

Name of work

**Low side Central Air Conditioning works including
SITC of AHU(s) and FCU(s) at various Labs and
Main Auditorium in IIT Kanpur**

BID DOCUMENT



OFFICE OF INFRASTRUCTURE AND PLANNING
INDIAN INSTITUTE OF TECHNOLOGY KANPUR
November, 2023

Indian Institute of Technology Kanpur

Contents

	Page
1 Notice Inviting e-Tenders	1
2 Information and Instructions for Bidders for E-Tendering	2
2.1 Schedule	2
2.2 Instructions for Online BID Submission	8
2.2.1 Registration	8
2.2.2 Searching for tender documents	9
2.2.3 Preparation of bids	9
2.2.4 Submission of bids	9
2.2.5 Assistance to bidders	10
2.2.6 General instruction to bidders	10
2.3 List of documents to be scanned and uploaded within the period of bid submission	12
2.3.1 Envelope - 1: Technical Bid	12
2.3.2 Envelope - 2: Financial Bid	12
3 Eligibility Criteria	13
3.1 Eligibility criteria for contractors	13
4 Bid Evaluation and Award	14
4.1 Technical Bid Evaluation	14
4.2 Financial Bid Evaluation	14
5 Various Forms and Formats	15
5.1 Declaration in lieu of submitting Earnest Money Deposit	15
5.2 Format for submission of processing fees	16
5.3 Undertaking regarding obtaining GST registration	17
5.4 Affidavit for not being blacklisted/debarred/restrained	18
5.5 Financial Information	19
5.6 Banker's Certificate from a scheduled Bank	20
5.7 Net Worth Certificate by certified Chartered Accountant	21
5.8 Performance report on work executed	22
5.9 Structure and Organization of the Agency	23
5.10 Declaration on Details of the Bidders	24
5.11 Details of Similar Nature of Works Completed	26
5.12 Declaration About Site Inspection	27
5.13 Letter of Transmittal	28
5.14 CPWD-7	29
6 Proforma of Schedules	31
6.1 SCHEDULE 'A': Schedule of Quantities	31

6.2	SCHEDULE ‘B’: Schedule of materials to be issued to the contractor	31
6.3	SCHEDULE ‘C’: Tools and plants to be hired to the contractor	31
6.4	SCHEDULE ‘D’: Extra schedule for specific requirements/document for the work, if any	31
6.5	SCHEDULE ‘E’: Reference to General Conditions of contract	31
6.6	SCHEDULE ‘F’: General Rules and Directions	31
6.6.1	Definitions	32
6.6.2	Clauses	32
7	Scope of work	37
7.1	Brief of the works	37
7.2	Materials Verification	37
7.3	Specifications for HVAC Works	37
7.3.1	Technical Specifications for HVAC Works	37
7.3.2	DUCT WORK AND OUTLETS	37
7.3.3	PIPE WORK	42
7.3.4	INSULATION	48
7.3.5	ELECTRIC CABLING	50
7.3.6	TESTING AND COMMISSIONING	52
7.3.7	DOUBLE SKIN AIR HANDLING UNITS	57
7.3.8	FAN COIL UNITS	59
7.3.9	FILTERS	60
7.3.10	VARIABLE FREQUENCY DRIVES FOR HVAC SYSTEM	61
7.4	Preferable Makes for HVAC Installation Works (as applicable)	69
8	Special Conditions of Contract	77
8.1	Timely Completion	77
8.2	Rates	78
8.3	Quality and Workmanship	79
8.4	Natural calamity:	81
8.5	Stocking and Disposal of Materials & Debris	81
8.6	Nondisclosure Agreement	81
8.7	Indemnification:	82
8.8	Force Majeure:	82
8.9	Dispute resolution	82
8.10	Arbitration	83
8.11	Jurisdiction of Courts	83
8.12	Safety and Security	83
8.13	Approach to Site	84
8.14	Water and Flooding	84
8.15	Acts and Laws	85
8.16	Labour and Laws	85
8.17	E& M Works	85
8.18	INSPECTION, TESTING AND COMMISSIONING OF HVAC WORK	88

It is certified that this document contains 96 pages starting with Page No. i

Officer-in-Charge, Office of Infrastructure and Planning

1 Notice Inviting e-Tenders

The Dean of Infrastructure and Planning on behalf of Board of Governors of Indian Institute of Technology Kanpur invites online [percentage rate tenders from eligible air conditioning contractors, satisfying the eligibility criteria mentioned in the document.](#)

NIT No: [HVAC/30/11/2023-1](#)

1	Name of work	:	Low side Central Air Conditioning works including SITC of AHU(s) and FCU(s) at various Labs and Main Auditorium in IIT Kanpur
2	Estimated Cost exclusive of GST	:	Rs. 34,64,296/-
3	Earnest Money Deposit (Rs.)	:	EMD Declaration to be submitted in lieu of EMD as per Form 5.1
4	Duration of contract	:	Eight (8) weeks
5	Last Time & date of submission of bids (Up to)	:	As per CPP portal data (https://eprocure.gov.in/eprocure/app)
6	Opening of bids	:	As per CPP portal data
7	Time allowed for submission of requisite documents by lowest bidder	:	Within One week of opening of financial bids

The bid forms and other details may be downloaded from Central Public Procurement Portal (<http://eprocure.gov.in/eprocure/app>). Aspiring bidders who have not enrolled / registered in e- procurement should enroll / register themselves before participating through web site <http://eprocure.gov.in/eprocure/app>. The portal enrolment is free of cost. Bidders are advised to go through instructions provided at “Instructions for online bid submission.”

Bidders can access quotation / tender documents on the website (for searching in the NIC site), kindly go to quotation search option and type ‘IIT’. Thereafter, click on “GO” button to view all IIT quotations. Select the appropriate quotation / tender and fill them with all relevant information and submit the completed Quotation / Tender document online on the website <http://eprocure.gov.in/eprocure/app> as per the schedule given in the next page.

Note: No manual bids will be accepted. All bids (both Technical & Financial) should be submitted in the e-procurement portal.

Applicants are advised to keep visiting the above-mentioned websites from time to time (till the deadline for bid submission) for any updates in respect of the tender documents, if any. Failure to do so shall not absolve the applicant of his liabilities to submit the applications complete in all respect including updates thereof, if any. An incomplete application may be liable for rejection.

Officer-in-Charge, Office of Infrastructure and Planning

2 Information and Instructions for Bidders for E-Tendering

The Dean of Infrastructure and Planning on behalf of Board of Governors of Indian Institute of Technology Kanpur invites online [percentage rate tenders from eligible air conditioning contractors, satisfying the eligibility criteria mentioned in the document.](#)

2.1 Schedule

1	Name of organization	:	Indian Institute of Technology Kanpur
2	NIT No:	:	HVAC/30/11/2023-1
	Location	:	Indian Institute of Technology Kanpur
3	Tender / Quotation type (open / limited / EOI / auction / single)	:	Open
4	Tender / Quotation category (services / goods / works)	:	Works
5	Type of Contract (work / supply / auction / service / buy / empanelment / sell)	:	Work
6	Form of contract (IITK-7/8)	:	IITK-7
7	Work Category (civil / electrical / fleet management / computer systems)	:	HVAC
8	Is multi-currency allowed?	:	No
9	Date of publishing / issue / start	:	As per CPP portal
10	Document download start date	:	As per CPP portal
11	Document download end date	:	As per CPP portal
12	Date & time of pre-bid meeting	:	As per CPP portal
13	Venue of pre-bid meeting	:	As per CPP portal
14	Last date & time of uploading of bids	:	As per CPP portal
15	Date & time of opening of Technical bids	:	As per CPP portal
16	Bid Validity Days	:	90 days after opening of technical bid
17	Earnest Money Deposit (EMD)	:	EMD Declaration to be submitted in lieu of EMD as per FORM given in section 5.1

18	Non- Refundable Processing Fee (Inclusive of GST @18%) as given in section 5.2	Rs 10,000/-for Non MSME/NSIC/Startup and Rs. 1,500/-for MSME/NSIC/Startup to The Registrar, Indian Institute of Technology Kanpur. The proof of submission must be uploaded along with transaction slip with due mention of NIT No. in the CPP portal for valid tender submission as per format given in section 5.2
19	No. of Bids / Covers (1 / 2 / 3 / 4)	: 2
20	Address for communication	: Office of Infrastructure and Planning, Indian Institute of Technology Kanpur, Kanpur, U.P. Pin - 208016
21	e-mail address	: tender_doip@iitk.ac.in

The intending bidder must read the terms and conditions of CPWD-6 carefully. He should only submit his bid if he considers himself eligible and he is in possession of all the documents required.

1. Information and instructions for bidders posted on website shall form part of bid document.
2. The bid document consisting of specifications, schedule of quantities of items to be executed, schedule of stages for payment as applicable and the set of terms & conditions of the contract to be complied with and other necessary documents can be seen and downloaded free of cost from www.eprocure.gov.in
3. But the bid can only be submitted after deposition of e processing fee and with the EMD declaration.
4. Those contractors not registered on the website mentioned above, are required to get registered beforehand. Only e-bids shall be accepted in CPPP portal through e-tendering processes.
5. The intending bidder must have valid Class-III digital signature to submit the bid.
6. On opening date, the contractor can login and see the bid opening process. After opening of bids, he will receive the competitor bid sheets.
7. Contractor can upload documents in the form of JPG format and PDF format.
8. Contractor must ensure to quote rate of each item. The column meant for quoting rate in figures appears in pink colour and the moment rate is entered, it turns sky blue.

In addition to this, while selecting any of the cells a warning appears that if any cell is left blank the same shall be treated as "0". Therefore, if any cell is left blank and no rate is quoted by the bidder, rate of such item shall be treated as "0" (ZERO).

However, if a tenderer quotes nil rates against each item in item rate tender or does not quote any percentage above/below on the total amount of the tender or any section /

sub head in percentage rate tender, the tender shall be treated as invalid and will not be considered as lowest tenderer.

9. The “Eligibility/technical Bid” shall be opened first on due date and time as per the evaluation scheme. The “Financial Bid” of bidders qualifying the technical bid shall be opened on a later date as to be announced in CPP portal.
10. The bidders are advised to visit the site before submission of bids to have more clarity about the site conditions and availability of space for execution of the work.
11. All modifications/addendums/corrigendums issued regarding this bidding process shall be uploaded on website only.
12. The department reserves the right to reject any or all bids without assigning any reason thereof and may restrict the list of qualified bidders to any number deemed suitable by it, if too many bids are received satisfying the minimum laid down criteria.
13. The rates for all items of work, shall unless clearly specified otherwise, include cost of all operations and all inputs of labour, material, T&P, scaffolding, wastages, watch and ward, other inputs, all incidental charges, all other taxes (exclusive of GST), cess, duties, levies etc. required for execution of the work.
14. The specialized works shall be in compliance with 3 Star GRIHA rating and as per environmental policies of Institute. Nothing extra shall be payable on this account.
15. If the clause of enlistment is applicable, The enlistment of the contractors should be valid on the last date of submission of bids. In case the last date of submission of bid is extended, the enlistment of contractor should be valid on the original date of submission of bids.
16. The description of the work is as follows: “[Low side Central Air Conditioning works including SITC of AHU\(s\) and FCU\(s\) at various Labs and Main Auditorium in IIT Kanpur](#)”
17. The work is estimated to cost **Rs.34,64,296/-**. However, this estimate given is mere approximation for guide.
18. Agreement shall be drawn with the successful bidders on prescribed Form No. CPWD 7 which is available as a Govt. of India Publication and also available on website www.cpwd.gov.in. Bidders shall quote his rates as per various terms and conditions of the said form which will form part of the agreement.
19. The time allowed for carrying out the entire work will be [Eight \(8\) weeks](#) from the date of start as defined in Schedule “F” or from the first date of handing over of the site, whichever is later, in accordance with the phasing as detailed in special conditions of contract in the bid document.
20. The site for the work will be handed over as per the special terms and conditions of the document.
21. An approved programme of completion submitted by the contractor after award of work based on the milestones given in the tender.
22. The bid document consisting of NIT, the schedule of quantities of various types of items to be executed and the set of terms and conditions of the contract to be complied with and other necessary documents can be seen and downloaded from website www.eprocure.gov.in free of cost.

23. After submission of the bid the contractor can re-submit revised bid any number of times but before last time and date of submission of bid as notified.
24. While submitting the revised bid, contractor can revise the rate of one or more item(s) any number of times (he need not re-enter rate of all the items) but before last time and date of submission of bid as notified.
25. Earnest Money Declaration shall be uploaded to the e-Tendering website within period of submission
26. The receipt of e-processing fee shall also be uploaded to the e-tendering website by the intending bidder up to the specified bid. The Details of Institute Account for submitting e-processing fees is given in 5.2 under Section [Various Forms and Formats](#).
27. Copy of documents as specified in the bid shall be scanned and uploaded to the e-tendering website within the period of bid submission.
28. The bid submitted shall be opened at as per the details provided in the CPP portal at DOIP office. The date of opening of Financial Bid shall be informed through web site after the opening of financial bid
29. [The bid submitted shall become invalid and e- processing fee shall not be refunded if:](#)
 - (i) The bidder is found ineligible.
 - (ii) The bidder does not upload scanned copies of all the documents stipulated in the bid document.
 - (iii) If a tenderer quotes nil rates against each item in item rate tender or does not quote any percentage above/below on the total amount of the tender or any section / sub head in percentage rate tender, the tender shall be treated as invalid and will not be considered as lowest tenderer.
30. The contractor whose bid is accepted will be required to furnish performance guarantee of [5% of tendered value](#) within the period specified in Schedule F. This guarantee shall be in the form of or Deposit at Call receipt of any scheduled bank/ Banker's cheque of any scheduled bank/ Demand Draft of any scheduled bank/ Pay order of any Scheduled Bank of any scheduled bank (in case guarantee amount is less than Rs. 1,00,000/-) or Government Securities or Fixed Deposit Receipts or Guarantee Bonds of any Scheduled Bank or the State Bank of India in accordance with the prescribed form.
31. In case the contractor fails to deposit the said performance guarantee within the period as indicated in Schedule 'F' including the extended period if any, the contractor shall be suspended for [two years and shall not be eligible to bid for IITK tenders from the date of issue of suspension order](#).
32. The contractor whose bid is accepted will also be required to furnish either copy of applicable licenses/ registrations or proof of applying for obtaining licenses, registration with EPFO, ESIC and BOCW Welfare Board including Provident Fund Code No. If applicable and also ensure the compliance of afore said provisions by the sub-contractors, if any engaged by the contractor for the said work and program chart (Time and Progress) within the period specified in Schedule 'F'.
33. Intending Bidders are advised to inspect and examine the sites and its surroundings and satisfy themselves before submitting their bids as to the form and nature of the site, the

means of access to the site, making proper arrangements to the site for smooth operation, the accommodation they may require and in general shall themselves obtain all necessary information as to risks, contingencies and other circumstances which may influence or affect their bid. Bidder shall be deemed to have full knowledge of the sites whether he inspects it or not and no extra charge consequent on any misunderstanding or otherwise shall be allowed. The bidder shall be responsible for arranging and maintaining at his own cost all materials, tools & plants, water, electricity access, facilities for workers and all other services required for executing the work unless otherwise specifically provided for in the contract documents. Submission of a bid by a bidder implies that he has read this notice and all other contract documents and has made himself aware of the scope and specifications of the work to be done and of conditions and rates at which stores, tools and plant, etc. will be issued to him by the Institute and local conditions and other factors having a bearing on the execution of the work.

34. Intending Bidders are advised to get familiarized with the specifications /rules related (i.e., [Low side Central Air Conditioning works including SITC of AHU\(s\) and FCU\(s\) at various Labs and Main Auditorium in IIT Kanpur](#)) to the work as approved by the competent authority and various policies related to c&d waste and other environmental guidelines of the institute pertaining to the. Bidder shall be deemed to have full knowledge of such rules and regulations whether he has read it or not and no extra charge consequent on any misunderstanding or otherwise shall be allowed. In case of reduction of scope of work or no work is possible to carry out on account of such issues, no cost shall be payable to them. Submission of a bid by the bidder implies that he has read this notice and all other documents and has made himself aware of the Institute Regulations and other factors having a bearing on the execution of the work.
35. The competent authority on behalf of the Board of Governors does not bind itself to accept the lowest or any other bid and reserves to itself the authority to reject any or all the bids received without assigning any reason. Bids in which any of the prescribed conditions is not fulfilled or any condition including that of conditional rebate is put forth by the bidders shall be summarily rejected.
36. Canvassing whether directly or indirectly, in connection with bids is strictly prohibited and the bids submitted by the bidders who resort to canvassing will be liable to rejection.
37. The competent authority on behalf of the Board of Governors reserves to himself the right of accepting the whole or any part of the bid and the bidders shall be bound to perform the same at the rate quoted.
38. The contractor shall not be permitted to bid for works in the [Office of Infrastructure and Planning / Institute Works Department responsible for award and execution of contracts](#), in which his near relative is posted as Divisional Accountant or as an officer in any capacity between the grades of [Superintending Engineer and Junior Engineer \(both inclusive\) in IWD and Office of Infrastructure and Planning](#). He shall also intimate the names of persons who are working with him in any capacity or are subsequently employed by him and who are near relatives to any gazetted officer in the Office of Infrastructure and Planning/ Institute Works Department. Any breach of this condition by the contractor would render him liable to be removed from the approved list of contractors of this Department.
39. No Engineer of Gazetted Rank or other Gazetted Officer employed in Engineering or Administrative duties in an Engineering Department of the Government of India is allowed to work as a contractor for a period of one year after his retirement from Government

service, without the prior permission of the Government of India in writing. This contract is liable to be canceled if either the contractor or any of his employees is found any time to be such a person who had not obtained the permission of the Government of India as aforesaid before submission of the bid or engagement in the contractor's service.

