to be ductile iron and manufactured in accordance with MSS-SP-67. Body shall have at least 2 inch extended neck for insulating. Valves to have EPDM rubber encapsulated disc with polymer-coated body. Stem shall be 400 series stainless steel and shall not have exposed stem to disc fasteners. Valves shall be capable for use as isolation valves for Bi-directional dead-end service at full pressure. Sizes up to 6 inch shall be lever operated. Sizes 8 inch and above shall be gear operated.

All valves shall be provided with manufacturer's matching flanges and gaskets.

All valves shall be brand new / unused. Any defected / used / re-painted material shall be rejected. Contractor shall provide pressure test certificate, certificate of origin, MTC and warranty certificate for all valves at the time of site inspection.

20.0 BACKFLOW PREVENTERS

Unless otherwise required by BS Standards and Codes, backflow preventers shall be of the double check valve type incorporating resilient elastic and positively tight seals designed to permit water to flow in one direction only.

Backflow preventers shall be suitable for installation in horizontal or vertical position.

They shall be pressure rated for 16 bar and BS kite marked.

Construction shall be:

Body	- Bronze
Check valve	- Brass
Drain valve	- Brass
Seals/Membrane	- Nitrile : NBR Rubber
Springs/bolts/Nuts	- Stainless steel

All valves shall be brand new / unused. Any defected / used / re-painted material shall be rejected. Contractor shall provide pressure test certificate, certificate of origin, MTC and warranty certificate for all valves at the time of site inspection.

21.0 PRESSURE SAFETY VALVE

Pressure safety valve shall be of bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

All valves shall be brand new / unused. Any defected / used / re-painted material shall be rejected. Contractor shall provide pressure test certificate, certificate of origin, MTC and warranty certificate for all valves at the time of site inspection.

22.0 GAS VALVE

Gas valve shall be ball valve, non-blowout stem design. Quarter turn of handle shall fully open or close valve. Handle position shall indicate whether valve is open or closed. Handle stops shall be a permanent, integral part of the body.

Valves size 50 mm and smaller shall be standard port, 2-piece construction with screwed ends. Valves shall have bronze body, chromium plated or stainless steel ball, steel handle with vinyl grip, and replaceable teflon seats.

Valves size 65mm and larger shall be standard port. BS 5159 with flanged ends. Valves shall have steel body, chrome or nickel plated steel or stainless steel ball, replaceable teflon seats, and steel stem and handle.

All valves shall be brand new / unused. Any defected / used / re-painted material shall be rejected. Contractor shall provide pressure test certificate, certificate of origin, MTC and warranty certificate for all valves at the time of site inspection.

23.0 Y-STRAINERS:

Strainers shall be "Y" types, with bronze body and threaded ends up to 2 inches. Screen shall be of 20 mesh monel.

Strainers above 2 inches shall have cast iron body with flanged ends. Screen cover shall be provided with blow off tapping. Screen shall be of perforated stainless steel, 233 holes per sq. inch, with 0.045 inch diameter holes and 0.016 inch thick screen.

All strainers shall be suitable for 150 SWP & 250°F and shall be provided as per List of Approved Manufacturer's.

Y-Strainer shall be provided with valve dirt- blow-out connection suitably piped to the nearest floor drain.

All strainers shall be provided with manufacturer's matching flanges and gaskets.

All strainers shall be brand new / unused. Any defected / used / re-painted material shall be rejected. Contractor shall provide pressure test certificate, certificate of origin, MTC and warranty certificate for all strainers at the time of site inspection.

24.0 BALANCING VALVES:

Calibrated Balancing Valves: shall be furnished & installed where shown on the drawings. The valves shall have NPT connections (Internal Threads) suitable for 300 psig (20 bars) for pipe size 50 mm or below, or flanged connections suitable for 240 psig (16 bars) for pipe size 65 mm or above, as required. The Valves shall be suitable sized between 3.0 to 6.0 Pa at fully open position. The each balancing valves shall have permanent measuring points for connecting a direct flow rate read-out meter. The measuring points shall be self-sealing type to prevent system fluid loss during balancing/monitoring and future. The measuring points shall be easily accessible for measuring purpose, especially on the flanged valves; it should be located on the flanged. Each balancing valve shall have a calibrated digital hand wheel for easy determination of location of the hand wheel by directly reading the number of turns on the top of the hand wheel. Each balancing valve shall have a nameplate to assure specific value settings and shall be constructed with internal spindle seals (EPDM O-rings) to prevent leakage around the rotating element.

Balancing Valves shall be provided as per List of Approved Manufacturer's or equivalent make subject to the approval of Consultant.

24.1 BALANCING INSTRUMENT:

The balancing instrument shall consist of an electronic differential pressure gauge and a microcomputer, which should be programmed with the balancing valve characteristics, which makes possible a direct reading of flow and differential pressure.

The balancing instrument shall have two main components:

- An instrument which contains a microcomputer, input touch pad, LCD display and re-chargeable NiMh batteries.
- A sensor unit, which contains a piezo-resistive, pressure sensor, one measurement valve and connections. The measurement valve shall have a safety function, which protects the sensor from too high differential pressure.

The balancing instrument shall also have PT 100-temperature sensor, which allows measurement of temperature of the chilled water directly.

The meter shall be provided as per List of Approved Manufacturer's.

All valves shall be provided with manufacturer's matching flanges and gaskets.

All valves shall be brand new / unused. Any defected / used / re-painted material shall be rejected. Contractor shall provide pressure test certificate, certificate of origin, MTC and warranty certificate for all valves at the time of site inspection.

25.0 EXPANSION JOINTS:

25.1 GENERAL:

Expansion joints shall be supplied conforming the following specifications. Expansion joint shall be provided in all chilled water supply/return pipes whenever the pipes cross building expansion joint and shall be provided as per List of Approved Manufacturer's and shall be suitable for water 35 to 250°F, designed for 150 Psi operating pressure; with adequate traverse capacity to relieve all stresses due to expansion or contraction of pipe at its operating temperature using a base temperature of 80°F.

25.2 SLIP – TUBE TYPE JOINTS:

Shall be single or double slip, with base and shall be designed to carry the weight of the expansion tubes by means of machine guides at both ends of the tubes.

Each joint shall be designed for replacement or addition of packing while operating under full line pressure.

The joint shall be threaded up to 2 inches and flanged for larger sizes.

25.3 PACKLESS TYPE JOINTS:

Shall be internally guided and shall be provided with threaded ends up to 2 inches and flanged for larger sizes. Bases shall be provided with each joint. Single element joint shall be provided with bases designed for use as an end anchor.

25.4 EXPANSION COMPENSATORS:

Shall consist of bellows with protected shrouds. Expansion compensators for iron and steel pipes shall have corrosion resisting steel bellows; carbon steel shrouds, internal guides, and shall be provided with threaded ends up to 2 inches and flanged ends for larger size. Gasket or other means of sealing shall not be permitted. When double compensators are used, they shall be provided with bases. Expansion compensators shall be provided on all chilled water and condenser water piping crossing building expansion Joints.

26.0 FLEXIBLE CONNECTORS:

Flexible connectors shall be constructed of rubber, tetrafluoroethylene resin, or corrosion resisting steel, bronze, monel or galvanized steel. The material used and the configuration shall be suitable for pressure, vacuum, temperature and circulation medium. The flexible sections may have threaded, welded, soldered, flanged or socket ends and shall be suitable for service intended. The flexible section may be reinforced with metal retaining rings, with built in reinforcement and restriction bolts or with wire braid cover suitable for the service intended. Flanged assemblies shall be equipped with limit bolts to restrict maximum travel within limits standard with the manufacturer.

Unless otherwise shown on the drawings, the length of the flexible connector shall be as recommended by the manufacturer for the service intended.

Internal sleeves or liners shall be provided when recommended by the manufacturer suitable for the circulating medium. Covers to protect the bellows will be provided where necessary or directed. Flexible connectors shall be designed for 150 Psi service, and 250°F and shall be provided as per List of Approved Manufacturer's.