40. The bids for the work shall remain open for acceptance for a period of **Ninety (90) days** from the date of opening of bids. If any bidder withdraws his bid before the said period or issue of letter of acceptance, whichever is earlier, or makes any modifications in the terms and conditions of the bid which are not acceptable to the department, then the Institute shall, without prejudice to any other right or remedy, be at liberty to suspend the bidder for one year
41. This notice inviting Bid shall form a part of the contract document. The successful bidders/contractor, on acceptance of his bid by the Accepting Authority shall within 7 days from the stipulated date of start of the work, will sign the contract.
42. The Notice Inviting Bid, all the documents including additional conditions, specifications and drawings, if any, forming part of the bid as uploaded at the time of invitation of bid and the rates quoted online at the time of submission of bid and acceptance thereof together with any correspondence leading thereto
43. Standard C.P.W.D. Form 7 or other Standard C.P.W.D. Form as applicable.
44. The bid document will include the following components:
 - (a) CPWD-7 and CPWD-6 including **Schedule A to F** for all the components of the work, Standard General Conditions of Contract for CPWD 2023 as amended/modified up to last date of submission of the bid.
 - (b) General / specific conditions, specifications applicable to the all aspects of the work.
45. The eligible bidders shall quote percentage rates after considering all the components.
46. After acceptance of the bid by competent authority, the Dean, Infrastructure and Planning shall issue letter of award on behalf of the Board of Governors to the contractor. After the work is awarded, the contractor will have to enter into one agreement with Dean, Infrastructure and Planning. One such signed set of agreement shall be handed over to Engineer-In-Charge as applicable.
47. Entire work under the scope of bid shall be executed under one agreement.
48. The requirement of technical staff given in various specialized works is as per requirements given in clause 32 of NIT document. The actual deployment of these technical staff will be as per execution of work and direction of the **Dean of Infrastructure and Planning, IITK**.
49. **Running bill must be generated based on the work component decided for execution as directed by Engineer In Charge as per the tender clauses. The work of each component must be satisfactorily executed before a running bill is cleared by the Engineer In Charge.// Payment shall be regulated as under**
 - (a) 75% of the tendered value on receipt of materials at site.
 - (b) 15% of the tendered value on installation and connection.
 - (c) 10% of the tendered value on testing and commissioning.

50. Running bill and final bill for components shall be facilitated by Engineer-in-Charge to the contractor.
51. The work shall be treated as complete when all the components of the work are complete.
52. It will be obligatory on the part of bidder to sign the contract document for all components before the first payment is released.
53. In case of reduction in scope of work no claim on account of reduction in value of work, loss of expected profit, consequential overheads etc. shall be entertained.
54. A team of officers from Indian Institute of Technology Kanpur may visit the office/ site of work of bidders for establishing their credibility and verification of submitted documents
55. The mentioned work is urgent as requested by client/Institute and to be completed strictly in given time schedule as per special terms and conditions. The contractor has to deploy the labour and supervisory staff in shifts to meet the targeted completion date. The work may be executed in extended shifts or two shifts. The rates quoted by the contractor will be deemed to be inclusive of any extra expenditures on account of this reason. Nothing shall be paid on this account.

2.2 Instructions for Online BID Submission

This tender document has been published on the Central Public Procurement Portal (URL: <http://eprocure.gov.in/eprocure/app>). The bidders are required to submit softcopies of their bids electronically on the CPP portal, using valid Digital Signature Certificates (DSC). The instructions given below are meant to assist the bidders in registering on the CPP portal, prepare their bids in accordance with the requirements and submitting their bids online on the CPP portal.

More information useful for submitting online bids on the CPP portal may be obtained at <http://eprocure.gov.in/eprocure/app>

2.2.1 Registration

1. Bidders are required to enroll on the e-procurement module of the Central Public Procurement portal (URL:<http://eprocure.gov.in/eprocure/app>) by clicking on the link, “click here to enroll”. Enrolment on the CPP portal is free of charge
2. As part of the enrolment process, the bidders will be required to choose a unique username and assign a password for the accounts.
3. Bidders are advised to register their valid e-mail address and mobile number as part of the registration process. These would be used for any communication from the CPPP portal.
4. Upon enrolment, the bidders will be required to register their valid Digital Signature Certificate (class 2 or class 3 certificates with signing key usage) issued by any certifying authority recognized by CCA India (e.g. Sify / TCS / nCode/ eMudhra etc.) with their profile.
5. Only one valid DSC should be registered by a bidder. Please note that bidders are responsible to ensure that they do not lend their DSCs to others which may lead to misuse.
6. Bidder then logs in to the site through the secured log-in by entering their user ID Password and the password of the DSC / eToken.

2.2.2 Searching for tender documents

1. There are various search options built in the CPP portal to facilitate bidders to search active tenders by several parameters. These parameters could include tender ID, organization name, location, date, value, etc. There is also an option of advanced search for tenders, wherein the bidders may combine a number of search parameters such as organization name, form of contract, location, date, other keywords etc. to search for a tender published on the CPP portal.
2. Once the bidders have selected the tenders they are interested in, they may download the required documents / tender schedules. The tenders can be moved to the respective “My Tenders” folder. This would enable the CPP portal to intimate the bidders through SMS / e-mail in case there is any corrigendum issued to the tender document.
3. The bidder should make a note of the unique Tender ID assigned to each other; in case they want to obtain any clarification/help from the Helpdesk.

2.2.3 Preparation of bids

1. Bidder should take into account any corrigendum published on the tender document before submitting their bids.
2. Please go through the tender advertisement and the tender document carefully to understand the documents required to be submitted as part of the bids. Please note the number of covers in which the bid documents have to be submitted. Any deviations from these may lead to rejection of the bids.
3. Bidder, in advance, should get ready the bid documents to be submitted as indicated in the tender document / schedule and generally, they can be in PDF / XLS / RAR / DWF formats. Bid documents may be scanned with 100 dpi with black & white option.
4. To avoid the time and effort required in uploading the same set of standard documents which are required to be submitted as a part of every bid, a provision of uploading such standard documents (e.g., PAN card copy, annual reports, auditor’s certificates, etc.) has been provided to the bidders. Bidders can use “My Space” area available to them to upload such documents. These documents may be directly submitted from the “My Space” area while submitting a bid, and need not be uploaded again and again. This will lead to a reduction in the time required for bid submission process.

2.2.4 Submission of bids

1. Bidder should log into the site well in advance for bid submission so that he / she upload the bid in time i.e. on or before the bid submission time. Bidder will be responsible for any delay due to other issues.
2. The bidder has to digitally sign and upload the required bid documents one by one as indicated in the tender document.
3. Bidder has to select the payment option as “on-line” to pay the EMD as applicable and enter details of the instrument
4. A standard BOQ Format has been provided with the tender document to be filled by all the bidders. Bidders are requested to note that they should necessarily submit their financial bids in the format provided and no other format is acceptable. Bidders are required to

download the BOQ file, open it and complete the white colored [unprotected] cells with their respective financial quotes and other details (such as name of the bidder). No other cells should be changed. Once the details have been completed, the bidder should save it online, without changing the filename. If the BOQ file is found to be modified by the bidder, the bid will be rejected.

OR

In some cases, financial bids can be submitted in PDF format as well (in lieu of BOQ).

5. The server time (which is displayed on the bidders' dashboard) will be considered as the standard time for referencing the deadlines for submission of the bids by the bidders, opening of bids etc. The bidders should follow this time during bid submission.
6. All the documents being submitted by the bidders would be encrypted using PKI encryption techniques to ensure the secrecy of the data. The data entered cannot be viewed by unauthorized persons until the time of bid opening. The confidentiality of the bids is maintained using the secured Socket Layer 128-bit encryption technology. Data storage encryption of sensitive fields is done.
7. The uploaded tender documents become readable only after the tender opening by the authorized bid openers.
8. Upon the successful and timely submission of bids, the portal will give a successful bid submission message & a bid summary will be displayed with the bid no. and the date & time of submission of the bid with all other relevant details.
9. Add scanned PDF of all relevant documents in a single PDF file of compliance sheet.

2.2.5 Assistance to bidders

1. Any queries relating to tender document and the terms and conditions contained therein should be addressed to the tender inviting authority for a tender or the relevant contact person indicated in the tender.
2. Any queries relating to the process of online bid submission or queries relating to CPP portal in general may be directed to the 24 x 7 CPP Portal Help Desk.

2.2.6 General instruction to bidders

1. The tenders will be received online through portal <https://eprocure.gov.in/eprocure/app>. In the technical bids, the bidders are required to upload all the documents in PDF format.
2. Possession of a valid class II / III Digital Signature Certificate (DSC) in the form of smart card / e-token in the company's name is a prerequisite for registration and participating in the bid submission activities through <https://eprocure.gov.in/eprocure/app>. Digital Signature Certificates can be obtained from the authorized certifying agencies, details of which are available in the website <https://eprocure.gov.in/eprocure/app> under the link "Information about DSC".

Tenderers are advised to follow the instructions provided in the "Instructions to the tenderer" for the e-submission of the bids online through the Central Public Procurement Portal for e-procurement at <https://eprocure.gov.in/eprocure/app>.

Dean, Infrastructure and Planning
Indian Institute of Technology Kanpur

2.3 List of documents to be scanned and uploaded within the period of bid submission

The following mandatory documents to be submitted with online bid submission:

The Online bids (complete in all respect) must be uploaded online in two Envelops as explained here: -

2.3.1 Envelope - 1: Technical Bid

The following mandatory documents to be provided as **a single PDF** file in the same sequence as listed:

1. EMD Declaration [as per 5.1](#)
2. Proof of submission of Processing Fees [as per 5.2](#)
3. GST Registration Certificate or GST Undertaking [as per 5.3](#)
4. EPF & ESI Registration
5. Copy of PAN card
6. Turnover and Other Financial statement of the Agency [as per 5.5](#)
7. Affidavit for not being blacklisted/debarred/restrained [As per 5.4](#)
8. Solvency certificate [as per 5.6](#) **Or** Net Worth Certificate from certified Chartered Accountant [as per 5.7](#)
9. Performance report of works executed [as per 5.8](#)
10. Structure and Organization of the Agency [as per 5.9](#)
11. Declaration on Details of the Bidder(s) [as per 5.10](#)
12. Details of Similar Nature of Works Completed [as per 5.11](#) The works certificates submitted by the bidder clearly indicate that:
 - (a) The completion certificate cost of the executed air-conditioning works.
 - (b) Actual date of completion of the above air-conditioning work.
13. Declaration about Site Inspection [as per 5.12](#)
14. Letter of Transmittal [as per 5.13](#)

2.3.2 Envelope - 2: Financial Bid

Price bid should be submitted in BOQ format

3 Eligibility Criteria

3.1 Eligibility criteria for contractors

Contractors who fulfill the following criteria shall be eligible to apply.

Eligible Bidders

Eligible bidders should satisfy the following criteria for evaluation:

1. **Average annual financial turn over:**

Average annual financial turnover of HVAC/Air-conditioning works should be at least 30% of the estimated cost of work put to tender during the last 3 consecutive financial years by the certified Chartered Accountant.

Audited turnover statements to be furnished as proof of the same duly certified by chartered accountant along with Profit & Loss Statements.

The bidder should not have incurred loss (profit after tax should be positive) in more than two years during last five financial years ending **31st March 2023**, duly audited and certified by the Chartered Accountant.

Solvency Certificate- 30% of the estimated cost put to tender

2. **Experience (value of work done shall be within a span of one year):**

Firms/Contractors must have completed satisfactorily

i) One similar work of 80% value of the estimated cost put to tender

Or

ii) Two similar work of 60% value of the estimated cost put to tender

or

iii) Three similar work of 40% value of the estimated cost put to tender

Works completed during last 7 years ending on date **31.03.2023**.

3. **Definition of similar work:** Similar type of work means “**SITC of AHU, FCU and associated central air conditioning work etc**” done with any Central Government Department / Central Autonomous Body / Central Public Sector Undertakings /State Government and Private Institute / Establishment of repute in last 7 years (Not earlier than **01-04-2016**).

Eligible bidders must also satisfy the following conditions and ensure submission of all documents mentioned in 2.3

1. **Legal:** Unregistered Partnership Firm and Joint Venture or Consortium are not eligible.
2. **Registration:** Bidder should be registered with the Income Tax Department, Employees Provident Fund (EPF) Organization, Employees State Insurance (ESI) Corporation & GST. Bidders are not eligible in absence of these documents.
3. **Office:** Bidders have to establish its local accessible office registered with local GSTIN at IIT Kanpur to run the awarded work.

4 Bid Evaluation and Award

The following process will be followed for the Technical and Financial Bids Evaluation:

4.1 Technical Bid Evaluation

- Technical bids received complete in all respects covering the entire scope of work, will only be opened
- The technical bid evaluation is done only for bidders who satisfy the minimum criteria by submitting documentary proof supporting eligibility criteria and the bids of agencies who have not submitted these documents are liable to be rejected without notice

4.2 Financial Bid Evaluation

For financial bids, the following points shall be followed:

- After evaluation of Pre-Qualification Documents, a list of short listed agencies will be prepared.
- Thereafter the financial bids of only the qualified and technically acceptable bidders shall be opened at the notified time, date and place in the presence of the qualified bidders or their representatives, if present.
- The bid shall remain valid for **Ninety (90) days** from date of opening of eligibility bids/Technical bid.

NOTE

The employer reserves the right, without being liable for any damages or obligation to inform the bidder, to:

- Amend the scope and value of contract to the bidder.
- Reject any or all the applications without assigning any reason.

Any effort on the part of the bidder or his agent to exercise influence or to pressurize the employer would result in rejection of his bid. Canvassing of any kind is prohibited.

5 Various Forms and Formats

5.1 Declaration in lieu of submitting Earnest Money Deposit

Proforma for Declaration in lieu of submitting Earnest Money Deposit
(Scanned copy of this Declaration to be uploaded at the time of submission of bid)

Whereas, I/we (name of agency) have submitted bids for Name of work: - “Low side Central Air Conditioning works including SITC of AHU(s) and FCU(s) at various Labs and Main Auditorium in IIT Kanpur”.

I/we hereby submit following declaration in lieu of submitting Earnest Money Deposit:

1. If after the opening of tender, I/we withdraw or modify my/our bid during the period of validity of tender (including extended validity of tender) specified in the tender documents,
or
2. If, after the award of work, I/we fail to sign the contract, or to submit performance guarantee before the deadline defined in the tender documents,

I/we shall be suspended for **two year** and shall not be eligible to bid for IITK tenders from date of issue of suspension order.

.....
Signature of the Bidder(s)

5.2 Format for submission of processing fees

Format for proof of submission to be uploaded along with transaction slip
(Scanned copy of this page to be uploaded at the time of submission of bid)

I/we have submitted the processing fees as per the following details:

NIT No	:	HVAC/30/11/2023-1
Name of Agency	:	
GST number of Agency	:	
Date of transaction	:	
Total amount transferred	:	
UTR number	:	

.....
Signature of the Bidder(s)

Details of Institute Account for submitting processing fees are as follows:

Beneficiary Name: The Registrar, IIT Kanpur
Bank Name: SBI, IIT Kanpur
Account Number: 30632766814
IFSC Code: SBIN0001161

5.3 Undertaking regarding obtaining GST registration

Proforma for Undertaking regarding obtaining GST registration Certificate of The State in which work is to be taken up

(Undertaking to be furnished on a 'Non-Judicial' stamp paper worth Rs.100/)

(Scanned copy of this notarized undertaking to be uploaded at the time of submission of bid, if required)

If work is awarded to me, I/we shall obtain GST registration Certificate of the State, in which work is to be taken up within one month from the date of receipt of award letter or before release of any payment by IITK, whichever is earlier, failing which I/We shall be responsible for any delay in payments which will be due towards me/us on a/c of the work executed and/or for any action taken by IITK or GST department in this regard.