27.0 AUTOMATIC AIR VENTS FOR LIQUID SYSTEMS:

Automatic air vent shall be suitable for liquid systems. Body and cover shall be of malleable iron. Float and valve seat shall be of stainless steel. Valve head shall be of Viton (Synthetic Rubber). Connections shall be 1/2 inch or 3/4 inch as specified screwed BSP. Vents shall be suitable for service up to 150 SWP and 250°F service.

Vents shall be provided as per List of Approved Manufacturer's.

28.0 THERMOMETERS:

28.1 GENERAL:

The ranges of thermometers shall comply with the system parameters, ensuring normal indication in the mid-region. Ranges much under or above the required readings shall not be acceptable, unless specifically approved by the Consultants. Thermometers shall be provided as per List of Approved Manufacturer's.

Contractor shall be delivered the thermometer at site with manufacturer's calibration certificate.

28.2 PIPE THERMOMETERS:

These shall be adjustable every angle type (dial can be rotated 360° and can be angled 180°), with threaded connection. Case shall be silicon liquid filled and hermetically sealed, with an external adjustment. Windows shall be heavy-duty glass. Dials shall have Maxi-vision format to minimize parallax error Dial shall be white with jet-black embossed figures and graduations. Pointer shall be micrometer type, black finished and red tipped. Bimetallic coils shall be of Teflon. Shafts shall be of stainless steel wire. Connection shall be 1/2 inch NPT.

- Dial size: 5 inches dia.
- Stem length: 6 inches.

28.3 DUCT THERMOMETERS:

These shall conform to specification given above for pipe thermometers, except the duct thermometers shall be supplied with mounting flanges.

- Dial size: 3 inches dia.
- Stem length: 12 inches.

28.4 THERMOMETER WELLS:

These shall be of brass suitable for pipeline mounting. Wells for insulated piping shall be provided with extension necks compatible to insulation thickness, to allow thermometer to clear the insulation.

28.5 INSTALLATION:

Shall be installed wherever shown on the drawings. Installation on both ducts and piping shall conform to the manufacturer's recommendations. On thermally installed ducts, casing, equipment or piping standoff mounting brackets, bases, adopters or extended tubes shall be provided. These items shall provide clearance not less than the thickness of the insulation. Thermometers shall have ranges suitable for the fluid being served.

29.0 PRESSURE GAUGES:

29.1 CONSTRUCTION:

Case shall be of cast aluminum, black finished. Ring shall be close type, chrome plated. Window shall be clear glass. Dial shall be white with jet black embossed figures and graduations. Pointer shall be micrometer type, black finished and red tipped. Movement shall be stainless steel, rotary type. Bourdon tube shall be phosphor bronze, silver brazed to socket and tip. Socket shall be forged brass. Accuracy shall be ½% of the scale range. Gauge shall be provided as per List of Approved Manufacturer's.

All gauges shall be supplied with pressure Snubbers. Contractor shall be delivered the pressure gauges at site with manufacturer's calibration certificate

29.2 RANGE:

Shall be minimum as required to suit application. Dial size for equipment in Plant Room shall be 4½ ∅ and for Air handling Units shall be 3½∅.

29.3 INSTALLATION:

Shall be installed where shown on drawings. These shall be installed with ball valves to serve as gauge cocks. For pressure gauges installed on steam line, a coil siphon shall be installed. Gauges shall be screwed in so that no leakage exists, and shall be installed in a neat and workmanlike manner and the dials aligned for convenient reading.

30.0 TOOLS & INSTRUMENTS:

The Contractor shall furnish imported superior quality tools and instruments required for the minor testing, service and maintenance of the plant, as per the list given below. The tools shall be supplied in properly constructed wooden toolboxes.

1.	Digital Thermometer.	....	1 No.
2.	Sling Psychrometer.	....	1 No.
3.	Fin brushes.	....	4 Nos.
4.	Amprobe.	....	1 No.
5.	Volt-Ohm-Multimeter.	....	1 No.
6.	Adjustable Spanners (Three Sizes).	....	3 Nos.
7.	Set of fixed spanners.	....	2 Sets.
8.	Set of Screw Drivers.	....	2 Sets.
9.	Set of Phillips Screw Drivers.	....	2 Sets.
10.	Flat Pliers.	....	2 Nos.
11.	Nose Pliers.	....	2 Nos.
12.	Set of Files.	....	2 Sets.

13.	Hammers.	....	3 Nos.
14.	Hack Saw Set.	....	2 Nos.
15.	Flaring & Cutting Tool	....	1 No.
16.	Velocity meter (by Al-Noor, airflow or approved equal) with local hood for outlets.	....	1 No.
17.	Pitot tube and inclined manometer	....	1 Set

31.0 AIR SEPRATORS, EXPANSION TANKS & RELIEF VALVES:

i. AIR SEPARATORS

- A. Air separator shall be constructed of steel designed and fabricated per ASME Section VIII Division I with a maximum working pressure rating of 250 PSIG at 375 F units up to 2 ½” connection sizes shall have threaded connections and units 3” and above connection sizes shall have flanged connections. Units shall have separate top connections for system expansion tank and air venting, and bottom connection for blow down cleaning.
- B. Air separator shall be furnished with a removal stainless steel strainer and filter with a free area not less than five times the cross-sectional area of the connections pipe.

ii. EXPANSION TANKS

Bladder type tanks shall be designed and constructed per ASME section VIII, Division I and rated for a maximum working pressure of 250 PSI at 240 F. Units shall be furnished with lifting rings, and have the system connection and charging valve at the tank top and a tank drain connection at the bottom. Bladder type expansion tanks shall have an internal replaceable elastomer bladder with maximum acceptance volume and factory precharge pressure as shown on the plans. The bladder shall be suitable for a maximum system operating temperature of 240 B. Bladder type tanks shall be furnished with a steel base ring for vertical mounting.

Bladder type CA tanks shall be furnished with galvanised cover for corrosion resistance. Bladder type tanks shall be furnished with a factory installed replaceable California code “Bulls Eye” sight glass. All bladder type tanks shall be furnished with seismic mounting clips. All materials of construction shall be compatible with water and ethylene and propylene glycol mixtures. Automatic Cold Water Fill Assembly: Pressure reducing valve, for installation of accessories. Reduced pressure double check backflow preventer, test cocks, strainer, vacuum breaker and valve bypass.

Chilled water pressurization unit: shall comprise with centrifugal pumps (duty and standby), expansion tank, isolating valves, pressure switches, pressure gauges, and interconnecting pipework and valves , all mounted on to a steel base plate. The construction of centrifugal pumps shall be as per specification given in section 4.0.

iii. RELIEF VALVES

- A. ASME rated direct spring-loaded type, lever operated, non-adjustable factory set discharge pressure.
- B. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heating converters, and compression tanks.
- C. Select system relief valves capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

32.0 CLEANING, TESTING, BALANCING AND TEST DATA:

32.1 GENERAL:

- a) The entire testing balancing and adjusting process to be thoroughly organized & planned. All activities, including the organization, procurement of required test instrumentation and the actual system should be scheduled as soon as practical after the installation has been completed.
- b) The contractor shall appoint an independent agency specialized in the testing & balancing of HVAC systems as a third party and their appointment must be subjected to consultant's and client approval.
- c) Testing and balancing shall be performed in accordance with NEBB (National Environmental Balancing Bureau) USA, code of practices and all final reports shall be signed and certified by the agency appointed to perform such works.
- d) The TBA agency must carry out the preparatory works which shall include the planning and scheduling of all TBA procedures, collecting the necessary data, reviewing the data collected, studying the system to be balanced, recording the published data on the test report forms, and finally, making preliminary field checks of the HVAC equipment and systems.
- e) The contractor shall submit six copies of the complete test procedure to the engineer for approval one month prior to the date of commencement of the balancing and performance test.

32.2 CLEANING AND ADJUSTING:

Pipe shall be cleaned free of scale and thoroughly flushed of all foreign matter. Temporary bypass shall be provided for all water coils to prevent flushing water from passing through coils. Strainers and valves shall be thoroughly cleaned of all debris and blown free of all small particles of rubbish and dust before installation of outer faces. Equipment shall be wiped clean, with all traces of oil, dust or paint spots removed. Temporary filters shall be provided for all fans that are operated during construction, and after all construction dirt has been removed from the building, new filters will be installed.

Bearings shall be properly lubricated with oil or grease as per recommendations of the manufacturer. Belts shall be tightened to proper tension. All control valves and other miscellaneous equipment, are requiring adjustment shall be adjusted for setting indicated

or directed. Fans shall be adjusted to speed indicated by the manufacturer to meet the specified conditions.

32.3 TESTING:

- (a) Piping: After cleaning, water and steam piping shall be hydrostatically tested at a pressure equal to 150% of the maximum operating pressure for a period of time sufficient to inspect every joint in the system and in no case less than four hours. No loss of pressure will be allowed. Leaks found during tests shall be repaired by re-welding or replacing pipe or fittings. Caulking of joints will not be permitted. Concealed piping shall be tested in place before concealing. Tests shall be conducted in the presence of the Consultant or the Consultant's representative who shall be given 10 days' notice before any test is to be conducted. Water and electricity required for the test shall be furnished by the Owner. Any material, equipment or instruments required for tests shall be provided by the Contractor.
- b) Duct Work: Ducts, plenums and casings shall be tested and made substantially air tight at static pressure indicated for the system before covering with insulation or concealing in the masonry. The term substantially airtight shall be constructed to mean that no air leakage is noticeable through the senses of feeling or hearing.

32.4 BALANCING:

- (a) Water piping system shall be balanced to produce water quantities as indicated.
- (b) Duct system shall be balanced to produce air quantities within 5% of that indicated.

32.5 PERFORMANCE TESTS:

After cleaning, balancing, and testing operations have been completed, as herein before specified, the system shall be tested as a whole to see that all items perform as an integral part of the system, and that temperature and conditions are evenly controlled throughout the building. Corrections and adjustments shall be made as necessary to produce the conditions indicated, at no additional cost to the Owner.

32.6 TEST DATA:

General: The Contractor shall provide the Consultant with typewritten schedules of readings taken during the balancing and testing operation for the following items:

32.6.1 AIR BALANCE:

- (a) Fans: Size, type, speed in revolutions per minute, static pressure in inches of water, air quantity in cubic feet per minute, and motor load in amperes and voltage.
- (b) Coils: Size, face velocity in feet per minute, air-condition on-and-off Uni.-wet-bulb and dry-bulb temperature in °F., water temperature drop through heating/cooling coil, temperatures entering coil in °F.
- (c) Ducts: Size, velocity in feet per minute, and air quantity in cubic feet per minute.

- (d) Air Outlets and Inlets: Size, velocity in feet per minute, and air quantity in cubic feet per minute.

32.6.2 WATER BALANCE:

- (a) Pumps: GPM, suction head, discharge head, rpm, motor load in amperes and voltage.
- (b) Chillers: Evaporator gpm, evaporator pressure drop, and evaporator entering water temperature, evaporators leaving water temperature and power consumption.
- (c) Air Handling Unit: gpm through each Air Handling Unit.
- (d) Cooling Tower: Air quantity in cubic feet per minute at full load operation, entering air dry bulb and wet bulb temperature, motor load in amperes and voltage.

32.7 CONTROL SETTING:

The actual on site setting of all automatic controls including thermostats, safety controls, minimum damper settings, fan safety thermostats, pressure controls, temperature and humidity controls and other similar items shall be provided in the form of a tabulated list indicating type of control, location, setting and function.

32.8 OTHER EQUIPMENT:

The contractor shall also provide written data on the performance of any other equipment; in the form and manner and giving all information required by the Consultant/Engineer. The Contractor shall also submit a certificate along with all test reports submitted, certifying that all test have been carried out by component engineers, and that all data submitted has been verified and found to be correct.

32.9 TEST PROCEDURES:

The contractor shall be responsible to follow the test procedure as under

1. Preliminary inspection & tests.
2. Balancing and commissioning.
3. Performance tests
4. Reliability trail test.

33.0 PAINTING AND FINISHING:

33.1 GENERAL:

Painting shall include furnishing labour, materials, equipment, ladders, scaffolding, protective covers, other items required to prepare and finish surfaces of work specified herein or in any other sections.

Paint shall be applied as per manufacturer's printed application directions. Paint color schemes shall be specified at the time of painting or earlier.

Paint shall be applied to the following:

- (a) Materials and Equipment: All materials and equipment factory fabricated, imported or otherwise shall be provided with a fresh coat of paint, of same color as the original factory-paint. Unless otherwise directed by the Consultant. The items covered under this head shall include chillers, air handling units, fan coil units, pumps, Cooling tower, fans, etc.
- (b) Piping and Pipe fittings and valves etc. shall be provided with two coats of red lead from an approved manufacturer. Chilled water piping shall be further provided with two finish coats. All valves etc. shall be painted in a color, different from the color on the adjacent pipe. Apply two coats of asphalt paint to all pipes laid in concrete or passing through concrete.
- (c) Hangers and Supports shall be provided with two coats of red iron from an approved manufacturer. All hangers and supports exposed to view shall be further providing with two coats of finish paint of an approved color.

All new surfaces to be painted are prepared properly to receive prime coat of paint. Surfaces shall be scraped or wire-brushed to remove mill scale, rust and clean with solvent of remove grease, oil and dirt. All surfaces shall be thoroughly dried before application of paint. Prime coat shall be suitable for subsequently applied finish coats. For prime coat red lead paint of an approved manufacturer shall be used, such as 'KROMIC' Synthetic Red Lead by Johnson & Nicholson shall be used.

Before finish coat is applied to all prime coated surfaces shall be properly touched up. The equipment and piping shall not be finished painted until they have been tested and approved. All succeeding coats shall be applied only when the undercoats are thoroughly dried.

For piping system identification a color scheme based on American Standard "Scheme for identification of Piping System", "ASA A-13.1-1975" shall be specified and get approved by the Consultant and then this color scheme shall be used to finish painting.

33.2 STENCILING:

The Contractor shall stencil near each valve on the pipe, the name of the fluid. Also an arrow should be painted next to the legend indicating the direction of flow in pipe. The stencil legend shall be placed in a location so that it can easily be read from the floor.

33.3 IDENTIFICATION TAGS:

Shall be installed on valves, controls and other parts of the system where directed to do so. Tags shall be polished or lacquered brass 40 mm round, or octagonal with stamped letters or numbers, 12 mm high, filled with black paint and fastened securely with brass "S" hooks or chains.

The Contractor shall further provide charts, diagrams, of size and type as approved designating number, service or function and location of each tagged item.

33.4 PIPING AND DUCT WORK IDENTIFICATION:

1. After completion of insulation and /or painting, all piping and ductwork exposed or concealed shall be marked in English to show the services name and direction of flow.
2. Marking shall be placed at each side of any wall, partition or floor, at 10m intervals on all exposed piping and ductwork and at each access panel or door. Marking shall be located so as to be in full view.
3. Marking shall be stenciled. Use black stencil on light coloured surfaces, yellow stencils on dark coloured surface except where fire lines which shall be stenciled in accordance with civil defence requirements. Stencils shall have distinct edges. Blurred stencils are not acceptable. The name of the services shall be stenciled fully or with abbreviations standard to the industry. Non standard abbreviations are not acceptable. Letters shall be a minimum of 50mm high for ducts and for pipes 75mm or larger to outside of insulation. Letters for smaller pipes shall be 20mm high. All markings shall be clearly legible from 1.5m above the adjacent floor or platform.