.....
(Signature of Bidder(s))

Or

.....
(An authorized Officer of the firm with stamp)

.....
(Signature of Notary with seal)

5.4 Affidavit for not being blacklisted/debarred/restrained

Proforma for AFFIDAVIT for not being blacklisted/debarred/restrained

(AFFIDAVIT to be submitted on a 'Non-Judicial' stamp paper worth Rs.100/)

(Scanned copy of this notarized affidavit to be uploaded at the time of submission of bid)

I/we undertake and confirm that our firm/partnership firm has not been blacklisted and/or debarred/restrained by ny Central Govt./ State Govt. Agency/ Autonomous body of the Central or State govt./ PSU etc. Further that, if such information comes to the notice of the Institute, then I/we shall be debarred for bidding in the Institute in future forever. Also, if such information comes to the notice of the Institute on any day before date of start of work, the competent authority shall be free to cancel the agreement and to forfeit the entire amount of Earnest Money Deposit/Performance Guarantee.

.....
(Signature of Bidder(s))

Or

.....
(An authorized Officer of the firm with stamp)

.....
(Signature of Notary with seal)

5.5 Financial Information

Proforma for providing Financial Information

(Scanned copy of the completed information sheet to be uploaded at the time of submission of bid)

Financial Analysis: Details to be furnished duly supported by figures in balance sheet/ profit & loss account for the last three financial years duly certified by the Chartered Accountant, as submitted by the applicant to the Income Tax Department (Copies to be attached).

Financial Years	2019	2020	2021	2022
Gross Annual turnover				
Profit/Loss				

.....
Signature of Chartered Accountant with Seal

.....
Signature of the bidders(s)

5.6 Banker's Certificate from a scheduled Bank

Proforma of Banker's Certificate from a Scheduled Bank

(To be printed in Bank's Letterhead)

(Scanned copy of the Certificate to be uploaded at the time of submission of bid)

This is to certify that to the best of our knowledge and information that M/s./Sh.....
having marginally noted address, a customer of our bank are/is respectable and can be treated
as good for any engagement up to a limit of Rs (Rupees). This
certificate is issued without any guarantee or responsibility on the bank or any of the officers.

.....
(Signature for the Bank)

NOTE:

1. Bankers certificates should be on letter head of the Bank, addressed to tendering authority.
2. In case of partnership firm, certificate should include names of all partners as recorded with the Bank.

5.7 Net Worth Certificate by certified Chartered Accountant

Proforma of Net Worth Certificate by certified Chartered Accountant

(To be printed in Letterhead of Chartered Accountant)

(Scanned copy of the Certificate to be uploaded at the time of submission of bid)

This is to certify that as per the audited Balance Sheet and Profit & Loss statement of the account during the financial year, the net worth of M/s./Sh.....(Name & Registered Address of individual/firm/company) as on 31.3.2023 is Rs. (Rupees.) after considering all liabilities.. It is further certified that the net worth of the company has not eroded by more than 30% in the last three years ending on 31.3.2023.

.....
(Signature of the Chartered Accountant)

.....
(Name of the Chartered Accountant)

.....
(Membership No. of ICAI)

.....
(Date & Seal)

5.8 Performance report on work executed

Proforma of Performance report on works referred to in Financial Information

(To be printed in Company's Letterhead)

(Scanned copy of the Performance Reports to be uploaded at the time of submission of bid)

1. Name of work/project & location:
2. Agreement no.:
3. Estimated cost:
4. Tendered cost:
5. Date of start:
6. Date of completion:
7. Stipulated date of completion:
8. Actual date of completion:
9. Amount of compensation levied for delayed completion, if any:
10. Amount of reduced rate items, if any:
11. Performance Report:
 - (a) Quality of work: Outstanding / Very Good / Good /Poor
 - (b) Technical Proficiency: Outstanding / Very Good / Good /Poor
 - (c) Resourcefulness: Outstanding / Very Good / Good /Poor
 - (d) General Behavior: Outstanding / Very Good / Good /Poor

Date:

Signature of Superintending Engineer or Equivalent

5.9 Structure and Organization of the Agency

Proforma of providing Structure and Organization of the Bidding Agency

(To be printed in Company's Letterhead)

(Scanned copy of the Structure and Organization Document to be uploaded at the time of submission of bid)

1. Name & address of the bidder:
2. Telephone no./Telex no./Fax no.:
3. Email address for Communication.:
4. Legal status of the bidder (attach copies of original document defining the legal status):
 - (a) An Individual:
 - (b) A proprietary firm:
 - (c) A firm in partnership:
 - (d) A limited company or Corporation:
5. Particulars of registration with various Government Bodies (attach attested photocopy)
Organization / Place of registration Registration No.
 - 1.
 - 2.
 - 3.
6. Names and titles of Directors & Officers with designation to be concerned with this work.
7. Designation of individuals authorized to act for the organization
8. Has the bidder, or any constituent partner in case of partnership firm, ever been convicted by the court of law? If so, give details.
9. Any other information considered necessary but not included above.

(Signature of of Bidder(s))

5.10 Declaration on Details of the Bidders

Proforma of Declaration on Details of the Bidders

(To be printed in Company's Letterhead)

(Scanned copy of the Performance Reports to be uploaded at the time of submission of bid)

DECLARATION

I/We,hereby declare that all the information and data furnished by our organization with regard to this tender specification are true and complete to the best of our knowledge. I/we have gone through the specification, conditions and stipulations in details and agree to comply with the requirements and intent of specification.

Particulars of the bidder as per following details:

1	Name of the firm / organization	:	
2	Type of the firm / organization: Public Ltd. / Private Ltd. / Registered firm	:	
3	Registered address	:	
4	Address of office	:	
5	Contact people	:	
6	Name & Designation	:	
7	Landline & Mobile numbers	:	
8	E-mail IDs	:	
9	PAN No.	:	
10	GST No.	:	
11	EPFO Reg. No.	:	
12	ESIC Reg. No.	:	
13	Annual Turnover for the last 3 years (Enclose copies of audited balance sheet and P&L A/c.)	:	
13.1	2021-2022	:	
13.2	2020-2021	:	
13.3	2019-2020	:	
14	EMD Declaration attached with signature	:	
15	Has the applicant ever been required to suspend any project for a period of more than six months continuously after Commencement of work?	:	If so, give the name of the project and reasons of suspension of project

16	Has the applicant ever been convicted by a court of law?	YES / NO, If yes, give details of the case
17	Details of any litigation in which the applicant is/was involved.	
18	All forms submitted as desired in the bid	Yes / No
19	Undertaking regarding no subletting of work	

We further declare that our organization has not been blacklisted /delisted or put to any holiday by any Institutional agency / Govt. Department / Public Sector Undertaking in the last three years.

Date:

Signature of Bidder(s) with seal

5.11 Details of Similar Nature of Works Completed

Proforma for submission of Details of Eligible Similar Nature of Works Completed* during the Last Seven Years ending previous day of the last date of submission of tenders (Scanned copy of the Performance Reports to be uploaded)

The bidding capacity of the contractor should be equal to, or more than the estimated cost of the work put to tender. The bidding capacity shall be worked out by the following formula: Bidding Capacity = $[A \times N \times 1.5] - B$, where

A = Maximum turnover in construction works executed in any one year during the last seven years taking into account the completed as well as works in progress. The value of completed works shall be brought to current costing level by enhancing at a simple rate of $7N$ = Number of years prescribed for completion of work for which bids has been invited. B = Value of existing commitments and ongoing works to be completed during the period of completion of work for which bids have been invited.

The contractor needs to submit the supporting documents for calculation of A & B as above. For calculation of B , information is to be supplied in the following tabular format:

Sr.No	Name of work/project and location	Owner or sponsoring organization	Cost of work in crores of rupees	Date of commencement as per contract	Stipulated date of completion	Actual date of completion	Litigation / arbitration cases pending / in progress with details*	Name and address/ telephone number of officers to whom reference maybe made	Whether the work was done on back to back basis Yes / No
1	2	3	4	5	6	7	8	9	10

* Indicate gross amount claimed and amount awarded by the Arbitrator.

Date:

Signature(s) of Bidder with seal

5.12 Declaration About Site Inspection

Declaration about Site Inspection

(By Bidder)

To

The Dean Infrastructure and Planning

Subject: Submission of Tender for the work of “[Low side Central Air Conditioning works including SITC of AHU\(s\) and FCU\(s\) at various Labs and Main Auditorium in IIT Kanpur](#)”.

Dear Sir/Madam,

It is hereby declared that as per terms and conditions of this tender document, I/ We the bidder inspected and examined the subject site and its surrounding and satisfy myself / ourselves as to the forms and nature of the site./ ourselves before submitting the bid, the accommodation which may require and all necessary information as to risks, contingencies and other circumstances which may influence or affect our bid have been obtained. I/We the bidder shall have full knowledge of the site and no extra charge consequent upon any misunderstanding or otherwise shall be claimed in later date. I /We bidder shall be responsible for arranging and maintaining at own cost all materials, tools & plants, water, electricity access, facilities for workers and all other services required for executing the work unless otherwise specifically provided for in the contract documents. Submission of a bid by me/us implies that I / We have read this notice and all other contract documents and has made myself /ourselves aware of the scope and specifications of the work to be done and local conditions and other factors having a bearing on the execution of the work.

Sincerely

(Duly authorized signatory of the Bidder)

5.13 Letter of Transmittal

To

The Dean, Infrastructure and Planning
Indian Institute of Technology Kanpur
Kanpur, UP - 208016

Name of Work: [Low side Central Air Conditioning works including SITC of AHU\(s\) and FCU\(s\) at various Labs and Main Auditorium in IIT Kanpur](#)

Dear Sir/Madam

Having examined details given in Notice and bid document for the above work, I/we hereby submit the relevant information.

1. I/We hereby certify that all the statements made and information supplied in the enclosed forms and accompanying statement are true and correct.
2. I/we have furnished all information and details necessary for eligibility and have no further pertinent information to supply.
3. I/We also authorize the Dean, Infrastructure and Planning, Indian Institute of Technology Kanpur or his representative(s) to approach individuals, employers, firms and corporation to verify our competence, work experience, and general reputation.
4. I/we submit the following certificates in support of our suitability, technical knowledge and capability for having successfully completed the following eligible completed works:

Sl. No.	Name of work	Amount	Certificate issued by
1.			
2.			
3.			
4.			

CERTIFICATE

It is certified that the information given in the enclosed eligibility bid are correct. It is also certified that I/We shall be liable to be debarred, disqualified/ cancelation of enlistment in case any information furnished by me/us found to be incorrect.

Enclosures:

Date of submission:

Signature(s) of Bidder with seal

5.14 CPWD-7

CPWD-7

PERCENTAGE RATE TENDER & CONTRACT FOR WORKS

Tender for the “Low side Central Air Conditioning works including SITC of AHU(s) and FCU(s) at various Labs and Main Auditorium in IIT Kanpur”

1. To be uploaded as per details uploaded in CPP portal at www.eprocure.gov
2. To be opened in the presence of tenderers who may be present at the time of opening in the Dean, Infrastructure and Planning, IIT Kanpur.
3. The pre-qualification/Technical bid shall be opened first on due date and time as mentioned above. The time and date of opening of financial bid of contractors qualifying the technical bid shall be communicated to them at a later date.

TENDER

((To be signed in Company's Letterhead))

I/We have read and examined the notice inviting tender, schedule, A, B, C, D, E & F Specifications applicable, Drawings & Designs, General Rules and Directions, General Conditions of Contract (For construction works) 2023, clauses of contract, Special conditions, Schedule of Rate & other documents and Rules referred to in the conditions of contract and all other contents in the tender document for the work.

I/We hereby tender for the execution of the work specified for the Board of Governors within the time specified in Schedule 'F' viz., schedule of quantities and in accordance in all respect with the specifications, designs, drawing and instructions in writing referred to in Rule-1 of General Rules and Directions and in Clause 11 of the Conditions of contract and with such materials as are provided for, by, and in respect of accordance with, such conditions so far as applicable.

We agree to keep the tender open for **Ninety (90) days** from the due date of its opening and not to make any modification in its terms and conditions.

In lieu of EMD, I/We hereby submit Earnest Money Deposit (EMD) Declaration as per **5.1**

If I/We, fail to furnish the prescribed performance guarantee within prescribed period, I/We agree that the said Board of Governors or his successors, in office shall without prejudice to any other right or remedy, be at liberty to take action as per my/our EMD declaration as per Annexure-I. Further, if I/We fail to commence work as specified, I/We agree that Board of Governors or the successors in office shall without prejudice to any other right or remedy available in law, be at liberty to forfeit the said performance guarantee absolutely. The said Performance Guarantee shall be a guarantee to execute all the works referred to in the tender documents upon the terms and conditions contained or referred to those in excess of that limit at the rates to be determined in accordance with the provision contained in Clauses 12.2 and 12.3 of the tender form.

Further, I/We agree that in case of myself / our self-becoming liable for action as per my/our EMD declaration or forfeiture of Performance Guarantee as aforesaid, I/We shall be debarred for participation in the re-tendering process of the work.

I/We undertake and confirm that eligible similar work(s) has/have not been got executed through another contractor on back-to-back basis. Further that, if such a violation comes to the notice of Department, then I/we shall be debarred for tendering in Indian Institute of Technology Kanpur in future forever. Also, if such a violation comes to the notice of Indian Institute of Technology Kanpur before date of start of work, the Dean, Infrastructure and Planning shall be free to forfeit the entire amount of Performance Guarantee.

I/We hereby declare that I/We shall treat the tender documents drawings and other records connected with the work as secret/confidential documents and shall not communicate information/derived there from to any person other than a person to whom I/We am/are authorized to communicate the same or use the information in any manner prejudicial to the safety & integrity of IIT Kanpur

Date:

Signature(s) of Contractor(s) with seal

Address:

Occupation:

6 Proforma of Schedules

PROFORMA OF SCHEDULES (Tender)

6.1 SCHEDULE 'A': Schedule of Quantities

Schedule of Quantities : BOQ uploaded separately

6.2 SCHEDULE 'B': Schedule of materials to be issued to the contractor

Schedule of materials to be issued to the contractor: NIL

6.3 SCHEDULE 'C': Tools and plants to be hired to the contractor

Tools and plants to be hired to the contractor: NIL

6.4 SCHEDULE 'D': Extra schedule for specific requirements/document for the work, if any

Extra schedule for specific requirements/document for the work, if any: NIL

6.5 SCHEDULE 'E': Reference to General Conditions of contract

Reference to General Conditions of contract	:	General Conditions of Contract 2023 for Construction Works & Maintenance work and as amended / modified up to the last date of submission of Bid.
Name of Work	:	“Low side Central Air Conditioning works including SITC of AHU(s) and FCU(s) at various Labs and Main Auditorium in IIT Kanpur”
Total Estimated cost of work	:	Rs. 34,64,296/-
Earnest Money	:	EMD declaration to be submitted
Performance Guarantee	:	5% of tendered value
Security Deposit	:	2.5% of tendered value will be deducted from each bill. Same would be released after successful completion of One year defect liability period and as mentioned in special conditions of the contract.

6.6 SCHEDULE 'F': General Rules and Directions

GENERAL RULES & DIRECTIONS:

Officer Inviting tender: Dean, Infrastructure and Planning

6.6.1 Definitions

1 Inviting Authority	:	Dean, Infrastructure and Planning
2(v) Engineer-in-Charge: For Electrical and Mechanical Items of Work	:	Engineer Authorized by Dean, Infrastructure and Planning
2(viii) Accepting Authority	:	Deputy Director
2(x) Percentage on cost of materials and Labour to cover all overheads and profits	:	15%
2(xi) Standard Schedule of Rates	:	For Electrical Work: DSR (E&M) - 2022, & MR with up-to-date correction slip
2(xii) Department	:	Infrastructure and Planning, IIT Kanpur
9(ii) General Conditions of Contract 2023, SOPs 2022, CPWD Form 7 as amended / modified up to the last date of submission of Bid.		

6.6.2 Clauses

Clause 1	
Time allowed for submission of Performance Guarantee, Programme Chart (Time and Progress) and applicable labour licenses, registration with EPFO, ESIC and BOCW welfare board or proof of applying thereof from the date of issue of the letter of acceptance	: 7 days
Maximum allowable extension with late fee @ 0.1% per day of Performance Guarantee amount beyond the Period provided in (i) above	: 7 days
Clause 1A	: Applicable. The Defect liability period shall be One year from the date of handing over of the assigned works to the user/Institute
Clause 2	
Authority for fixing compensation under Clause 2	: Dy. Director/Director, IIT Kanpur
Clause 2A	
Whether Clause 2A shall be applicable	: YES

Clause 5	:	
(i): Number of days from the date of issue of letter of acceptance for reckoning date of start	:	15 days
ii: Milestones	:	As per Table 6
Clause 6: Computerized Measurement Bill	:	<i>Applicable</i>
Clause 7A	:	Applicable
Clause 10A	:	Applicable
Clause 10B (ii)	:	Not Applicable
Clause 10B (iii)	:	Not Applicable
Clause 10C	:	<i>Not Applicable</i>
Clause 10CA	:	<i>Not Applicable</i>
Clause 10CC	:	Not applicable
Clause 11	:	CPWD specifications of all E&M items, General Specifications for Heating, Ventilation & Air-Conditioning (HVAC)-2017 with amendments and correction Slips issued up to the last date of receipt of tenders (herein called CPWD Specifications also) and as per NIT for E&M works and HVAC Works .
Clause 12: Type of work	:	Original Work
Clause 12.2 & 12.3: Deviation limit beyond which clause 12.2 & 12.3 shall apply for Building & foundation work (except items mentioned in earth work in DSR and related items)	:	-
Clause 16 Competent Authority for deciding reduced rates: For Civil items and For Electrical items of work	:	As per Table 7
Clause 17 - Defect liability period completion of contract whichever is later	:	One year and those listed in Special Conditions of Contract
Clause 18 - List of mandatory machinery, tools & plants to be deployed by the contractor at site	:	Those Listed in Special Conditions of Contract, if any
Clause 32 - Requirement of Technical Representative(s)	:	as per Table 8

If the Contractor commits default in commencing the execution of the work as aforesaid, the performance guarantee shall be forfeited.