34.0 OPERATING AND MAINTENANCE INSTRUCTIONS:

34.1 BOUND INSTRUCTIONS:

Six complete sets of operating and maintenance manuals, duly approved by the Consultant, shall be supplied by the Contractor, prior to hand over of the project to the owner. Each set shall be permanently bound and shall have a hard cover. Each manual shall be inscribed with suitable legend for proper identification and use of the manual. The matter shall be legibly typed and/or shall be clear Photostat copies of the original documents, catalogues, etc. Flysheets shall be placed before instructions covering each subject. The instruction sheets shall be approximately 8 ½" x 11", with large sheets of drawings folded in. The manual shall be arranged in two parts, and shall generally conform to the arrangement shown below.

Part I – Systems

1. The system volumes shall be organized into divisions wherein each division represents a generic function. System shall then be classified under appropriate divisions.
2. The material for each system shall then be organize in sections descriptive of the following basic areas of information:
 - (a) Descriptive Information
 - (b) Operating Instructions
 - (c) Inspection and maintenance instructions.
3. Sections shall be organized to include the following categories of information:
 - (a) Descriptive Information:
 - (1) Function of service.

- (2) Classification.
- (3) Design Capability.
- (4) Performance characteristics.
- (5) Principal components.
- (6) Distribution arrangement.
- (7) Schematic diagram.
- (8) Control diagram.
- (9) Equipment data:
 - (a) Inventory designation.
 - (b) Manufacturer and Model.
 - (c) Size and rating.
 - (d) Pressure, speed, and temperature limitations.

(b) Operating Instructions:

- (1) Starting and stopping procedures.
- (2) Adjustment and regulation.
- (3) Seasonal changeover.
- (4) Seasonal start-up.
- (5) Seasonal shutdown.
- (6) Logs and records.

(c) Inspection and Maintenance:

- (1) Inspection schedule & checklist.
- (2) Schedules and procedures for lubrication, adjustment, cleaning, painting, protection and testing.
- (3) Inspection and maintenance record.

4. Reference Documents.

- (a) Construction drawing list.
- (b) Construction Specifications.
- (c) As-built record drawings.
- (d) Test and balance records.

Part II – Equipment

1. This part of the manual shall be composed of manufacturer's data on equipment and materials organized into divisions wherein each division represents generic classification of equipment, such as:

Division Title

Air-conditioning & Ventilation..	1
Controls.	2
Instruments & Accessories	3
Motors	4
Pumps	5
Refrigeration	6
Starters	7
Valves	8

2. Each division shall be organized in sections wherein each section would represent a specific type of equipment. For example, for Division 1 the sections shall generally include the following:

Air Conditioning & Ventilating	1.0
Coils cooling	1.1
Preheat	1.2
Reheat	1.3
Fans	1.4
Centrifugal	1.5
Propeller	1.6
Filters roughing	1.7
Intermediate	1.8
Terminal	1.9
Humidifier central	1.10
Duct..	1.11
Other equipment	1.12

3. Coverage of section. Each section shall include the following manufacturer information:

(a) Descriptive literature

- (1) Catalogue cuts, brochures, or shop drawings.
- (2) Dimensional drawings.
- (3) Materials of constructions.
- (4) Parts designations.

(b) Operating characteristics:

- (1) Performance tables and charts.
- (2) Performance curves.
- (3) Pressure, temperature and speed limitations.
- (4) Safety devices.

(c) Operating Instructions:

- (1) Prestart checklist.
- (2) Start-up procedures.
- (3) Inspection during operation.
- (4) Adjustment and regulations.
- (5) Testing.
- (6) Detection of malfunction.
- (7) Precautions.

(d) Inspection Instructions and procedures:

- (1) Normal and abnormal operating temperature, pressures and speed limits.
- (2) Schedule and manner of operation.
- (3) Detection signals.

- (e) Maintenance Instructions and Procedures
 - (1) Schedule of routine maintenance.
 - (2) Procedures.
 - (3) Troubleshooting chart.
- (f) Parts List.
- (g) Spare parts.
 - (1) Essential inventory.
 - (2) Distributor Directory.
- (h) Service Contracts.

34.2 FRAMED INSTRUCTIONS:

Approved wiring and control diagrams showing the complete layout of the entire system, including equipment, piping, valves and control sequence, framed under glass or in approved laminated plastic, shall be posted, wherever directed. In addition, condensed operating instructions, explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams and posted beside the diagrams. Proposed diagrams, instructions, and other sheets shall be submitted for approval prior to posting. The framed instructions shall be posted before acceptance testing of the system.

34.3 FIELD INSTRUCTIONS:

Upon completion of the work and at a time designated, the services of one or more project engineers shall be provided by the Contractor for a period of not less than 60 days to instruct representatives of the Owner in the operation and maintenance of the Air-conditioning system. The field instructions shall cover all the items contained in the bound instructions.

35.0 TEST RUN

35.1 GENERAL:

After completion of the installation of the Systems the Contractor shall carry out a two months test run in summer or as per direction of the client or consultant. The certificate of substantial completion shall be provided on completion of the test run to the satisfaction of the Consultant and in keeping with the stipulations of relevant clauses of the General & Special Conditions of Contract. This test run shall be constructed to form a part of the "Performance Tests" specified herein before.

36.0 SCHEDULE OF ITEM RATES

36.1 GENERAL:

The item rates for the following shall be given and should be based on the prices quoted and filled in the schedule of item wise prices. The purpose of this Schedule is to assess the cost of any modification in the system layout which might decrease or increase the quantities of these items.

The rates given in this Schedule will be binding on the contractor and no variation in these rates will be allowed for the duration of the contract.

36.2 DUCTING:

The cost shall be given per square meter (m²) of ducting including average hangers reinforcement of bracing materials etc.

Material	Cost of Material (Pak Rs)
16 gauge steel sheet	
18 gauge steel sheet	
18 gauge 304 stainless steel sheet	
18 gauge 316 stainless steel sheet	

37.3 INSULATION:

The cost shall be given per square meter (m²) of insulation for ducting and shall include all accessories.

Material	Cost of Material (Pak Rs)
50 mm thick fiberglass duct insulation, 48 kg/m ³ density	
50 mm thick fiberglass duct insulation, 24 kg/m ³ density	
65 mm thick fiberglass pipe insulation, 64 kg/m ³ density	
75 mm thick fiberglass pipe insulation, 64 kg/m ³ density	

37.4 GALVANIZED PIPE:

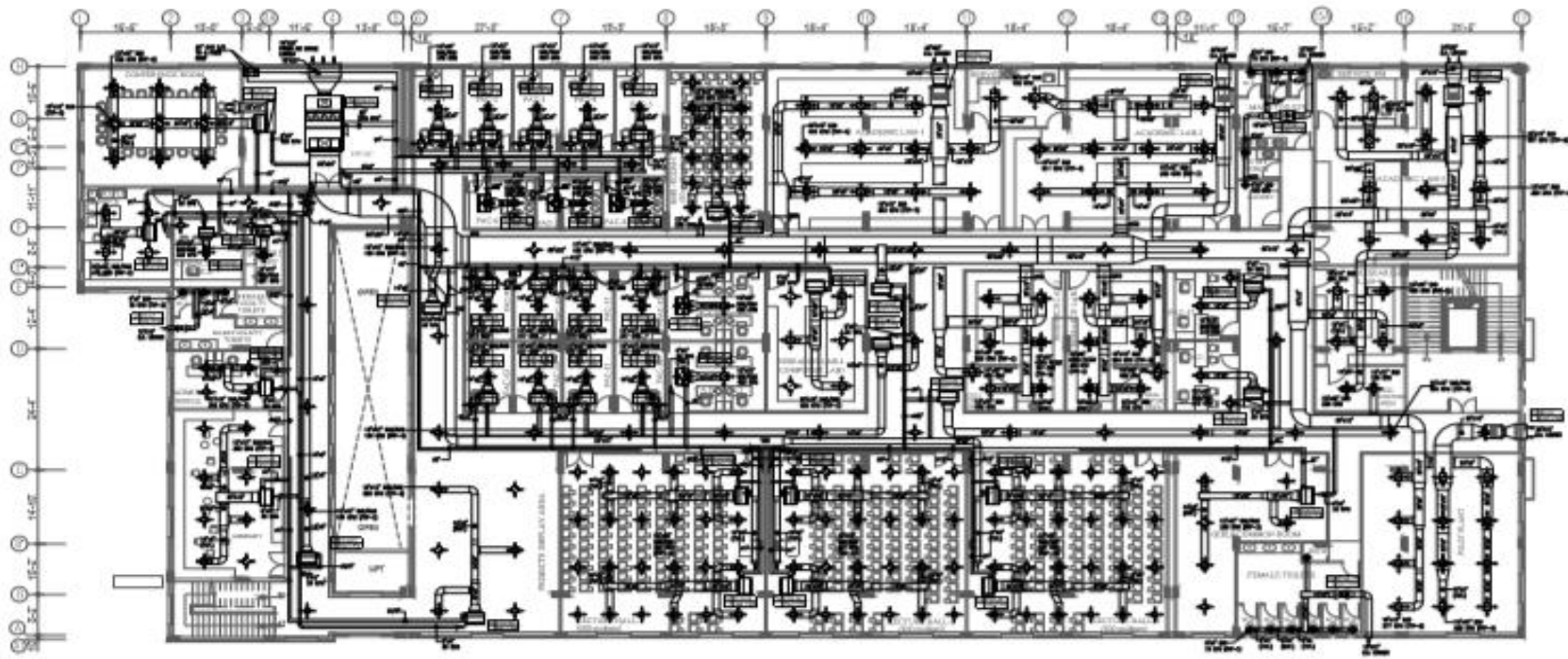
The rate for G.I. Piping shall be given per meter including average fittings, supports etc.