Table 6: Major milestones of the project

Sl. No.	Description of Milestone (Physical)	Time allowed from date of start	Maximum Duration of work	Amount to be withheld in case of non-achievement of milestone (% of composite tendered amount)
1	SITC of 3000/ Higher cfm floor mounted AHU with mixing chamber and associated works at SL-208C	4 weeks	4 weeks	5
2	SITC of 06 x 02 tr FCU's (Modular) Ceiling/ Wall type & associated work at WL-235 & WL-237	4 weeks	4 weeks	5
3	SITC of Air Handling Units (AHUs) and other associated works in main auditorium, IIT Kanpur	8 weeks	8 weeks	5

The detailed program chart approved by the engineer-in-charge shall indicate how the resources will be deployed by the contractor to maintain desired progress and for the completion of the work within the specified period. If the submitted program is approved, the milestone shall be redefined accordingly by the [Dean, Infrastructure and Planning, Indian Institute of Technology Kanpur](#). The amount to be withheld in such a case, for non-achievement of milestone(s), shall remain unaltered i.e., 5% of tendered amount.

Time allowed for execution of work : Eight (8) weeks

Table 7: Authority to decide

(i)	Extension of time (EOT)	:	Dy. Director/Director, IIT Kanpur
(ii)	Rescheduling of milestones	:	Dean, Infrastructure and Planning, IIT Kanpur
(iii)	Shifting of date of start in case of delay in handing over of site	:	Dean, Infrastructure and Planning, IIT Kanpur

Table 8: Requirement of one of these technical staffs for the work, Clause 32

Sl No.	Requirement of Technical staff (of major + minor component)		Minimum experience in Year	Designation	Rate at which recovery shall be made from the contractor in the event of not fulfilling provision of Clause 32	
	Qualification	Number			Figures	Words
1	Graduate Engineer (Or Diploma Engineer)	1	5 years	Project Planning/ quality/ billing Engineer (Electrical & Mechanical Allied Works)	Rs. 21,000/-pm per month per person	Rupees Twenty One Thousand only per month per person

Note: For supervision of air-conditioning/refrigeration activities throughout the period of supply, testing and installation, technical representatives of the respective disciplines will be required to be deployed

7 Scope of work

7.1 Brief of the works

1. SITC of 3000/ Higher cfm floor mounted AHU with mixing chamber and associated works at SL-208C.
2. SITC of 06 x 02 tr FCU's (Modular) Ceiling/ Wall type & associated work at WL-235 & WL-237.
3. SITC of Air Handling Units (AHUs) and other associated works in main auditorium, IIT Kanpur.

Note: The scope of the works listed above is indicative only. The work has to be done strictly as per the specifications in the BoQ.

7.2 Materials Verification

The contractor shall inform the Engineer in charge in advance, for verifying the measurement of the concealed items like pipes, pipes laying, cable laying, conduiting, wiring etc. done by the contractor on the very day of the above said events.

7.3 Specifications for HVAC Works

7.3.1 Technical Specifications for HVAC Works

7.3.2 DUCT WORK AND OUTLETS

1. General:

The work under this part shall consist of furnishing labour materials, equipment and appliances as specified necessary and required to install all sheet metal and other allied work to make the air conditioning supply, ventilating, and exhaust system ready for operation as per drawings.

Except as otherwise specified all duct work and related items shall be in accordance with these specifications.

Duct work shall mean all ducts, casings, dampers, access doors, joints, stiffeners and hangers.

2. Duct Materials:

The ducts shall be fabricated from galvanized steel sheets class VIII conforming to ISS:277-1962 (revised) or aluminium sheets conforming to ISS:737-1955 (wherever aluminium ducts are specified).

All duct work, sheet metal thickness and fabrication unless otherwise directed, shall strictly meet requirements, as described in IS:655-1963 with amendment-I (1971 edition)

The thickness of the sheet shall be as follows :-

The gauges, joints and bracings for sheet metal duct work shall further conform to the provisions as shown on the drawings.

Size of Duct	Sheet Thickness		Type of Joints	Bracing if any
Upto 750 mm	0.63 mm	24 Ga	G.I. Flange	
751 mm to 1000 mm	0.80 mm	22 Ga	25x25x3 mm Angle iron frame with 8 mm dia nuts & bolts	25x25x3 mm at the rate of 1.2 M from joints
1001 mm to 1500 mm	0.80 mm	22 Ga	40x40x5 mm Angle iron frame with 8 mm dia nuts & bolts	40x40x5 mm at the rate of 1.2 M from joints
1501 mm to 2250 mm	1.00 mm	20 Ga.	50x50x5 mm Angle iron frame with 10 mm dia nuts & bolts at 125 mm centre.	40x40x3 mm at the rate of 1.2 M to be Braced Diagonally
2251 mm and above	1.25 mm	18 Ga.	50x50x6 mm Angle iron frame with 10 mm dia nuts & bolts at 125 mm centre.	40x40x3 mm at the rate of 1.6 M from joints

Ducts larger than 600 MM shall be cross broken, duct sections upto 1200 MM length may be used with bracing angles omitted.

Changes in section of duct work shall be affected by tapering the ducts with as long a taper as possible. All branches shall be taken off at not more than 45 DEG. Angle from the axis of the main duct unless otherwise approved by the Engineer-In-Charge.

All ducts shall be supported from the ceiling/slab by means of M.S. Rods of 9 MM (3/8")DIA with M.S. Angle at the bottom. The rods shall be anchored to R.C. Slab using metallic expansion fasteners.

3. Installations During the construction, the contractor shall temporarily close duct openings with sheet metal covers to prevent debris entering ducts and to maintain opening straight and square, as per direction of Engineer-In-Charge.
 - (a) Great care should be taken to ensure that the duct work does not extend outside and beyond height limits as noted on the drawings.
 - (b) All duct work shall be of high quality approved galvanized sheet steel guaranteed not to crack or peel on bending or fabrication of ducts. All joints shall be air tight and shall be made in the direction of air flow.

The ducts shall be re-inforced with structured members where necessary, and must be secured in place so as to avoid vibration of the duct on its support.

- (c) All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence.

Turning vanes shall be securely fastened to prevent noise or vibration.

- (d) The duct work shall be varied in shape and position to fit actual conditions at building site. All changes shall be subjected to the approval of the Engineer-In-Charge. The contractor shall verify all measurements at site and shall notify the Engineer-In-Charge of any difficulty in carrying out his work before fabrication.
- (e) Sponge rubber or approved equal gaskets of 6 MM maximum thickness shall be self adhesive installed between duct flanges as well as between all connections of sheet metal ducts to walls, floor columns, heater casings and filter casings. Sheet metal connections shall be made to walls and floors by means of wooden member anchored to the building structure with anchor bolts and with the sheet screwed to them.
- (f) Flanges bracings and supports are to be black, mild steel and are to be painted with rust proof primer on all surfaces before erection. Accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish similar to the adjacent ducting, as specified.
- (g) Joints, seams, sleeves, splitters, branches, takeoffs and supports are to be as per duct details as specified, or as decided by Engineer-In-Charge.
- (h) Joints requiring bolting or rivetting may be fixed by Hexagon nuts and bolts, stove bolts or buck bolts, rivets or closed centre top rivets or spot welding. Self tapping screws must not be used. All jointing material must have a finish such as cadmium plating or Galvanized as appropriate.
- (i) Fire retarding flexible joints are to be fitted to the suction and delivery of all fans. The material is to be normally double heavy canvass or as directed by Engineer-In-Charge. On all circular spigots the flexible materials are to be screwed or clip band with adjustable screws or toggle fitting. For rectangular ducts the material is to be flanged and bolted with a backing flat or bolted to mating flange with backing flat.
- (j) The flexible joints are to be not less than 75 MM and not more than 250 MM between faces.
- (k) The duct work should be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling contractors.
- (l) Duct passing through brick or masonry, wooden frame work shall be provided within the opening. Crossing duct shall have heavy flanges, collars on each side of wooden frame to make the duct leak proof.

4. Dampers

- (a) At the junction of each branch duct with main duct and split of main duct, volume dampers must be provided. Dampers shall be two gauges heavier than the gauge of the large duct and shall be rigid in construction.
- (b) The volume dampers shall be of an approved type, lever operated and completed with locking devices which will permit the dampers to be adjusted and locked in any positions and clearly indicating the damper position.
- (c) The dampers shall be of splitter, butterfly or louver type. The damper blade shall not be less than 1.25 MM (18) Gauge, reinforced with 25 MM angles 3 MM thick

along any unsupported side longer than 250 MM. Angles shall not interfere with the operation of dampers, nor cause any turbulence.

- (d) Automatic and manual volume opposed blade dampers shall be completed with frames and bronze bearings as per drawings. Dampers and frames shall be constructed of 1.6 MM steel sheets and blades shall not be over 225 MM wide. The dampers for fresh air inlet shall additionally be provided with fly mesh screen, on the outside, of 0.8 MM thickness with fine mesh.
- (e) Wherever require for system balancing, a volume balancing opposed blade damper with quadrant and thumb screw lock shall be provided.
- (f) After completion of the duct work, dampers are to be adjusted and set to deliver air flow as specified on the drawings.

5. Fire Dampers

- (a) Automatic fire dampers shall be provided wherever shown on the drawings. The damper shall be multi blade louvre type. The blades should remain in the air stream in open position and shall be constructed with minimum 1.8 MM thick galvanised sheets. The frame shall be of 1.6 MM thickness. Other materials shall include locking device, motorised actuator, control panel to trip AHU motor etc.
- (b) The fire dampers shall be capable of operating automatically on receiving signal from a fire alarm panel. All control wiring shall be provided between fire damper and electric panel.

6. Access panel

A hinged and gasketed access panel measuring at least 450 MM x 450 MM shall be provided on duct work before each reheat coil and at each control device that may be located inside the duct work.

7. Miscellaneous

- (a) All duct work joints are to be true right angle and with all sharp edges removed.
- (b) Sponge rubber gaskets also to be provided behind the flange of all grilles.
- (c) Each chute from the duct, leading to a grille, shall be provided with an air deflector to divert the air into the grille through the shoot.
- (d) Diverting vanes must be provided at the bends exceeding 600 MM and at branches connected into the main duct without a neck.
- (e) Proper hangers and supports should be provided to hold the duct rigidly, to keep them straight and to avoid vibrations. Additional supports are to be provided where required for rigidity or as directed by Engineer-In-Charge.
- (f) The ducts should be routed directly with a minimum of directional change.
- (g) The duct work shall be provided with additional supports/hangers, wherever required or as directed by the Engineer-In-Charge, at no extra cost.
- (h) All angle iron flanges to be welded electrically and holes to be drilled.
- (i) All the angle iron flanges to be connected to the GSS ducts by rivets at 100 MM centres.

- (j) All the flanged joints, to have a sponge rubber packing stuck to the flanges with suitable adhesive.
- (k) The G.S.S. ducts should be lapped 6 MM across the flanges.
- (l) The ducts should be supported by approved type supports at a distance not exceeding 2.0 Metres.

8. Standard Grilles

The supply and return air grilles shall be fabricated from extruded aluminium sections. The supply air grilles shall have single/double louvers. The front horizontal louvers shall be of extruded section, fixed/adjustable type. The rear vertical louvers where required shall of aluminium extruded sections and adjustable type. The return air grille shall have single horizontal extruded section fixed louvers. The grilles may or may not be with an outer frame.

The damper blades shall also be of extruded aluminium sections. The grill flange shall be fabricated out of aluminium extruded section. Grilles longer than 450 MM shall have intermediate supports for the horizontal louvers.

9. Diffusers

- (a) The ceiling type square diffusers shall be of aluminum extruded sections with flush or step down face, as specified with fixed pattern and neck.
- (b) All supply diffusers shall be provided with extruded aluminium dampers, with arrangement for adjustment from the bottom.
- (c) The slot diffusers shall be of aluminium extruded sections with diffusion plate and sliding damper.

10. Linear Diffusers/Grilles

- (a) The linear diffusers/grilles shall be fabricated from Aluminium extruded sections.
- (b) The diffusion blades shall be extruded, flush mounted type with single or double direction air flow.
- (c) The frame shall be of aluminum extruded section and shall hold the louvers tightly in fixed position.
- (d) The dampers as described under grilles shall be provided wherever specified.

11. Exhaust Grilles

The exhaust grilles shall be fabricated from aluminum extruded sections.

The exhaust grilles shall be horizontal fixed bar grilles with 150 blade inclination.

12. Sensor Terminal

Sensor mounting terminal with cap shall be provided for taking temperature, pressure or other measurement in ducts or AHUs.

The terminal shall be fabricated from gun metal stock, duly threaded with check nut, nut and washers.

13. Painting and Vision Barrier

All grilles, and diffusers shall be powder coated, before installation, in approved colour.

All ducts immediately behind the grilles/diffusers etc. are to be given two coats of black paint in matt finish.

The return air and dummy portion of all linear grilles shall be provided with a vision barrier made of 24 gauge galvanised sheets. The vision barrier shall be fixed to the false ceiling frame with self tapping screws and shall be given two coats of black paint in matt finish. Care shall be taken to ensure that the return air path is not obstructed.

14. Testing

After completion, all duct system shall be tested for air leakage.

The entire air distribution system shall be balanced to supply the air quantity as required in various areas and the final tabulation of air quantity through each outlet shall be submitted to the Engineer-In-Charge for approval.

7.3.3 PIPE WORK

1. General:

All piping work shall conform to quality standards and shall be carried out as per specifications and details given hereunder & shall follow the applicable on relevant Indian standards.

2. Pipes

All pipes upto 150 MM shall be M.S. E.R.W tube (black steel) heavy class as per I.S. 1239-79, Part-I with amendment-I of January '81.

3. Fittings

- (a) The dimensions of the fittings shall conform to I.S.1239/69 Part-II unless otherwise indicated, in the specifications.
- (b) All bends in sizes upto and including 150 MM dia. shall be readymade of heavy duty, wrought steel of appropriate class.
- (c) All bends in sizes 200 MM and larger dia. shall be fabricated from pipes of the same dia. and thickness, with a minimum of 4 sections, and having a minimum centre line radius of 1.5 diameter of pipes.
- (d) All fittings such as branches reducers etc. in all sizes shall be fabricated from pipes of the same Dia. and thickness, and its length should be at least twice the dia. of the pipe.
- (e) The branches may be Butt welded straight to the main line, without making a separate fitting, where specified on drawings or required by Engineer-In-Charge.
- (f) Blank ends are to be formed with flanged joints and 6 MM thick blank insertion of rubber gasket between flange pair for 150 mm and over, in case where, a future extension is to be made otherwise blank end discs of 6 mm thickness are to be welded on, with additional cross stiffeners from 50 mm x 50 mm M.S. Heavy angles, for sizes upto 350 MM dia. All ends larger than 400 MM dia. shall have dished ends.

4. Flanges

- (a) All flanges shall be of mild steel as per I.S. 6392/71 and shall be steel slip-on-type, welded to the pipes, flange thickness shall be as per BS10.
- (b) Flanges may be tack welded into position, but all final welding shall be done with joints dismantled. 3 mm thick gaskets shall be used with all flanged joints. The gaskets shall be fibre reinforced rubber as approved by the Engineer-In-Charge. Special adhesive compound shall be used between flanges of steam, air and gas lines.
- (c) Flanges shall be used as follows :-
- (d) Counter flanges for equipment having flanged connections.
- (e) Flanged pairs shall be used on all such equipment, which may require to be isolated or removed for service e.g. Pumps, refrigeration machines, air handling units etc.
- (f) All threaded valves shall be provided with nipples and flanged pairs on both sides to permit flange connections, for removal of valves from main lines for repair/replacement.

5. Valves

(a) Butterfly Valves

- i. The butterfly valve shall consist of cast iron body preferably in two piece construction.
- ii. The disc shall consist of disc pivot and driving stem shall be in one piece centrally located.
- iii. The valve seat shall be synthetic material suitable for water duty. It shall line the whole body.
- iv. The disc should move in slide bearings on both ends with 'o' ring to prevent leakage.
- v. The handle should have arrangement for locking in any set position.
- vi. All valves 200mm Dia. and above shall be gear operated.
- vii. The valve should be suitable for 12 Kg/cm² working pressure.

(b) Ball Valves

- i. All Valves 40 mm Dia. and below shall be of Gun Metal Ball type Valves with (FPT) female threads conforming to class 2 of IS 778 and mating flanges fitting.
- ii. All Ball valves shall be ISI Marked.

(c) Balancing Valves

- i. The balancing valves upto 80 mm Dia. shall be of gunmetal screwed type conforming to BS 5154 or equivalent specifications.
- ii. The valve shall be cast gunmetal ASTM B-62 and complete with non rising spindle. PTFE disc seal cast metal hand wheel.
- iii. The port opening shall permit precise regulation of flow rate, by accurately measuring the pressure drop across the port.
- iv. The valve shall be completed with two ports for connections to a mercury manometer, to measure the pressure drop, as well as a drain port.

- v. The spindle shall have a shielded screw to set the flow at the desired level.
 - vi. This valve shall be used wherever specified.
- (d) Duel Plate Check Valves
- i. The body of the check valve shall be made from a single piece casting in cylindrical shape.
 - ii. There shall be two plate, which shall be hinged in the centre of the circle. Both plates shall be have springs attached to them for assisting in closing action of the valve.
 - iii. There shall be properly/designed metal to metal seal between the plates and the outer body, to ensure non leaking sealing.
 - iv. The valve design shall confirm to API 594 or equivalent specifications.
- (e) Automatic/Dynamic Balancing Valve.
- (f) Automatic Dynamic Balancing Valve shall be of forged brass (upto 40mm dia.) grey iron (above 40mm dia.) construction of 1350K Pa pressure and 120 C temperature rating. The valves shall have precision calibrated, stainless steel carriage to achieve the desired/pre-fixed flow rates irrespective of the pressure fluctuations in the water lines within a range of 10-210 K. Pa. The flow rate within a tolerance of 5
- (g) Strainers
- i. The strainers shall either be pot type or 'Y' type with cast iron or fabricated steel body, tested upto pressure applicable for the valves as shown on the drawings.
 - ii. The strainers shall have a perforated bronze sheet screen with 3 mm perforation and with a permanent magnet, to catch iron fillings.
 - iii. Pot strainers shall be provided with flanged connections and 'Y' strainers shall be provided with flanged ends.
 - iv. The strainers shall be designed to facilitate easy removal of filter screen for cleaning, without disconnection of pipe line.
- (h) Other Valves All gauge cocks shall be of gunmetal plug type, complete with siphon (brass chrome plated). All drain valves shall be of gunmetal with a hose union connection on one hand.
- (i) 'V' Form Thermometers (Industrial Type) The body shall be of aluminium alloy with anodized gold colored surface. The casing shall be adjustable side ways for reading from the front. The glass capillary shall be triangular in shape with the blue mercury filled in glass. Scale of reading shall be of the range 00C to 500C/320F to 1200F. Thermometer shall be suitable for 12 mm connections with long stem, so that thermometer is removable without damaging the insulation. M.S. socket to be welded on pipes shall be provided with thermometer.
- (j) Jointing All pipe lines shall be welded type. Square cut plain ends will be welded for pipes upto and including 100 MM Dia. All pipes 125 MM Dia. or larger will be bevelled by 35 DEG. before welding.

- (k) Pipe Supports/Hangers Pipe supports shall be provided and installed for all piping wherever indicated, required or otherwise specified. Wherever necessary, additional hangers and supports shall be provided to prevent vibration or excessive deflection of piping and tubing. All vertical pipe support shall be made of 10mm M.S. Rods and the horizontal support shall be of M.S. angles of 50x50x4 mm thick. Pipe supports shall be adjustable for height and prime coated with rust preventive paint & finish coated with black paint using approved grade of paint.

The spacing of pipe supports shall not be more than that specified below :

Nominal pipe size MM	Spacing (Metres)
15	1.25
20 & 25	2.00
32,30,50 & 65	2.50
80,100 & 125	2.50
150 & Above	3.00

Extra supports shall be provided at the bends and at heavy fittings like valves to avoid undue stresses on the pipes. Pipe hangers shall be fixed on wall and ceiling by means of approved metallic dash fasteners. Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation, cause condensation. The pipe supports or Saddles shall be of PUF, factory fabricated to suit pipe sizes. Hangers shall be supported from structural steel, concrete inserts & pipe racks, as specifically approved. No hangers shall be secured to underside of light weight roof decking and light weight floor glass. Mechanical equipment shall be suspended midway between steel joints and panel points. Drilling or punching of holes in steel joint members will not be permitted. Contractor shall make shop drawing for fixing of support for approval.

(l) Miscellaneous

- i. Provide all pipe work as required to make the apparatus connected complete and ready for regular and safe operation. Unless otherwise noted, connect all apparatus and equipment in accordance with manufacturer's standard details, as approved by Engineer-In-Charge.
- ii. Provide valves and capped connections for all low points in piping system, where necessary or required for draining systems. Provide Isolating valves & Drain valves in all risers to permit repairs without interfering with the rest of the system.
- iii. During construction, temporarily close, open ends of pipes with sheet metal caps, where necessary, or required to prevent debris from entering the piping system.
- iv. Support piping independently of all equipment so that the equipment is not stressed by the piping weight or expansion.
- v. To facilitate the maintenance, repair and replacement:

- vi. Provide shut-off valves where indicated and for individual equipment, units at inlet and outlet, to permit unit removal for repairs, without interfering with the remainder of the system. Additional shut-off valves shall be provided as required to enable all systems to be fully sectionalized. By-pass and stop valves shall be provided for all automatic control valves as specified.
- vii. Arrange piping for maximum accessibility for maintenance and repair, locate valves for easy access and operation. No valves shall be installed with handles pointing down, unless unavoidable.
- viii. Cut the pipes accurately according to measurements, established at building site & work into place without springing or forging.
- ix. Where pipes are to be buried under ground, they should be coated with one coat of bituminous paint. The top of the pipes shall not be less than 75 CM. from the ground level. Where this is not practical permission of Engineer-In-Charge shall be obtained for burying the pipes at lesser depth. The pipes shall be surrounded on all sides by sand cushions of not less than 15 CM. After the pipes have been laid and top sand cushions provided, the trench shall be refilled with the excavated soil, excess soil shall be removed from the site of work by the contractor.

(m) Sleeves

- i. Where pipes pass through floors, walls, etc provide Galvanized steel pipe sleeves 50 MM larger than outside diameter of pipe. Where pipes are insulated, sleeves shall be large enough to ample clearance for insulation.
- ii. Where pipes pass through outside walls or foundations, the space between pipe and sleeve shall be filled with rock wool covered with GI sheet.
- iii. The centre of pipes shall be in the centre of sleeves, and sleeves shall be flushed with the finished surface.

(n) Arrangement and alignment of piping

- i. All piping shall be arranged and aligned in accordance with the drawings as specified. Where special conditions are encountered in the field, the arrangement and alignment of piping shall be as directed by the Engineer-In-Charge.
- ii. The piping shall be installed in a uniform manner, parallel or perpendicular to walls or ceilings, and all changes in directions shall be made with fittings. The horizontal piping shall be run at right angles and shall not run diagonally across rooms or other piping. wherever possible all piping shall be arranged to provide maximum head room.
- iii. All piping shall be installed as directly as possible between connecting points in so far as the work of other trades permits. Where interference occurs with another trade whose work is more difficult to route, this contractor shall reroute his pipes as required to avoid interference, at the discretion of the Engineer-In-Charge.
- iv. All piping shall be carefully installed to provide for proper alignment, slope and expansion.
- v. The stresses in pipe lines shall be guided and pipes shall be supported in such a manner that pipe lines shall not creep, sag or buckle.

- vi. Anchors and supports shall be provided wherever necessary to prevent any misalignment of piping.
- vii. Small tubing gauges, controls or other equipment installed on any apparatus, shall not be coiled nor excessive in length, but shall be installed neatly, carefully bent at all changes in direction, secured in place and properly fastened to equipment at intervals to prevent sagging.
- viii. The piping shall be grouped wherever practical and shall be installed uniformly in straight parallel lines in either vertical or horizontal positions.

(o) Testing

- i. In general, tests shall be applied to piping before connection of equipment and appliances. In no case shall the piping, equipment or appliances be subjected to pressures exceeding their test ratings.
- ii. The tests shall be completed and approved before any insulation is applied. Testing of segments of pipe work will be permitted, provided all open ends are first closed, by blank offs or flanges.
- iii. After tests have been completed the system shall be drained and flushed 3 to 4 times and cleaned of all dust and foreign matter. All strainers, valves and fittings shall be cleaned of all dirt, fillings and debris.
- iv. All piping shall be tested to hydraulic test pressure of at least one and half times the maximum operating pressure but not less than 10 kg/cm² for a period of not less than 12 hours. All leaks and defects in the joints revealed during the testing shall be rectified to the satisfaction of the Engineer-In-Charge, without any extra cost.
- v. All the piping systems shall be tested in the presence of the Engineer-In-Charge or their authorized representative. Advance notice of test dates shall be given and all equipments, labour, materials required for inspection, and repairs during the test shall be provided by the contractor. A test shall be repeated till the entire systems are found to be satisfactory to the above authority. The tests shall be carried out for a part of work if required by Engineer-In-Charge in order to avoid hindrance in the work of the insulation contractor.
- vi. Miscellaneous piping, tests with air at 10.5 kg/cm² for a minimum of 24 hours without drop in pressure.
- vii. The contractor shall make sure that proper noiseless circulation is achieved through all piping systems. If due to poor bond, proper circulation is not achieved, the contractor shall bear all expenses for carrying out the rectification work including finishing of floors, walls and ceiling damaged in the process of rectifications.
- viii. The contractor shall provide all labours and materials to make provision for removing water and throwing it at the proper place, during the testing or/and after the testing to avoid damages to employer or other contractors' properties. Any damages caused by the contractor to the employer or other contractors' properties, shall be borne by the contractor.

(p) Drain Piping

- i. The drain piping shall be medium class galvanized steel as per IS 1239/1979.
- ii. The fittings shall be of 'R' brand or " Unik" or equal forged with screwed connections.
- iii. The gate valves shall be of gun metal duly ISI marked on each valve.
- iv. Pipe crosses shall be provided at bends, to permit easy cleaning of drain line.
- v. The drain line shall be provided upto the nearest drain trap and pitched towards the trap.
- vi. Drain lines shall be provided at all the lowest points in the system, as well as at equipments, where leakage of water is likely to occur, or to remove condensate and water from pump glands.

(q) Painting

All pipes supports, hangers, etc., shall be given two coats of red oxide primer. All pipes, which are not to be insulated, shall then be given two coat of finish paint, of a type and colour, as approved by the Engineer-In-Charge.

7.3.4 INSULATION

1. General

The Insulation of water piping, air handling units, ducting, chillers & refrigerant piping etc., shall be carried out as per specifications given below:

2. Materials

The materials to be used for insulation shall be as follows, unless some other material is specifically mentioned elsewhere. The detailed specifications of the materials are listed under respective sub heads.

Pipe Insulation : Rigid Polyurethane Foam (PUF) Drain Pipe Insulation : Polyethylene Foam (Kinney Foam) Duct Insulation : Resin Bonded glass wool Acoustic Treatment : Resin Bonded glass wool Equipment Insulation : Expanded Polystyrene (SE) (EP). Refrigerant Pipe : Nitrile rubber insulation

3. Pipe Insulation

- (a) The insulation for chilled water and drain piping, chillers, pump etc. shall be carried out from rigid polyurethane foam having a 'K' value of 0.018 W/mK. at mean temperature of 10oC and a density of 27.2 to 39.9 kgs/cubm. The material shall be factory faced on one side with aluminium foil on the outside, reinforced with kraft paper and fused to the insulation material. The aluminium foil shall be extended by a minimum of 50 mm on one side of the pipe section along the length to seal all longitudinal joints. The aluminium foil facing shall be replaced with Kraft Paper facing wherever the pipe is to be covered with Tar felt. The thickness of the insulation for chilled water pipes shall be 30 MM. Preformed pipe sections shall be used for pipes upto and including 350 mm dia. Pipes above 350 mm dia. shall be insulated with insulation slabs cut in mitred sections.

- (b) Drain Pipe Insulation

The material for insulation of drain pipes shall be sheets of Polyethelene foam having a 'K' value of 0.027 W/mK at a mean temperature of 10 C and a minimum density of 26 Kg./cubm. The thickness of insulation shall be 2 layer of 6 mm thickness..

(c) Duct Insulation

The materials for duct insulation shall be resin bonded fibre glass, as described earlier but conforming to I.S. 8183 of 1976. The density of insulation shall not be less than 24 kg/cubm and material shall be in the form of blankets/rolls of uniform thickness. The 'K' value at 10o C. Shall not be less than 0.031 W/mK. It shall be factory faced with aluminium foil on one side reinforced with kraft paper and fused to the insulation material. The thickness of duct insulation shall be as follows : a. Duct in conditioned space - 25 mm thick b. Duct in unconditioned space - 50 mm thick

(d) Acoustic Treatment

The material for acoustic treatment of ducts, rooms, roofs etc. shall be resin bonded fibre glass, as described earlier, conforming to I.S. 8183 of 1976. The density of fibre glass shall be 32 kg/cub.m and the material shall be in the form of boards of uniform density. The 'k' value at 10oC shall not be less than 0.03 W/mK. Facing shall be provided with 0.5 mm perforated aluminium sheet held with G.I. Nuts bolts or nailed to the batten work as required. The thickness of insulation shall be as follow unless otherwise specified elsewhere: a. Duct Acoustic : 25 MM b. Room Acoustic : 50 MM

(e) Equipment Insulation

The materials for equipment insulation shall be slabs of expanded Polystyrenes (Self extinguishing grade) having a 'K' Value of 0.035 W/mK at 10 C and a density not less than 20 Kg./Cum. The complete shell of the chiller as well as its two heads, shall be factory insulated. The insulation on chilled water pumps and expansion tank shall be of expanded polystyrene having a 'K' value of 0.035 W/mK at a mean temperature of 10 C and a density not less than 20 Kg/Cubm. The thickness of the insulation will be as given below : i) Expansion tank - 50 mm ii) Chilled water pumps - 50 mm

(f) CPRX Compound

The cold compound adhesive being supplied shall be CPRX Type.

(g) Tar Felt

3.7.1 The Tar felt used for water proofing shall conform to IS: 1322 Type 3 Grade-I.

4. Installation

(a) Chilled Water Piping (PUF) The pipe shall be thoroughly cleaned with a wire brush and rendered free from all rust and grease. The pipes shall be given a coat of red oxide primer. Two coats of CPRX Compound shall be applied on the cleaned pipe surface. The preformed sections of insulation shall be fixed tightly to the surface taking care to seal all joints. All joints along the circumference of the pipe sections shall be sealed with 50 mm wide aluminium faced adhesive tape. All longitudinal joints shall be further sealed with 50 mm wide aluminium faced adhesive tape. Insulation on pipes and valves in the AHU room shall be covered with 0.5 mm aluminium sheet cladding.

(b) Drain Piping

The pipe shall be thoroughly cleaned with a wire brush and rendered free from all rust and grease. Coat the pipe with one layer of red oxide primer. Then two layer of 6mm thick insulation shall be wrapped on the pipe. Then it shall be tied with 1 mm thick G.I. wires.

(c) Ducting

Clean the surface with a wire brush and make it free from rust and oil. Apply two coats of CPRX compound on the cleaned surface. Wrap the duct with insulation blankets of the thickness mentioned in item 3.3.2 above and covered with 0.63 mm/19 mm wire mesh netting on the outside. The joints shall be sealed with aluminium tape before covering with wire netting. The Ducts in areas exposed to the weather shall be additionally covered with one layer of tar felt B.H. The tar felt shall be stuck with Hot Bitumen.

(d) Duct Acoustic Lining

The duct surface shall first be cleaned from inside. Then 25 mm square section made of 18 Ga (1.2 mm) thick G.I. sheet should be fixed on both ends of the duct piece. The insulation slabs should be fixed between these sections of ducts using adhesive compound and stick pins. The insulation shall the be covered with RP tissue, sealing all joint so that no fibre is visible. The insulation shall then be covered with 0.5 mm perforated aluminium sheets. The sheet of insulation shall be secured to the duct by means of stick pins as mentioned above.

(e) Equipment

The surface shall first be cleaned with wire brush. Then two layers of hot bitumen shall be applied. The insulation shall then be fixed in one layer and sealing them with hot bitumen. The insulation shall then be covered with 0.63 mm/ 19 mm mesh wire netting which shall be fixed to the insulation with brass 'U' nails. The final finish shall be 0.50 mm aluminium cladding.