Material Size (Dia mm)	Cost of Material (Pak Rs)
75	
50	
38	
25	

37.5 UPVC PIPE (CLASS E):

The rate for UPVC piping shall be given per meter including average fittings, supports etc.

Material Size (Dia mm)	Cost of Material (Pak Rs)
75	
65	
50	
40	
20	



PROJECT:

DOW COLLEGE OF BIOTECHNOLOGY (DCOB)
 SERO BIOLOGY BUILDING OJHA CAMPUS KARACHI

TITLE: HVAC LAYOUT FOR 3RD FLOOR
 (OPTION - 1)

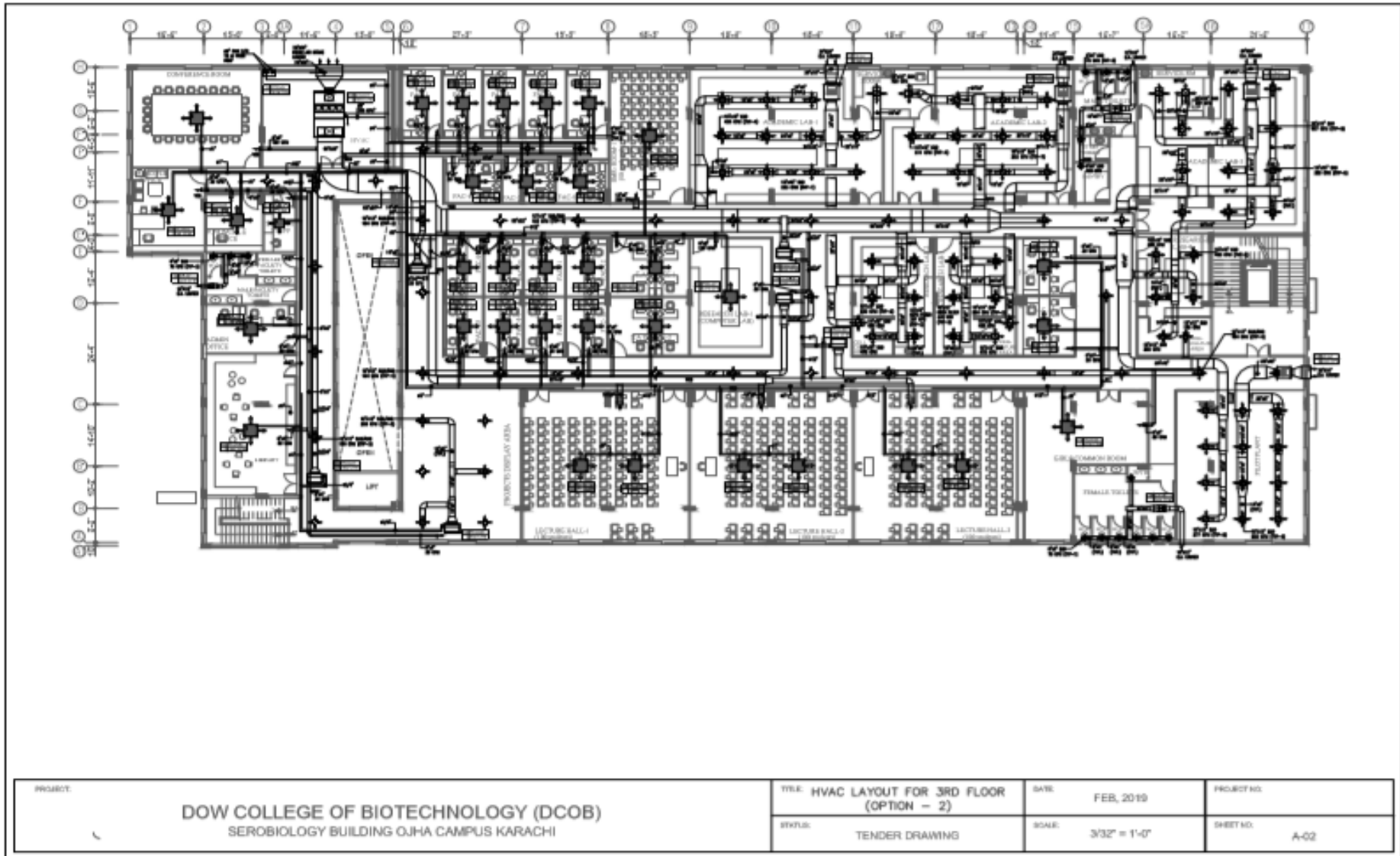
DATE: FEB, 2019

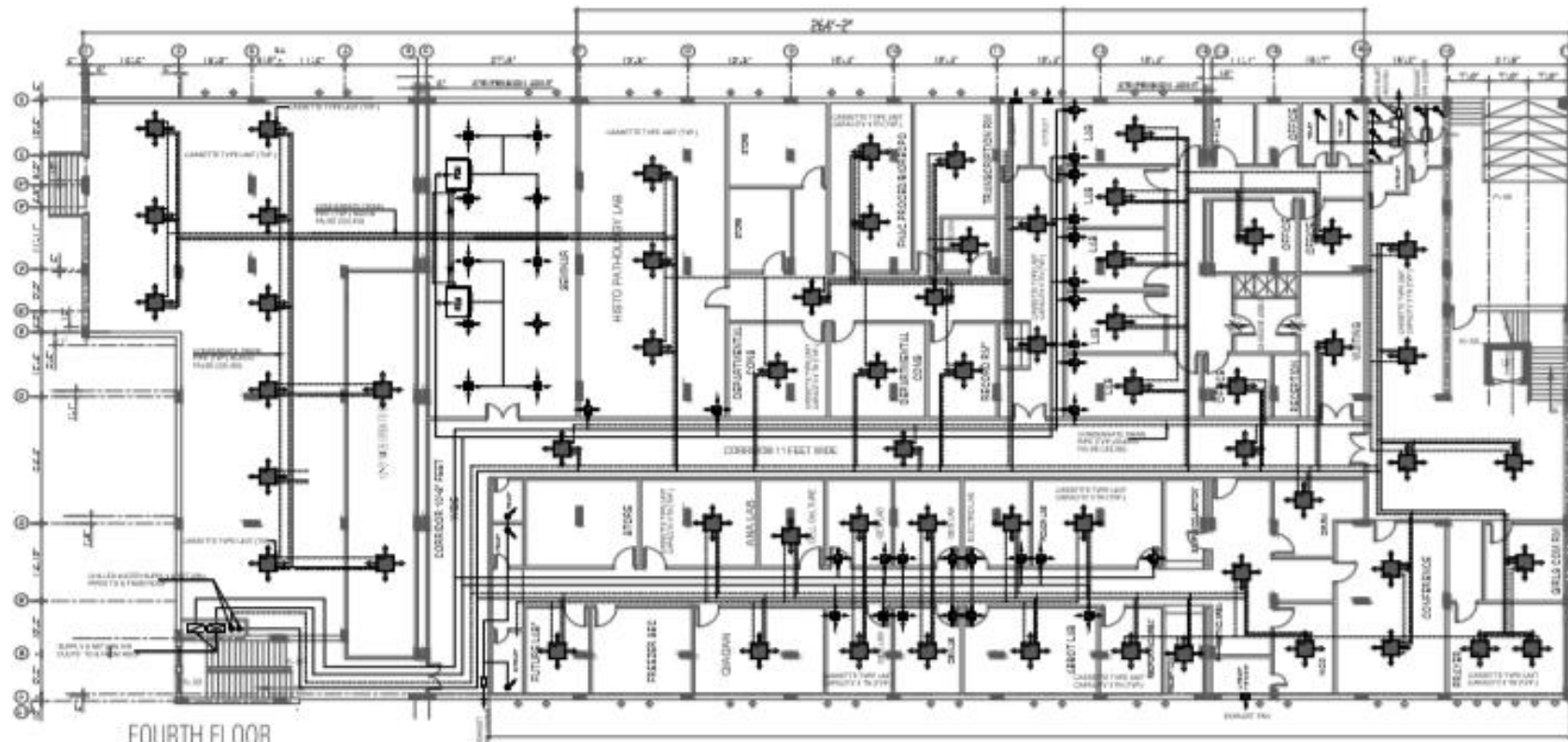
PROJECT NO:

STATUS: TENDER DRAWING

SCALE: 3/32" = 1'-0"

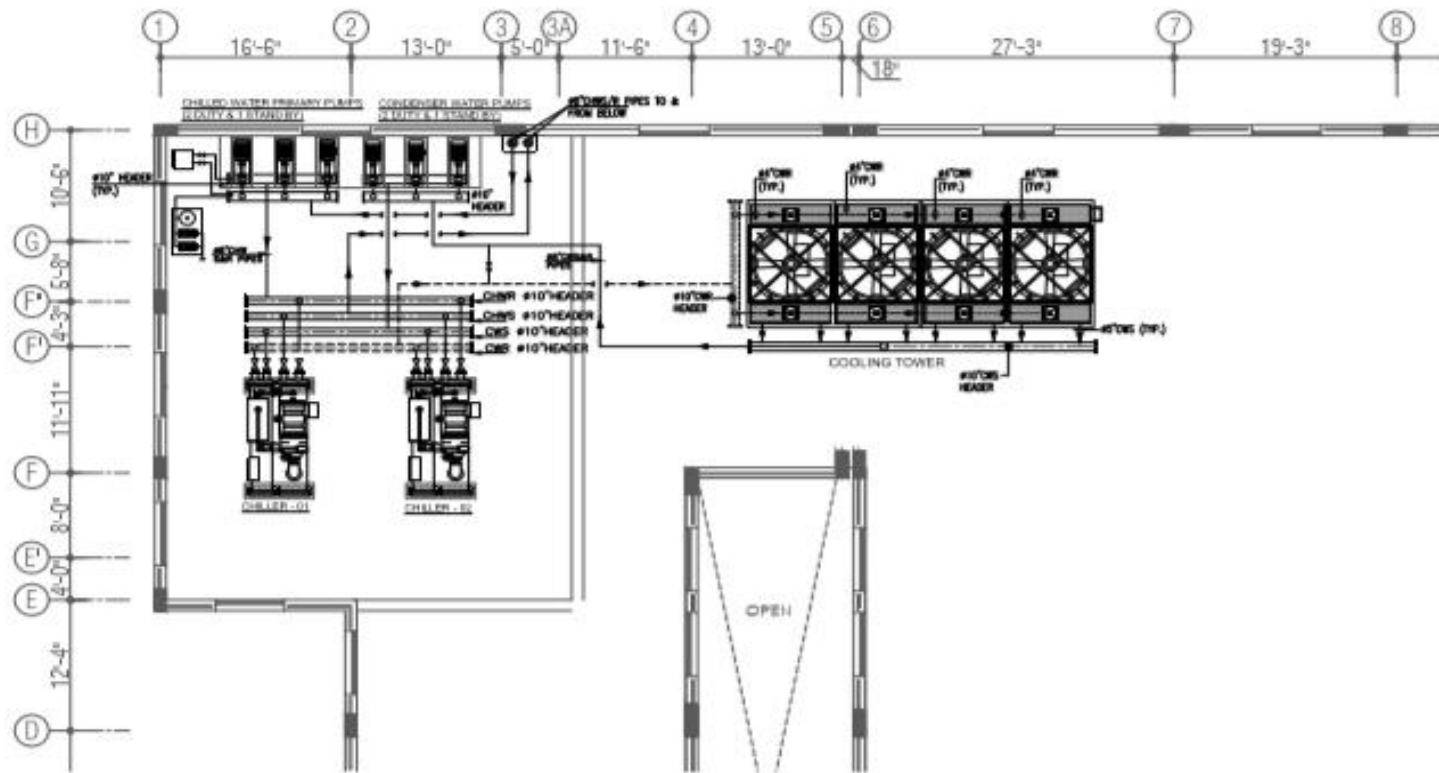
SHEET NO: A-02





FOURTH FLOOR
 30000.00 SQ.FT APPROX
 PROPOSED PLAN

PROJECT: DOW COLLEGE OF BIOTECHNOLOGY (DCOB) SERO BIOLOGY BUILDING OJHA CAMPUS KARACHI	TITLE: HVAC LAYOUT FOR 4TH FLOOR	DATE: FEB, 2019	PROJECT NO:
	STATUS: TENDER DRAWING	SCALE: 3/32" = 1'-0"	SHEET NO: A-02



PROJECT: DOW COLLEGE OF BIOTECHNOLOGY (DCOB) SEROBIOLOGY BUILDING OJHA CAMPUS KARACHI	NO.:	HVAC LAYOUT FOR ROOF	DATE:	FEB, 2019	PROJECT NO:
	STATUS:	TENDER DRAWING	SCALE:	3/16" = 1'-0"	SHEET NO:
					A-02

SUPPLY / FIXING / INSTALLATION / COMMISSIONING OF HVAC FOR 3RD & 4TH FLOOR OF SEROBIOLOGY BUILDING ON (TURNKEY BASIS) AT OJHA CAMPUS, DUHS, KARACHI

SCHEDULE OF EQUIPMENT

CENTRIFUGAL OIL FREE WATER COOLED CHILLER SCHEDULE

TAG	LOCATION	COOLING CAPACITY (TR)	QTY. (Nos)	EVAPORATOR DATA				CONDENSER DATA				ELECTRICAL		REMARKS
				FLOW (GPM)	EWT (°F)	LWT (°F)	FOULING FACTOR (m ² .°K/kW)	FLOW (GPM)	EWT (°F)	LWT (°F)	MAX. HEAD LOSS (KPa)	POWER kW	V-PH-HZ	
CH - 1 TO CH-2	PLANT ROOM 4 TH Floor	250 (EACH)	2	600 (Each)	53.6	42.8	0.088	785 (Each)	84.2	95.0	60	178	400-3-50	BOTH DUTY, HIGH EFFICIENCY/HIGH COP CHILLERS WITH VFD & MAGNETIC BEARINGTYPE WITH MINIMUM 2 RERIGERANT CIRCUITS

SUPPLY / FIXING / INSTALLATION / COMMISSIONING OF HVAC FOR 3RD & 4TH FLOOR OF SEROBIOLOGY BUILDING ON (TURNKEY BASIS) AT OJHA CAMPUS, DUHS, KARACHI