(f) Room Acoustic

Fix 40 mm x 50 mm G.I. channels at 0.5 metre interval longitudinally then fix cross battens at 1.0 metre centre using suitable gutties, and brass screws. Fill each rectangle with 50 mm glass wool and covered with RP tissue. Tie with 24 gauge G.I. Wires at 300 mm intervals. Then cover with 22 gauge (0.80 mm) perforated Aluminium sheet having 3 mm perforations at 6 mm centres. Overlap all joints and provide beading of 25 mm by 2 mm flats. All corners joints shall be covered with 25 x 25 x 2 mm thick aluminium angles.

7.3.5 ELECTRIC CABLING

1. General:

The electric cable connections of motors and earthing of all equipments shall be carried out, as per specifications, given hereunder.

2. Cabling

- (a) The cabling of various equipment shall be carried using PVC Insulated and armoured cables.

- (b) The PVC armoured power cable for use on 415 volts system shall be 3 or 3.5 Core with aluminium conductors and be of 660/1100 volts grade, as per IS 1554 (Part I) 1964. The cross section of the cable shall be to suit the load and rating of the equipment. The cables shall be of aluminium conductor, PVC insulated, strip armoured with overall PVC sheathing.

The cables shall be laid as per IS-1255/1967, Indian standard code of practice. The cables shall be laid, as per drawings in the ducts/pipes/trays etc. along a short and convenient route between switch board and the equipment, (either in trenches, on wall or on hangers, supported from the slab). Cable routing shall be checked at the site of work to avoid interference with structure, equipment etc. Where more than one cables are running close to each other, proper spacing should be provided between them. The radius of bends of the cable should not be less than 12 times the overall dia. of cable in order to prevent undue stress and damage at the bends, the cables should be supported with wooden cleats on M.S. Supports, when laid in trenches, or wall/ceiling suspended hangers. When laid underground the cables should be covered with fine soft earth and protected with 2nd Class bricks. Suitable G.I. Pipe shall be used wherever cables are laid under the roads etc. Wooden bushes shall be provided at the ends of pipes through which cables are connected through.

3. Surface Wiring

- (a) The surface wiring shall be cased in conduits which shall be of 1100 volts grade and conform to IS 9587-1987 (revised to date) The conduits used shall be of high quality & all joints shall be made with sockets. The bends and elbows shall have inspection covers fixed with grease free screws. The joints shall be water tight. Approved metal saddles shall be used to secure the exposed conduits at a space of 1 meter or less. The connection of the conduits to switches etc., shall be secured by check nuts and ebonite bushes provided at the ends of conduits. The M.S. conduits shall be heavy duty and rigid type-ISI marked/conforming to IS specifications. The wall thickness shall not be less than 2 mm. For conduits above 32 mm dia. Metallic conduits of 19 mm dia. and below shall not be used. Conduit accessories (Boxes etc.) shall conform to IS-5133-1968 and IS-2667-64 (amended-revised to date). Conduit pipes shall be jointed, wherever necessary by means of screwed couples and screwed accessories only. In Long distance straight, run of conduits inspection type couplers at suitable intervals shall be provided. Threads on conduit pipes shall be between 13 mm to 19 mm long. The wiring shall be carried-out as per IS 732-1989 (Amended and revised to date).
- (b) Flush inspection covers shall be provided in case of Concealed, recessed conduits. The staples for the conduits shall not be spaced more than 0.60 meters apart. Before filling up the chase with concrete the conduits should be given a coat of rust proof paint.
- (c) The wires shall be drawn only after all the conduits have been properly fixed in position. Fish wires (steel wire : 16 SWG) shall be laid in conduits for drawing of wires subsequently.

4. Control Cabling/wiring

Control cables shall be 1100 volts grade, as per IS 1554, made from copper conductor of 1.5 Sq mm PVC insulated single Core, strip armoured with an overall PVC sheathing.

The cables and conduits wiring shall be carried out as per details given under 2.2 and 2.3 above.

5. Earthing

All equipment connected with electric supply shall also be provided with double earthing continuity conductors. The size of G.I. earthing conductors shall be :-

Size of phase wire sq.mm Aluminium	Size of G.I. conductor Tape/Wire (Swg)
185	25 mm x 6 mm (strip)
150	25 mm x 6 mm (strip)
120	25 mm x 6 mm (strip)
95	4 Swg
70	4 Swg
50	6 Swg
35	6 Swg
25-6	6 Swg
4	6 Swg

Note : Aluminium earthing conductors of equivalent Size may be used in lieu of GSS conductors mentioned above.

6. Miscellaneous

- (a) The final connections to the equipment shall be through Flexible connections in case of conduit wiring and also where the equipment is likely to be moved back and forth, such as on slide rails.
- (b) An isolator switch shall be provided at any motor which is separated from the main switch panel by a wall or partition or other barrier or is more than 15 metres away from the main panel.
- (c) Two separate and distinct earthing conductors shall be Connected from the equipment upto the main switch board panel.
- (d) The branch lines from the main panel to each equipment shall be separated and should not criss cross other lines.
- (e) The entire installation shall be tested as per Electricity rules and I.S.S. 732-1973 with amendments 1,2&3 prior to the commissioning of the plant and a suitable test report furnished by a competent and authorized person. The test report will be obtain by contractor himself at his own expenses.
- (f) All exposed switch board panels, conduits, hangers etc. shall be given 2 coats of suitable paint of approved colour, when all work has been completed.

7.3.6 TESTING AND COMMISSIONING

1. General

The contractor must perform all inspection and tests of the system as a whole and of components individually as required, under the supervision of the architect, in accordance with the provisions of the applicable ASHRAE standards or approved equal in addition to furnish necessary test certificates from manufacturers.

The system shall then be commissioned, tested and balanced to fulfil the intent and purpose for which it is designed.

In addition continuous Run Tests shall be carried out during peak weather condition.

2. Compressors Condensers/Chillers/Evaporators/Pumps etc.

Hydraulic test for various components and assembled equipments at 1.5 times design pressure or double the operating pressure, whichever is higher.

Pneumatic leak test after assemblies at design pressure

Static and dynamic balancing on electronic precision machine for rotating parts, links, impellor/ crank shaft assemblies etc.

Testing of oil passages in compressor at 1.5 times pump discharge pressure.

Pressure drop test for condenser, chiller and evaporator.

For compressor assembly, electronic leak, air running test, pneumatic test with dry nitrogen and leak test in water.

3. Air Handling Units

- (a) Blowers Dynamic/static balancing of impellers. Performance test as per applicable codes.
- (b) Coils Pneumatic test.
- (c) Filters Test of filter elements as per B.S. 2831 B.S. 1701 as applicable. This is to ascertain filtration efficiency by weight at inlet and outlet. Manufacturer's test certificates also to be produced for the assembled A.H.U. Final dimensional check will be done. Inspection may be done during assembly of components for quality of workmanship, painting etc.
- (d) Piping Materials check for specifications and size.
- (e) Valves Hydraulic./pneumatic test certificates.
- (f) Motors Manufacturer's test certificate as per motor data sheet.
- (g) Instruments and Controls Visual examination.
- (h) Special Note Vendor to note that above procedure is to be followed in addition to the specifications attached with the tender.

4. Associated Works at Site.

- (a) All electrical items will be subjected to inspection at any stage during manufacturing activity. Routine electrical test as per relevant codes. Inspection of manufacturer's test certificates.
- (b) Inspection of raw materials to be used for fabrication and assembly and inspection of manufacturer's certificates.

- (c) Inspection of welding including welders qualification as desired by inspection engineers. Inspection of fabricated items.
- (d) Pressure testing of pipe fittings used for the refrigerant and water and other services.
- (e) Pressure testing, leak testing of complete piping network for chilled water. (Condenser water and refrigerant/services).
- (f) Checking of electrical circuits (power & controls) and checking functioning of controls of refrigerant systems and other circuits of air conditioning plant.
- (g) Checking of calibration of controls and instrumentation
- (h) Checking of assemblies or electrical control panel, instruments panels, local panels (dimensional and functional) annunciator panels etc.
- (i) Inspection of complete electrical installation at site.
- (j) Performance testing of complete A.C. Plant as per specifications.

5. Vendor Responsibility

The above inspection procedure is given for general guidance and information of vendors. The inspection of purchaser/consultant is strictly not limited to these.

The inspection engineer of purchaser/consultant will have full right, to have detailed inspection at any stage right from placement of order to completion of project, as and when desired by inspection engineer.

Co-ordination of inspection agency of purchaser/consultant with his factory/subvendor's factory/erection site will be the sole responsibility of successful vendor, subsequent to placement of order for complete air conditioning plant, covered under these technical specifications.

6. Piping System

In general pressure tests shall be applied to piping only before connection of equipment and appliances. In no case shall piping, equipment or appliances be subjected to pressure exceeding their test ratings.

Tests shall be completed and approved before any insulation is applied.

After tests have been completed, the system shall be drained and cleaned of all dust and foreign matter. All strainers, valves and fittings shall be cleaned of all dirt, fittings, and debris.

Water Piping

All water piping shall be tested and proven tight under Hydrostatic pressure of 11 Kg/Cm (150 PSI) or 1.5 times the design pressure which ever is more unless stated otherwise in the specifications. The prescribed pressure shall be maintained for eight hours. In case leaks are detected, the pressure test will be repeated, after the repair of the leaks.

7. Duct Work

All branches and outlets shall be tested for air quantity, and the total of the air quantities shall be within plus five percent (5%) of fan capacity.

Fire dampers, volume dampers and splitter dampers shall be tested for proper operation.

8. Electrical Equipment

- (a) All electrical equipment shall be cleaned and adjusted on site before application of power.

- (b) The following tests shall be carried out:

Cables and Wires continuity tests.

Insulation resistance tests, phase to phase and phase to earth, on all circuits and equipment, using a 500 Volts meggar. The meggar reading shall be not less than one megaohm.

Earth resistance between conduit system and earth must not exceed half (1/2) CMH.

Phasing out and phase rotation tests.

Operating tests on all protective relays to prove their correct operation before energising the main equipment.

Operating tests on all starters, circuit breakers etc.

9. Plant Audit & Certification work

- (a) The work of plant audit & certification shall be done by an approved outside agency.

- (b) The whole system balancing shall be tested with microprocessor based Hi-tech instruments with an accuracy of + 0.5

- (c) The instrument shall be capable of storing data and then down loading into a PC. The agency shall provide a minimum but not limited to the following instruments.

Microprocessor based velocity calculation meter to measure DB and WB temperature, RH and dew point.

Velocalc meter to measure air volume and air velocity.

Pitot tube.

Electronic Rotary Vane Anemometer.

Accubalance Flow Measuring Hood.

- (d) The outside agency shall analyse all the data and shall be responsible for the capacity and performance audit and certification of the plant.

- (e) The successful Bidder shall be responsible to provide necessary sockets and connections for fixing of the Testing Instruments, probes etc.

10. Commissioning of the System

- (a) The system shall be commissioned by adopting the following procedure.

- (b) The installation as a whole shall be balanced and tested upon completion, and all relevant information, including the following shall be submitted to the architects.

Air volume passing through each unit, duct, grilles, aperatures.

Static pressure in each air duct.

Water flow passing through each condenser, chiller, AHU etc.

Differential pressure readings across each filter, fan and coil, and through each pump.

Electrical current readings, in amperes of full and average load running and starting, together with name plate current of each electrical motor.

Continuous recording over a specified period, of ambient wet and dry bulb temperatures under varying degrees of internal heat loads and use and occupation, in each zone of each part of the building.

(c) Daily records should be maintained of hourly readings, taken under varying degrees of internal heat load and use and occupation, of wet and dry bulb temperatures, upstream "On-Coil" of each cooling coil. Also suction temperatures and pressures for each refrigerating unit. The current and voltage drawn by each machine.

(d) Any other readings shall be taken which may subsequently be specified by the architect.

11. Air Balancing

All air handling/ ventilation equipments, duct work and outlets shall be adjusted and balanced to deliver the specified air quantities, at each inlet and outlet as indicated on the drawings.

If these air quantities cannot be delivered without exceeding the speed range of the pulley or the available horse power, the architect shall be notified, before proceeding with the balancing of air distribution system.

A proper record shall be maintained as per Test Proforma given elsewhere.

12. Water Balancing

The output of water pumps shall be checked using the balancing valves, provided on the pumps, for this purpose, to ensure the output and pressures match the specified requirement.

Then flow to Condensers/Chillers, Air handling units etc. shall be individually adjusted and balanced to match the flow rate as given in specifications/ drawings to meet the requirement.

The balancing valves, provided on the equipments, shall be used for adjustment.

13. Miscellaneous

(a) The above tests and procedures are mentioned herein, for general guidance and information only, but not by way of limitation to the provisions of conditions of contract and specification.

(b) The date of commencement of all tests listed above, shall be subject to the approval of the architect and in accordance with the requirements of this specification.

(c) The contractor shall supply the skilled staff and all necessary instruments and carry out any test of any kind on a piece of equipment, apparatus, part of system or on a complete system, if the architect requests such a test for determining specified or guaranteed data, as given in the specification or on the drawings.

(d) Any damage resulting from the tests shall be repaired and/or damaged material replaced, to the satisfaction of the architect without any extra cost.

- (e) In the event of any repair or any adjustment having to be made, other than normal running adjustment, the tests shall be void and shall be recommenced after the adjustment or repairs have been completed.
- (f) The contractor must inform the architect when such tests are to be made, giving sufficient notice, in order that the architect or his nominated representative may be present.
- (g) Complete records of all tests must be kept and 3 copies of these and location drawings must be furnished to the architect.
- (h) The contractor may be required to repeat the test as required, should the Ambient conditions at the time, do not give, in the opinion of the architect, sufficient and suitable indication of the effect and performance of the installation as a whole or of any part, as required.

7.3.7 DOUBLE SKIN AIR HANDLING UNITS

1. Scope The scope of this section comprises of supply, erection, testing and commissioning of double skin construction air handling units with thermal break profile, conforming to these specifications and in accordance with requirements of drawings and schedule of quantities.

2. Type

The air handling units shall be double skin construction, draw-thru type comprising of various sections such as filter section, coil section, fan section and monsoon reheat section, factory assembled as elaborated in drawings and schedule of quantities.

3. Capacity

The air handling capacities, maximum motor HP, static pressure shall be as shown on drawings, appendices and schedule of quantities.

4. Housing/Casing The housing/casing of the air-handling unit shall be of double skin construction. The housing shall be so constructed that it can be delivered at site in total/semi knock down conditions depending upon the locations. The casing strength of the assembled Air Handling Unit shall be designed to meet BS EN 1886, Class 2A and the casing air leakage of the assembled Air Handling Unit shall be designed to meet BS EN 1886, Class B.

The framework shall be extruded aluminium hollow sections filled with preformed insulation section. Frames shall be assembled using mechanical joints to make a sturdy and strong framework for various sections.

Double skin panels (each not exceeding 750mm wide) shall be made out of 24 gauge pre painted galvanized steel sheet on outside and 24 gauge plain galvanized sheet inside with 48 mm thick injected CFC free PU foam insulation in between. These panels shall be bolted from inside on to the frame work with soft rubber gasket in between to make the joints air tight.

Frame work for each section shall be bolted together with soft rubber gasket in between to make the joints air tight. Suitable doors with pressure die cast aluminium hinges and latches shall be provided for access to various panels for maintenance. The entire housing shall be mounted on steel channel frame work. Each component section of the Air Handling Unit shall have matching cross- sectional dimensions of the same construction showing

a neat exterior along the length of the unit and a clean interior appearance to ensure even air flow through each plant item. Drain pan shall be constructed out of 18 gauge stainless steel with necessary slope to facilitate rapid removal of condensate water. Drain pan shall be factory insulated with minimum 9mm thick closed cell elastomeric insulation as required. Necessary supports will be provided to slide the coil in the drain pan. Outlet shall be provided from the drain pan in a manner that access panel can be opened without disconnecting the drain pipe connection.

5. Motor and Drive Fan motors shall be high efficiency IE-02 suitable for operation on 415 + 10% volts, 50 cycles, 3 phase, squirrel cage, totally enclosed fan cooled with IP-55 protection and class F insulation and class B temperature rise. Motors shall be especially designed for quiet operation and motor speed shall not exceed 1440 RPM & 2800 RPM for fans below 3500 Cfm. Drive to fan shall be provided through belt-drive arrangement. Belts shall be of the oil-resistant type. Efficiency of motors shall be 85 Fan The fan shall be forward curved floor standing double inlet double width type. The wheel and housing shall be fabricated in galvanized steel construction as per manufacturer standard. The fan impeller shall be mounted on a solid shaft supported to housing with angle iron frame/spider and self lubricated sealed eccentric type ball bearings. The impeller and fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 1800 FPM. Fan housing with motor shall be mounted on a common steel base mounted inside the air handling housing on anti-vibration spring mounts or rubber mounts. The fan outlet shall be connected to casing with the help of fire retardant canvass.

6. Cooling /Heating Coils

Chilled/Hot water coils shall have 12.5 mm to 16 mm dia tubes of wall thickness not less than 24 G with aluminium fins firmly bonded to copper tubes assembled in zinc coated steel frame. Face and surface areas shall be such as to ensure rated capacity from each unit and such that air velocity across each coil shall not exceed 500 FPM. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory tested at 21Kg/Sqcm air pressure under water. Tubes shall be hydraulically/ mechanically expanded for minimum thermal contact resistance with fins. Fin spacing shall be 11 to 13 fins per inch (4 to 5 fins per cm.)

7. Filters

Each unit shall be provided with a factory assembled filter section containing cleanable type pre-filters of synthetic media having anodized aluminium channels. The media shall be supported with HDP mesh on one side and aluminium mesh on other side. Filter face velocity shall not exceed 500 FPM. Filters shall fit so as to prevent by-pass. Holding frames shall be provided for installing a number of filter cells in banks. These cells shall be held within the frames by sliding the cells between guiding channels. Filters shall be of 90Heater Section

Each Air Handling units shall be provided with heater section for monsoon reheat & winter heating as required. The section shall include all control such as heating thermostat, control wiring etc. The unit shall also incorporate necessary safety features as mentioned under strip heaters. The heater terminals shall be extended in order to check parameters without opening the AHU door/panels. The capacity of the heater strip to be provided by the manufacturer at the time of drawing approval by Engineer In Charge. Supply and install (or paint) on the exterior of the unit in a prominent position adjacent to the heater bank a notice, which shall read.

8. Fire This unit contains electric heating elements and is fire resistant. In the event of fire, disconnect the power by the main isolating switch. (Characters to be in white, 15mm high for the word "FIRE" and 5mm high for the rest on a red background)
9. Accessories Each air handling unit shall be provided with manual air vent at highest point in the cooling/heating coil and drain plug at the bottom of the coil. Besides, the following accessories may be required at air handling units, the detailed specifications are given in individual sections, and quantities separately described in the schedule of quantities.

Motorized self balancing pressure independent valves located in chilled / hot water lines connecting to the coil. This valve shall be operated by the cooling/ heating thermostat and shall control the flow of chilled/hot water. Insulated butterfly valves/balancing valves, Y-strainer, unions and condensate drain piping upto sump or floor drain in air handling unit rooms as described in section "Piping". Dial type thermometer in the thermometer wells and pressure gauge (with cocks) within gauge ports in chilled/ hot water supply and return lines as per the section "Automatic Controls and Instruments".

10. Performance Data

Air handling units shall be selected for the lowest operating noise level. Technical submittal of air handling units shall be prepared for Consultants approval prior to procurement as mentioned under clause 7 under Special Conditions. Fan performance rating and power consumption characteristics shall be submitted and verified at the time of testing and commissioning of the entire installation.

11. Testing Cooling/heating capacity of various air handling unit models shall be computed from the measurements of air flow and dry and wet bulb temperatures of air entering and leaving the coil. Air flow measurements shall be carried out using air capture hood and temperature measurements by accurately calibrated thermometers by the vendor. Computed results shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

7.3.8 FAN COIL UNITS

1. General

The fan coil units shall be complete in all respects and shall generally comply with the specifications as given hereunder.

2. Fan Coil Units

- (a) The coil units shall be of seamless copper tube not less than 0.5 mm thick walls and min. 9 MM OD tube dia. The coil shall have continuous aluminium sheet fins with die formed collars for mounting. The finned coil, fan section with motor, drain pans, air filters, filter box, fan speed regulator and other controls.

- (b) Cooling Coil

The coil shall be of seamless copper tubes not less than 9 mm O.D. 0.40 mm thick. The coil have continuous aluminium plate fins. The fins shall be spaced by collars forming integral part of the fins. The tubes shall be staggered in the direction of air flow. The coil circuit should be sized for adequate water velocity but not exceeding 1.8 M/s (6 F.P.S) the fins shall be uniformly bonded to the tubes by hydraulic expansion of the tubes.

The coils shall be tested against leaks at a hydraulic pressure of 10 kg/sq.cm. This pressure shall be maintained for a period of 2 hours. No drop should be observed indicating any leaks.

(c) Fan Section

This shall consist of (2) two light weight aluminium impellers of forward curved type, both statically and dynamically balanced, along with properly designed G.I. sheet casings of 18 gauge.

The two impellers shall be directly mounted on to a double shaft, single phase multiple winding motor capable of running at (3) three speeds.

A. G.I. Plenum of 18 gauge shall connect the fan outlets to the coil.

(d) Drain pans

The drain pan shall be of double skin construction made of 1.6 mm (16 GA.) G.I. Sheet, covering the whole of coil section and extended on one side for accommodating coil connection, valve etc and complete with a 25 mm drain connection. The drain pan shall be insulated with 25 mm expanded polystyrene and covered with second G.I. tray.

(e) Air Filter

The filter shall be cleanable type 12 mm thick, of wire mesh to be mounted, behind the pan in a filter box made of G.I. Sheet of 18 gauge.

3. Speed Control

A sturdy switch shall be provided with the unit complete with wiring, for off and with minimum (3) three speed control, of the fan.

4. Painting

The fan coil units shall be powder coated in suitable colour.

5. Automatic Controls (Wherever Required)

(a) Each unit shall have a room type thermostat and a 2 way motorised water valve. The valve shall be fixed at a convenient location. The thermostat shall be mounted along with the speed control switch on a common plate. The plate shall clearly indicate the fan positions. The controls should be as per specifications under 'controls' (price separately)

(b) The water valves on inlet line shall be of gun metal ball type with integral water strainers, having BSP(FPT) inlet and flare type mpt outlet connection. The valve on return line shall be as above, but without the water strainer.

6. Water Connections

The water lines shall be finally connected to the coil of the fan coil unit, by at least 300 mm long, type 1 seamless solid drawn copper tubing with flare fittings and connections.

7.3.9 FILTERS

1. General

The various types of Filters to be used in the Different Systems, to achieve the required degree of air purification shall conform to the following specifications.

2. Standard Filters

The standard filters shall have an efficiency of 90 % down to 10 Microns.

The frames of the filter shall be of G.I. of suitable rigidity.

The filtering media shall be 5 ply pleated synthetic media, closely packed to give the required efficiency.

3. Miscellaneous

Suitable packing shall be provided in the frames of all filters, to prevent any leakage of air through the gaps, between the filter joints. All such joints shall be properly sealed against any leakage of unfiltered air.

7.3.10 VARIABLE FREQUENCY DRIVES FOR HVAC SYSTEM

1. GENERAL REQUIREMENTS

- (a) This specification covers complete variable frequency drives (VFDs) designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD.
- (b) The frequency converter shall not be a general purpose product, but a dedicated HVAC engineered product.
- (c) The VFD and its options shall be factory mounted and tested as a single unit under full load before dispatch.
- (d) The VFD shall be tested to UL 508C. The appropriate UL label shall be applied.
- (e) The VFD shall be CE marked and conform to the European Union Electro Magnetic Compatibility directive.
- (f) The VFD shall be UL listed for a short circuit current rating of 100 kA and labeled with this rating.

2. TECHNICAL REQUIREMENTS

- (a) The VFD shall convert incoming fixed frequency three-phase AC power into an adjustable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor derating.

When properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.

- (b) The VFD shall convert incoming fixed frequency three-phase AC power into an adjustable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be

varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor derating.

When properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.

- (c) The VFD shall include an input full-wave bridge rectifier and maintain a fundamental (displacement) power factor near unity regardless of speed or load.
- (d) The VFD shall have a dual 5% impedance DC link reactor (harmonic filters) on the positive and negative rails of the DC bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating. Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable.
- (e) VFDs with saturating (non-linear) DC link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.

IEEE519, 1992 recommendations shall be used for the basis of calculation of total harmonic distortion (THD) at the point of common coupling (PCC). On request VFD manufacturer shall provide THD figures for the total connected load. The contractor shall provide details of supply transformer rating, impedance, short circuit current, short circuit impedance etc to allow this calculation to be made.

- (f) All VFDs shall contain integral EMC Filters to attenuate Radio Frequency Interference conducted to the AC power line. The VFDs shall comply with the emission and immunity requirements of IEC 61800-3 : 2004, Category C1 with 50m motor cable (unrestricted distribution). The suppliers of VFDs shall include additional EMC filters if required to meet compliance to this requirement.
- (g) The VFD's full load output current rating shall meet or exceed the normal rated currents of standard IEC induction motors. The VFD shall be able to provide full rated output current continuously, 110
- (h) The VFD shall provide full motor torque at any selected frequency from 20 Hz to base speed while providing a variable torque V/Hz output at reduced speed. This is to allow driving direct drive fans without high speed derating or low speed excessive magnetization, as would occur if a constant torque V/Hz curve was used at reduced speeds. Breakaway current of 160
- (i) A programmable automatic energy optimization selection feature shall be provided as standard in the VFD. This feature shall automatically and continuously monitor the motor's speed and load to adjust the applied voltage to maximize energy savings.
- (j) The VFD must be able to produce full torque at low speed to operate direct driven fans.
- (k) Output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD.

- (l) An Automatic Motor Adaptation algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to perform the test.
- (m) Galvanic isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog I/O and discrete digital I/O shall include additional isolation modules.
- (n) VFD shall minimize the audible motor noise through the used of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise. VFDs with fixed carrier frequency are not acceptable.
- (o) The VFD shall allow up to at least 100 meters of SWA (Single Wire Armour) cable to be used between the FC and the motor and allow the use of MICS (Mineral Insulated Copper Sheath) cable in the motor circuit for fire locations.

3. PROTECTIVE FEATURES

- (a) A minimum of Class 20 I2t electronic motor overload protection for single motor applications shall be provided. Overload protection shall automatically compensate for changes in motor speed.
- (b) Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over voltage, under voltage, VFD over temperature and motor over temperature. The VFD shall display all faults in plain language. Codes are not acceptable.
- (c) Protect VFD from input phase loss. The VFD should be able to protect itself from damage and indicate the phase loss condition. During an input phase loss condition, the VFD shall be able to be programmed to either trip off while displaying an alarm, issue a warning while running at reduced output capacity, or issue a warning while running at full commanded speed. This function is independent of which input power phase is lost.
- (d) Protect from under voltage. The VFD shall provide full rated output with an input voltage as low as 90
- (e) VFD shall include current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload. If an output phase loss is detected, the VFD will trip off and identify which of the output phases is low or lost.
- (f) If the temperature of the VFD's heat sink rises to 80 C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. It shall also be possible to program the VFD so that it reduces its output current limit value if the VFD's temperature becomes too high.
- (g) In order to ensure operation during periods of overload, it must be possible to program the VFD to automatically reduce its output current to a programmed value during periods of excessive load. This allows the VFD to continue to run the load without tripping.

- (h) The VFD shall have temperature controlled cooling fan(s) for quiet operation, minimized losses, and increased fan life. At low loads or low ambient temperatures, the fan(s) may be off even when the VFD is running.
- (i) Protect from output switching : The VFD shall be fully protected from switching a contactor / isolator at the output without causing tripping e.g.: for switching on/off the isolators of the AHU / ventilation fans / pumps near the motor with VFD in ON mode.
- (j) The VFD shall store in memory the last 10 alarms. A description of the alarm, and the date and time of the alarm shall be recorded.
- (k) When used with a pumping system, the VFD shall be able to detect no-flow situations, dry pump conditions, and operation off the end of the pump curve. It shall be programmable to take appropriate protective action when one of the above situations is detected.

4. INTERFACE FEATURES

- (a) Hand, Off and Auto keys shall be provided on the control panel to start and stop the VFD and determine the source of the speed reference. It shall be possible to either disable these keys or password protect them from undesired operation.
- (b) There shall be an "Info" key on the keypad. The Info key shall include "on-line" context sensitive assistance for programming and troubleshooting.
- (c) The VFD shall be programmable to provide a digital output signal to indicate whether the VFD is in Hand or Auto mode. This is to alert the Building Automation System whether the VFD is being controlled locally or by the Building Automation System.
- (d) Password protected keypad with alphanumeric, graphical, backlit display can be remotely mounted. Two levels of password protection shall be provided to guard against unauthorized parameter changes.
- (e) All VFDs shall have the same customer interface. The keypad and display shall be identical and interchangeable for all sizes of VFDs.
- (f) To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD's keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters. Keypad shall provide visual indication of copy status.
- (g) Display shall be programmable to communicate in multiple languages including English, Chinese, Korean, Japanese, Thai and Indonesian.
- (h) A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.
- (i) A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD. The VFD shall also have individual Fan, Pump, and Compressor menus specifically designed to facilitate start-up of these applications.
- (j) A three-feedback PID controller to control the speed of the VFD shall be standard.

- (k) This controller shall accept up to three feedback signals. It shall be programmable to compare the feedback signals to a common setpoint or to individual setpoints and to automatically select either the maximum or minimum deviating signal as the controlling signal. It shall also be possible to calculate the controlling feedback signal as the average of all feedback signals or the difference between a pair of feedback signals.
- (l) The VFD shall be able to apply individual scaling to each feedback signal.
- (m) For fan flow tracking applications, the VFD shall be able to calculate the square root of any or all individual feedback signals so that a pressure sensor can be used to measure air flow.
- (n) The VFD's PID controller shall be able to actively adjust its setpoint based on flow. This allows the VFD to compensate for a pressure feedback sensor which is located near the output of the pump rather than out in the controlled system.
- (o) The VFD shall have three additional PID controllers which can be used to control damper and valve positioners in the system and to provide setpoint reset.
- (p) Floating point control interface shall be provided to increase/decrease speed in response to contact closures.
- (q) Five simultaneous meter displays shall be available. They shall be selectable from (at a minimum), frequency, motor current, motor voltage, VFD output power, VFD output energy, VFD temperature in degrees, feedback signals in their own units, among others.
- (r) Programmable Sleep Mode shall be able to stop the VFD. When its output frequency drops below set "sleep" level for a specified time, when an external contact commands that the VFD go into Sleep Mode, or when the VFD detects a no-flow situation, the VFD may be programmed to stop. When the VFD's speed is being controlled by its PID controller, it shall be possible to program a "wake-up" feedback value that will cause the VFD to start. To avoid excessive starting and stopping of the driven equipment, it shall be possible to program a minimum run time before sleep mode can be initiated and a minimum sleep time for the VFD.
- (s) A run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of initiating an output "run request" signal to indicate to the external equipment that the VFD has received a request to run.
- (t) VFD shall be programmable to display feedback signals in appropriate units, such as inches of water column (in-wg), pressure per square inch (psi) or temperature (F). Examples can be room temperature in 0C , return air temperature in 0C , supply air temperature in 0C, CO2 concentration in ppm, pressure in bar, differential pressure in PSI etc.
- (u) VFD shall be programmable to sense the loss of load. The VFD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. To ensure against nuisance indications, this feature must be based on motor torque, not current, and must include a proof timer to keep brief periods of no load from falsely triggering this indication.

(v) Standard Control and Monitoring Inputs and Outputs

Four dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.

Two terminals shall be programmable to act as either as digital outputs or additional digital inputs.

Two programmable relay outputs, Form C 240 V AC, 2 A, shall be provided for remote indication of VFD status.

Each relay shall have an adjustable on delay / off delay time.

Two programmable analog inputs shall be provided that can be either direct-or-reverse acting.

Each shall be independently selectable to be used with either an analog voltage or current signal.

The maximum and minimum range of each shall be able to be independently scalable from 0 to 10 V dc and 0 to 20 mA.

A programmable low-pass filter for either or both of the analog inputs must be included to compensate for noise. The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting,

One programmable analog current output (0/4 to 20 mA) shall be provided for indication of VFD status. This output shall be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power. It shall be possible to scale the minimum and maximum values of this output.

It shall be possible to read the status of all analog and digital inputs of the VFD through serial bus communications.

It shall be possible to command all digital and analog output through the serial communication bus.

(w) Optional Control and Monitoring Inputs and Outputs

It shall be possible to add optional modules to the VFD in the field to expand its analog and digital inputs and outputs.

These modules shall use rigid connectors to plug into VFD's control card.

The VFD shall automatically recognize the option module after it is powered up. There shall be no need to manually configure the module.

Modules may include such items as:

Additional digital outputs, including relay outputs

Additional digital inputs

Additional analog outputs

Additional analog inputs, including Ni or Pt temperature sensor inputs

It shall be possible through serial bus communications to control the status of all optional analog and digital outputs of the VFD.

- (x) Standard programmable firefighter's override mode allows a digital input to control the VFD and override all other local or remote commands. It shall be possible to program the VFD so that it will ignore most normal VFD safety circuits including motor overload. The VFD shall display FIREMODE whenever in firefighter's override mode. Firemode shall allow selection of forward or reverse operation and the selection of a speed source or preset speed, as required to accommodate local fire codes, standards and conditions.
- (y) A real-time clock shall be an integral part of the VFD.

It shall be possible to use this to display the current date and time on the VFD's display.

Ten programmable time periods, with individually selectable ON and OFF functions shall be available. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter setpoints and output relays. It shall be possible to program unique events that occur only during normal work days, others that occur only on non-work days, and others that occur on specific days or dates. The manufacturer shall provide free PC-based software to set up the calendar for this schedule.