SCHEDULE OF EQUIPMENT

COOLING TOWER SCHEDULE

TAG	TYPE	LOCATION	QUANTITY (NOS.)	WATER-SIDE DATA			AIR-SIDE DATA		ELECTRICAL		REMARKS
				FLOW	EWT	LWT	NO. OF CELLS	EAT, WB	POWER	V-PH-HZ	
				(GPM)	(°F)	(°F)	(QTY.)	(°F)	(KW)		
CT-1 TO CT-2	CROSS FLOW CLOSED TYPE	ROOF OF PLANT ROOM	2	785 (EACH) MINIMUM	99.5	89.6	Multi-Cell	86.0	10.0	400-3-50	BOTH DUTY

SUPPLY / FIXING / INSTALLATION / COMMISSIONING OF HVAC FOR 3RD & 4TH FLOOR OF SEROBIOLOGY BUILDING ON (TURNKEY BASIS) AT OJHA CAMPUS, DUHS, KARACHI

SCHEDULE OF EQUIPMENT

FRESH AIR HANDLING UNIT SCHEDULE

TAG	LOCATION	SERVICES	QTY.	SUPPLY AIR	ESP	WATER SIDE				AIR SIDE				COOLING CAPACITY		ELECTRICAL				REMARKS
				(CFM)	(in. of water)	FLOW (GPM)	MAX PRESSURE DROP (Ft. of water)	EWT (°F)	LWT (°F)	EDB (°F)	EWB (°F)	LDB (°F)	LWB (°F)	SENSIBLE (TR)	TOTAL (TR)	VOLTS	PHASE	HERTZ	KW	
FAHU-01 & 02	AHU ROOM 3RD FLOOR	100% FRESH AIR	2	16800	2.6	305.9	15	44	54	104	82.9	60.2	58.9	66.3	127.4	400	3	50	20.0	HORIZONTAL DOUBLE SKIN FLOOR MOUNTED, HYGIENIC DESIGN COMPLETE WITH PRE-FILTER, BAG FILTER, TOP DISCHARGE FAN, MOTOR WITH VFD. SUPPLIED EQUIPMENT SHOULD COMPLY WITH DIN 1946, PART4, O NORM H 6020, PART 1 CERTIFIED.

NOTES

1. PRE-FILTER SHALL BE EU4 WITH 90% ARRESTANCE EFFICIENCY, BAG FILTER SHALL BE EU9 WITH 90-95% DUST SPOT EFFICIENCY.

SUPPLY / FIXING / INSTALLATION / COMMISSIONING OF HVAC FOR 3RD & 4TH FLOOR OF SEROBIOLOGY BUILDING ON (TURNKEY BASIS) AT OJHA CAMPUS, DUHS, KARACHI

SCHEDULE OF EQUIPMENT

FRESH AIR HANDLING UNIT SCHEDULE

TAG	LOCATION	SERVICES	QTY.	SUPPLY AIR	ESP	WATER SIDE				AIR SIDE				COOLING CAPACITY		ELECTRICAL				REMARKS
				(CFM)	(in. of water)	FLOW (GPM)	MAX PRESSURE DROP (Ft. of water)	EWT (°F)	LWT (°F)	EDB (°F)	EWB (°F)	LDB (°F)	LWB (°F)	SENSIBLE (TR)	TOTAL (TR)	VOLTS	PHASE	HERTZ	KW	
FAHU-01 & 02	AHU ROOM 4TH FLOOR	100% FRESH AIR	2	16800	2.6	305.9	15	44	54	104	82.9	60.2	58.9	66.3	127.4	400	3	50	20.0	HORIZONTAL DOUBLE SKIN FLOOR MOUNTED, HYGIENIC DESIGN COMPLETE WITH PRE-FILTER, BAG FILTER, TOP DISCHARGE FAN, MOTOR WITH VFD. SUPPLIED EQUIPMENT SHOULD COMPLY WITH DIN 1946, PART4, O NORM H 6020, PART 1 CERTIFIED.

NOTES

1. PRE-FILTER SHALL BE EU4 WITH 90% ARRESTANCE EFFICIENCY, BAG FILTER SHALL BE EU9 WITH 90-95% DUST SPOT EFFICIENCY.

SUPPLY / FIXING / INSTALLATION / COMMISSIONING OF HVAC FOR 3RD & 4TH FLOOR OF SEROBIOLOGY BUILDING ON (TURNKEY BASIS) AT OJHA CAMPUS, DUHS, KARACHI

SCHEDULE OF EQUIPMENT

FAN COIL UNIT (FCU) SCHEDULE FOR THIRD FLOOR

TAG	ZONE NAME	FLOOR'S NAME	QTY.	SUPPLY AIR (CFM)	ESP (in.wg)	WATER SIDE			AIR SIDE			COOLING CAPACITY		ELECTRICAL				REMARKS
						FLOW RATE GPM	MAX. PRESS. DROP FT of H ₂ O	COOLING EWT °F/LWT °F	COOLING		SENSIBLE TR	TOTAL TR	VOLTS	PHASE	HERTZ	WATTS		
									EODB °F/ EWB °F	LDB °F/LWB °F								
FCU-01	CONFERENCE ROOM	THIRD FLOOR	1	1409	0.35	7.20	4.0	44 / 54	75 / 62.6	55 / 54	2.5	3.0	220	1	50	600	CASSETTE TYPE	
FCU-02	PRINCIPLE OFFICE	THIRD FLOOR	1	754	0.35	3.60	4.0	44 / 54	75 / 62.6	55 / 54	1.3	1.5	220	1	50	500	CASSETTE TYPE	
FCU-03	VICE PRINCIPLE OFFICE	THIRD FLOOR	1	322	0.35	2.40	4.0	44 / 54	75 / 62.6	55 / 54	0.9	1.0	220	1	50	350	CASSETTE TYPE	
FCU-04	SUPPORT OFFICE	THIRD FLOOR	1	321	0.35	2.40	4.0	44 / 54	75 / 62.6	55 / 54	0.9	1.0	220	1	50	350	CASSETTE TYPE	
FCU-05	ADMIN OFFICE	THIRD FLOOR	1	600	0.35	3.36	4.0	44 / 54	75 / 62.6	55 / 54	0.9	1.4	220	1	50	400	CASSETTE TYPE	
FCU-06	LIBRARY	THIRD FLOOR	1	1441	0.35	6.48	4.0	44 / 54	75 / 62.6	55 / 54	2.3	2.7	220	1	50	600	CASSETTE TYPE	
FCU-07 / 08 & 09	CORRIDOR	THIRD FLOOR	3	492	0.35	2.88	4.0	44 / 54	75 / 62.6	55 / 54	1.0	1.2	220	1	50	400	CASSETTE TYPE	
FCU-10 TO 14	FAC -1 TO FAC-5	THIRD FLOOR	5	375	0.35	2.40	4.0	44 / 54	75 / 62.6	55 / 54	0.9	1.0	220	1	50	350	CASSETTE TYPE	
FCU-15	SMR ROOM	THIRD FLOOR	1	1474	0.35	7.20	4.0	44 / 54	75 / 62.6	55 / 54	2.6	3.0	220	1	50	600	CASSETTE TYPE	
FCU-16 TO 19 & 21 TO 24	FAC -9 TO FAC-16	THIRD FLOOR	8	217	0.35	1.92	4.0	44 / 54	75 / 62.6	55 / 54	0.9	0.8	220	1	50	300	CASSETTE TYPE	
FCU-20	TA OFFICE-1	THIRD FLOOR	1	408	0.35	2.40	4.0	44 / 54	75 / 62.6	55 / 54	0.9	1.0	220	1	50	350	CASSETTE TYPE	
FCU-26	TA OFFICE-2	THIRD FLOOR	1	408	0.35	2.40	4.0	44 / 54	75 / 62.6	55 / 54	0.9	1.0	220	1	50	350	CASSETTE TYPE	
FCU-27 / 42 / 43 / 44 & 45	RESEARCH LAB-1 COMPUTER LAB	THIRD FLOOR	5	1375	0.35	7.20	4.0	44 / 54	75 / 62.6	55 / 54	0.9	3.0	220	1	50	350	CASSETTE TYPE	
FCU-28 / 29 & 30	CORRIDOR	THIRD FLOOR	3	656	0.35	3.60	4.0	44 / 54	75 / 62.6	55 / 54	1.2	1.5	220	1	50	400	CASSETTE TYPE	
FCU-31 & 32	FAC -17 TO FAC-18	THIRD FLOOR	2	217	0.35	1.92	4.0	44 / 54	75 / 62.6	55 / 54	0.9	0.8	220	1	50	300	CASSETTE TYPE	
FCU-33 & 46	GIRLS COMMON ROOM	THIRD FLOOR	2	1000	0.35	4.80	4.0	44 / 54	75 / 62.6	55 / 54	1.8	2.0	220	1	50	600	CASSETTE TYPE	
FCU-34 / 35 / 47 & 48	LECTURE HALL-01	THIRD FLOOR	4	1364	0.35	6.72	4.0	44 / 54	75 / 62.6	55 / 54	2.4	2.8	220	1	50	600	CASSETTE TYPE	
FCU-36 / 37 / 49 & 50	LECTURE HALL-02	THIRD FLOOR	4	1364	0.35	6.72	4.0	44 / 54	75 / 62.6	55 / 54	2.4	2.8	220	1	50	600	CASSETTE TYPE	
FCU-38 & 39	LECTURE HALL-03	THIRD FLOOR	2	1364	0.35	6.72	4.0	44 / 54	75 / 62.6	55 / 54	2.4	2.8	220	1	50	600	CASSETTE TYPE	
FCU-40 / 41 & 25	FAC -6 TO FAC-8	THIRD FLOOR	3	294	0.35	2.16	4.0	44 / 54	75 / 62.6	55 / 54	0.9	0.9	220	1	50	350	CASSETTE TYPE	

SUPPLY / FIXING / INSTALLATION / COMMISSIONING OF HVAC FOR 3RD & 4TH FLOOR OF SEROBIOLOGY BUILDING ON (TURNKEY BASIS) AT OJHA CAMPUS, DUHS, KARACHI

SCHEDULE OF EQUIPMENT

FAN COIL UNIT (FCU) SCHEDULE FOR FOURTH FLOOR

TAG	ZONE NAME	FLOOR'S NAME	QTY.	SUPPLY AIR (CFM)	ESP (in.wg)	WATER SIDE			AIR SIDE			COOLING CAPACITY		ELECTRICAL				REMARKS
						FLOW RATE	MAX. PRESS. DROP	COOLING	COOLING			SENSIBLE	TOTAL	VOLTS	PHASE	HERTZ	WATTS	
						GPM	FT of H ₂ O	EWT °F/LWT °F	EDB °F/ EWB °F	LDB °F/LWB °F	TR	TR						
FCU-01	CONFERENCE ROOM	FOURTH FLOOR	1	1409	0.35	7.20	4.0	44 / 54	75 / 62.6	55 / 54	2.5	3.0	220	1	50	600	CASSETTE TYPE	
FCU-02	PRINCIPLE OFFICE	FOURTH FLOOR	1	754	0.35	3.60	4.0	44 / 54	75 / 62.6	55 / 54	1.3	1.5	220	1	50	500	CASSETTE TYPE	
FCU-03	VICE PRINCIPLE OFFICE	FOURTH FLOOR	1	322	0.35	2.40	4.0	44 / 54	75 / 62.6	55 / 54	0.9	1.0	220	1	50	350	CASSETTE TYPE	
FCU-04	SUPPORT OFFICE	FOURTH FLOOR	1	321	0.35	2.40	4.0	44 / 54	75 / 62.6	55 / 54	0.9	1.0	220	1	50	350	CASSETTE TYPE	
FCU-05	ADMIN OFFICE	FOURTH FLOOR	1	600	0.35	3.36	4.0	44 / 54	75 / 62.6	55 / 54	0.9	1.4	220	1	50	400	CASSETTE TYPE	
FCU-06	LIBRARY	FOURTH FLOOR	1	1441	0.35	6.48	4.0	44 / 54	75 / 62.6	55 / 54	2.3	2.7	220	1	50	600	CASSETTE TYPE	
FCU- 07 / 08 & 09	CORRIDOR	FOURTH FLOOR	3	492	0.35	2.88	4.0	44 / 54	75 / 62.6	55 / 54	1.0	1.2	220	1	50	400	CASSETTE TYPE	
FCU-10 TO 14	FAC -1 TO FAC-5	FOURTH FLOOR	5	375	0.35	2.40	4.0	44 / 54	75 / 62.6	55 / 54	0.9	1.0	220	1	50	350	CASSETTE TYPE	
FCU-15 / 42 / 43 & 44	SMR ROOM	FOURTH FLOOR	4	1474	0.35	7.20	4.0	44 / 54	75 / 62.6	55 / 54	2.6	3.0	220	1	50	600	CASSETTE TYPE	
FCU-16 TO 19 & 21 TO 24	FAC -9 TO FAC-16	FOURTH FLOOR	8	217	0.35	1.92	4.0	44 / 54	75 / 62.6	55 / 54	0.9	0.8	220	1	50	300	CASSETTE TYPE	
FCU-20 / 45 & 46	TA OFFICE-1	FOURTH FLOOR	3	408	0.35	2.40	4.0	44 / 54	75 / 62.6	55 / 54	0.9	1.0	220	1	50	350	CASSETTE TYPE	
FCU-26 / 47 & 48	TA OFFICE-2	FOURTH FLOOR	3	408	0.35	2.40	4.0	44 / 54	75 / 62.6	55 / 54	0.9	1.0	220	1	50	350	CASSETTE TYPE	
FCU-27 / 49 / 50 / 51 / 52 / 53 / 54 & 55	RESEARCH LAB-1 COMPUTER LAB	FOURTH FLOOR	8	1375	0.35	7.20	4.0	44 / 54	75 / 62.6	55 / 54	0.9	3.0	220	1	50	350	CASSETTE TYPE	
FCU-28 / 29 & 30	CORRIDOR	FOURTH FLOOR	3	656	0.35	3.60	4.0	44 / 54	75 / 62.6	55 / 54	1.2	1.5	220	1	50	400	CASSETTE TYPE	
FCU-31 & 32	FAC -17 TO FAC-18	FOURTH FLOOR	2	217	0.35	1.92	4.0	44 / 54	75 / 62.6	55 / 54	0.9	0.8	220	1	50	300	CASSETTE TYPE	
FCU-33 & 56	GIRLS COMMON ROOM	FOURTH FLOOR	2	1000	0.35	4.80	4.0	44 / 54	75 / 62.6	55 / 54	1.8	2.0	220	1	50	600	CASSETTE TYPE	
FCU-34 / 35 / 57 & 58	LECTURE HALL-01	FOURTH FLOOR	4	1364	0.35	6.72	4.0	44 / 54	75 / 62.6	55 / 54	2.4	2.8	220	1	50	600	CASSETTE TYPE	
FCU-36 / 37 / 59 & 60	LECTURE HALL-02	FOURTH FLOOR	4	1364	0.35	6.72	4.0	44 / 54	75 / 62.6	55 / 54	2.4	2.8	220	1	50	600	CASSETTE TYPE	
FCU-38 / 39 / 61 / 62 / 63 / 64 & 65	LECTURE HALL-03	FOURTH FLOOR	7	1364	0.35	6.72	4.0	44 / 54	75 / 62.6	55 / 54	2.4	2.8	220	1	50	600	CASSETTE TYPE	
FCU-40 / 41 / 66 / 67 / 68 / 69 / 70 & 25	FAC -6 TO FAC-8	FOURTH FLOOR	8	294	0.35	2.16	4.0	44 / 54	75 / 62.6	55 / 54	0.9	0.9	220	1	50	350	CASSETTE TYPE	