All VFD faults shall be time stamped to aid troubleshooting.

It shall be possible to program maintenance reminders based on date and time, VFD running hours, or VFD operating hours.

The real-time clock shall be able to time and date stamp all faults recorded in the VFD fault log.

The VFD shall be able to store load profile data to assist in analyzing the system demand and energy consumption over time.

The VFD shall include a sequential logic controller to provide advanced control interface capabilities. This shall include: Comparators for comparing VFD analog values to programmed trigger values Logic operators to combine up to three logic expressions using Boolean algebra

Delay timers

A 20-step programmable structure

- (z) The VFD shall include a Cascade Controller which allows the VFD to operate in closed loop set point (PID) control mode one motor at a controlled speed and control the operation of 3 additional constant speed motor starters.

5. SERIAL COMMUNICATIONS

The VFD shall include a standard EIA-485 communications port, Modbus & Bacnet and capabilities to be connected to the following serial communication protocols at no additional cost and without a need to install any additional hardware or software in the VFD:

Metasys N2 Modbus RTU Bacnet

VFD shall have standard USB port for direct connection of Personal Computer (PC) to the VFD. The manufacturer shall provide no-charge PC software to allow complete setup and access of the VFD and logs of VFD operation through the USB port. It shall be possible to communicate to the VFD through this USB port without interrupting VFD communications to the building management system.

The VFD shall have provisions for an optional 24 V DC back-up power interface to power the VFD's control card. This is to allow the VFD to continue to communicate to the building automation system even if power to the VFD is lost.

6. ADJUSTMENTS

- (a) The VFD shall have a manually adjustable carrier frequency that can be adjusted in 0.5 kHz increments to allow the user to select the desired operating characteristics. The VFD shall also be programmable to automatically reduce its carrier frequency to avoid tripping due to thermal loading.
- (b) Four independent setups shall be provided.
- (c) Four preset speeds per setup shall be provided for a total of 16.
- (d) Each setup shall have two programmable ramp up and ramp down times. Acceleration and deceleration ramp times shall be adjustable over the range from 1 to 3,600 seconds.

Each setup shall be programmable for a unique current limit value. If the output current from the VFD reaches this value, any further attempt to increase the current produced by the VFD will cause the VFD to reduce its output frequency to reduce the load on the VFD. If desired, it shall be possible to program a timer which will cause the VFD to trip off after a programmed time period.

If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: external interlock, under-voltage, over-voltage, current limit, over temperature, and VFD overload.

The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.

An automatic "start delay" may be selected from 0 to 120 seconds. During this delay time, the VFD shall be programmable to either apply no voltage to the motor or apply a DC braking current if desired.

Four programmable critical frequency lockout ranges to prevent the VFD from operating the load at a speed that causes vibration in the driven equipment shall be provided. Semi-automatic setting of lockout ranges shall simplify the set-up.

7. OPTIONAL FEATURES

All optional features shall be built and mounted by VFD manufacturer as an inbuilt factory solution. All optional features shall be UL listed by the VFD manufacturer as a complete assembly and carry a UL label.

8. SERVICE CONDITIONS

- (a) Ambient temperature at full speed, full load operation with continuous drive rated output current:
- (b) -10 to 45 deg C for ratings upto 90 kW without derating

- (c) -10 to 40 deg C for ratings 110 kW and higher without derating
- (d) Relative Humidity : 0 to 95%, non-condensing.
- (e) Elevation : Up to 3,300 feet without derating.
- (f) AC line voltage variation : + 10% of nominal with full output.
- (g) VFD Enclosure protection : IP 55, integral, with no additional cabinets.
- (h) Side Clearances : No side clearance shall be required for cooling.
- (i) All power and control wiring shall be done from the bottom.
- (j) All VFDs shall be plenum rated.

9. QUALITY ASSURANCE

To ensure quality, the complete VFD shall be tested by the manufacturer. The VFD shall drive a motor connected to a dynamometer at full load and speed and shall be cycled during the automated test procedure.

All optional features shall be functionally tested at the factory for proper operation.

10. RESISTANCE TEMPERATURE DEVICE(RTD)

The device should be mineral Insulated. Available in all sheath diameters. Mineral Insulation enables flexibility and durability .Class 'A' Tolerance as per IEC-751. It should come with enclosures in all Categories

RTD should be simplex type having element of pt 10 with a temperature range of 0 to 60 C. Also it should have 2 wire configuration with a sheath diameter of 10 mm.

Following process connection should be used :

- 03B 1/8" BSP (M)
- 03N 1/8" NPT (M)
- 06B 1/4" BSP (M)
- 06N 1/4" NPT (M)
- 06BT 1/4" BSPT (M)
- 10B 3/8" BSP (M)
- 10BT 3/8" BSPT (M)
- 10N 3/8" NPT (M)
- 15N 1/2" NPT (M)
- 15B 1/2" BSP (M)
- 15BT 1/2" BSPT (M)
- M12 M 12 X 1 (M)
- M16 M 16 X 1.5 (M)
- M20 M 20 X 1.5 (M)

The head extension should be adjustable type with single wire entry.

7.4 Preferable Makes for HVAC Installation Works (as applicable)

The makes of various components (as applicable) are listed as follows:

S. No.	Items	Makes
1	PVC/ XLPE insulated aluminium/Copper conductor armoured	Havells / Finolex / KEI / Grandlay/ Polycab
2	FRLS PVC insulated copper conductor stranded flexible wires i/c control cables (ISI Marked)	Havells / Finolex / KEI / Grandlay/ Polycab
3	Cable Raceway Floor / wall mounted and accessories	Legrand / MK (Honeywell) / OBO
4	Cable Tray & Accessories	Venus/ MEM /BEC/ RM CON/ Indeana
5	Modular Switch , Socket & Accessories	Legrand (Myrius) / M.K.(Element) / Schneider (Zencelo)/Legrand (Arteor)
6	Metal clad Industrial Socket outlet and Sheet Steel Enclosure for MCCB/MCB	Legrand / Siemens / Schneider/ Hager
7	Cable Glands	Dowells/ Commet / Gripwell/ Raychem
8	Lugs and end termination	Dowells/Commet/Braco
9	Change over switch	L&T / Socomac / ABB / Schneider
10	Distribution boards	Siemens (Betagard), / Hager/ Schneider (Acti9) / Legrand (<i>Ekinor3</i> ³)/ L&T(Exora) /ABB(Elegence)
11	Protection Device (MCB/RCCB/RCBO/ELCB)	Siemens (5SL), / Hager/ Schneider (Acti9) / Legrand (DX 3)/ ABB(S200M)/L&T
12	Indicating Lamps LED type, Push Button	Siemens/ L&T / Schneider / Legrand
13	Electronic Digital Meters	Schenider (Conzerv)/ L&T/Secure/Siemens/ ABB/Legrand
14	MCCBs	Siemens (3VL) / L&T (D sine)/ Schneider (CVS) / Legrand (DPX 3)/ ABB (T max)
15	Power contactor	L&T (MNX) / Schneider (TesyS) / Legrand (<i>CTX</i> ³)/ABB(Ax)

16	Surge Protection Devices	Siemens/L&T / Schneider / Legrand/ OBO
17	Selector Switch	Salzer/Seimens/BCH/Kaycee/L&T
18	Auxiliary Relays	Siemens/ L&T / Schneider / Legrand / ABB
19	LED Lighting fixture	Philips/ Wipro/ Havells/ Crompton
20	Emergency Lighting / Exit Sign boards	Bajaj/ Prolite/ Glo-LIne
21	Ceiling Fan, Fresh Air Fan, Exhaust fan	Havells/ Crompton/ Usha/ Orient/Atomberg
22	Paint	Nerolac / Asian / Berger/ICI
23	Lightning Protection System	OBO/ Cape Electric/ Infinite/ APS/Jeff Techno/Axis
24	G.I. Pipe	Tata, Jindal-Hissar, Prakash Surya
25	Rubber Mat (ISI Marked)	Jyoti / Deep Jyoti/ Premier
26	CU/GI strip & GI wire for earthing	Jeff Techno/Axis/OBO
27	PVC Conduit and accessories	Polycab/AKG/Asian
28	1.1 KV aluminium armoured XLPE insulated and PVC sheathed Cable (LT cable)	Havells/KEI /Finolex/ Grandlay
29	Modular Switch & Socket	Legrand (Myrus)/M.K. (Element)/Schneider (Zencelo India)/Havells/ ABB
30	Panel Accessories	Siemens /L&T/Schneider / Legrand/Tecnic / ABB/ C&S/Neptune
31	LED/Metal Halide/Fluorescent Internal Lighting Fixture	Philips/ Wipro/Havells/Crompton
32	Advance Lighting Protection System (Early Streamer Emission Type)	LPI (Australia)-by allied power/SGI (Duval Messien/satellite (France)- by SGI/Bradlay (USA)- by JMV/Erico (USA)-by security shoppe/ABB
33	Air Circuit Breaker	Siemens / Schneider /L&T /Legrand/ C&S/ABB
34	Surge Voltage Protection	Siemens /Schneider/L&T/Legrand/ABB
35	Earth fault module	Siemens/Schneider/L&T/Legrand
36	Protection relays	Siemens/Areva/L&T/Legrand

37	Digital Meters	Siemens (PAC)/ Schneider/ (conzerv) / Secure Enersol / L&T/ Neptune
38	Power capacitors	Epcos/ Neptune / Legrand /ABB/ L&T
39	Automatic Power factor cor- rection relay/controller	Epcos/Siemens (PAC) /Schneider (Conzerv)/L&T/Neptune
40	Sealed Maintenance Free Bat- teries	Exide/Panasonic/Hitachi/Shinkobe
41	Cable Trays (Factory Fabric- ated/Overhead & Floor Race- ways	Legrand/MEM/OBO/ Milestone/ Neptune
42	HDPE underground cable duct	Rex Polyextru- sion/Tirpura/Plasomatics/Duraline
43	Insulation Mats	DL Miller & Co. Ltd.?Premier Polyfilm Ltd./RMG Polyvinyl India Ltd/Jyoti
44	Response indicators	PRD/System-Tek/ Simplex/ System Sensor/Agni
45	Speaker / Hooter	System-Tek/ Philips /Agni
46	Occupancy Sensors/ Move- ment Sensor	Legrand/ Philips/ Wipro
47	Flush type switch /socket	Anchor/ Kinjal/ SSK/ Havells Reo
48	Fuse switches unit / switch fuse unit /HRC fuse	L&T / Siemens/ Havells/ C&S
49	Exhaust fan	Almonard/ Alstom/ Crompton/ Havells
50	XLPE insulated HT cables	KEI/Havells
51	GI raceways	Milestone Engineering /Le- grand/MDS/Neptune Systems Pvt. Ltd./MK
52	Electronic ballast	Philips /Wipro/Bajaj/Decon/Crompton/Havells
53	DLP plastic trunking	Legrand/MK
54	Geysers	Recold /Venus /Usha Lexus /Sphere hot
55	Tower Light	Ligman/Simes/Bega
56	Programmable Logic Control- ler(PLC)	Siemens/Allen-Bradley/Schneider

57	Earthing (Chemical Earthing) Plate Earthing	JMV/As per CPWD Norms
58	Octagonal Pole	Bajaj / Crompton / Phillips
59	Lightning Arrestor	ABB/Alltec/JMV
60	Temp. Gauge	Guru
61	Gate Valve	Leader/Sant
62	Electrical Backup	Spare hot/ Racold
63	Thermostat	ISI Marked
64	Flat Collector Plate	Solocrome/ Tata BP/ Racold
65	S.S Sheet	Jindal / National
66	HT/LT cable joints (Straight through/outdoor/indoor)	3M/ Denson/ M Seal/Raychem/ Cabseal
67	Alternator	STAMFORD/Crompton Greaves
68	Lamp Holder (Brass)	Kay/SSk/Kinjal
69	Air handling unit/Treated Fresh Air Unit	System Air/Flaktwood/ Zeco/Edgetech
70	Blower	Nicotra/Comferi/ Kruger
71	Cooling coil	Zeco/Edgetech/ AHRI Certified
72	Hepa Filter	Thermadyne /Anfilco/ Dyna Air Filtration
73	Fan Coil Units	Cruise/Zeco/Edgetech/Kubic Midea/Trane
74	Duct (factory fabricated)	Rola Star / Techno Fabri-duct/Zeco/Ductofab
75	Water strainers (Y-strainer/pot strainer)	Emerald/Sant/D.S. Engineering / Maharaja Casting
76	Proportional thermostat	Siemens /Honeywell/Johnson
77	3 Way Motorized/ Mixing / Diverting valves	Siemens /Honeywell/Johnson/Anergy/ Rapid Control/Danfoss
78	Pressure gauges for water line/Refrigerant	Emerald / Fiebeg/ H. Guru
79	Thermometers	Emerald/ Japsin
80	V-Belts	Fenner India/ Dunlop
81	Fibre glass wool	UP Twiga /Owens Corning
82	Nitrile Rubber insulatio (Open/close cell) with specific-ation as per BOQ.	Armacell/ K-flex/ A-flex/ Supreme

83	Fire retardant flexible duct connection	Air flow / Twiga/ATCO/GP spira/caryaire
84	Gasket for ducts	Prima Kool / Nuprine
85	Anchor Fasteners	Hilti / Fischer
86	Extruded Aluminum grilles & diffusers Fresh air louvers/Dampers	Caryaire/ Ravi Star/ Air Flow/Air master/Titus/System air
87	Fire damper	Ravi Star/Air Flow/ Mapro/System air/Ruskin Titus/Greenheck
88	Duct attenuator	AirFlow/Ravi Star/ Continental/Mahajan
89	Vibration isolators	Resistolex /Gerb / Base/ Dunlop
90	Motors	Siemens/Crompton/ABB/Bharat Bijlee
91	Fuse switch unit/switch fuse unit/HRC fuse	Larsen Toubro / Siemens / Schneider (MG)/Havells
92	Humidistat	Honeywell/Danfoss/Penn
93	Condenser/ Chiller	Trane/Carrier/York/Daikin
94	Polyurethane Foam (PUF)	Malanpur/ Lloyd /Best Opuf
95	Thermocole	Pioneer/Styrin
96	Chemical Reagent	Antiscalant/ Descalant / Antifungal Hibird / amacid/ Maic
97	VFD with sensors	ABB/DANFOSS/ Siemens
98	Cooling Tower	Paharpur/Mihir/ Flow air-tech Pvt.Ltd
99	Cooling Tower PVC Fills	Paharpur/Mihir
100	Window/Split conditioner/Hi-wall AC	Air-split Voltas/Hitachi / Carrier/Panasonic/Blue Toshiba/Daikin Car-star/
101	Dosing pump	M/s Ion Exchange (I) Ltd/ Milton Royal
102	Tower AC units	Voltas/Hitachi / Carrier/Panasonic/Blue Toshiba/Daikin Car-star/
103	Inverter VRF system	Voltas/Hitachi/ Carrier/Panasonic/Blue Toshiba/Daikin/ Mitsubishi Electric Car-star/
104	Hi wall type chilled water FCU	Cruise/Zeco/Edgetech/Kubic Midea/Trane
105	Wet scrubber	Zeco/Edgetech/ZAIR

106	Air washer (Evaporative cooling unit)	Carryaire/Zeco/Zair/Edgetech/Airflow
107	Pre-Insulated Pipe	Zeco/Sevenstar-aircon/AGS Engineering
108	VAV Boxes	Ruskin Titus/Honeywell/Trox/Trane/Johnson Controls/Tristar
109	Self-Cooled PAC server Rack	Schneider/Emersion/ Flakt
110	Victaulic coupling	Sevcon/Victaulic/Smith Copper
111	Dehumidifier	Bry-Air/Munters/Bri
112	PICV valve	Advance/Siemens/Denfoss/Honeywell
113	Axial Fans	Krugar/Nicotra/Comefri/Green Deck/Airflow
114	Spiral Flat Oval Duct (with GSS sheets of approved make)	Dustech/GP spira/Spiral Tubes/Western air ducts/ Ductofab /Seven star
115	Silicone flexible duct connector	Easyflex/Airflow//Resistoflex/Dustech
116	Motorized butterfly valve/Modulating Valve/Solenoid valve	Advance/Danfoss/Belimo/Johnson Control/Zoloto/Tyco/Victaulic/Honeywell
117	Expansion Bellow	Easyflex/Resistoflex/Cori
118	Fire rated vane Axial/Fire rated tube Axial/Vane Axial/Tube Axial Fan	Nicotra/Comferi/Kruger/Greenheck/Airflow/system air/Zair
119	Inline Fan	Nicotra/ Kruger/Greenheck/Airflow/system air
120	Propeller fan	Nicotra/ Kruger/Caryaire/Crompton/GE
121	Butterfly valve	Audco / Advance / Deepak/ C&R/Honeywell/ Audco / Advance / Kirlosker
122	Check Valve (Non return valve)	Audco/SKS/Advance/ Zoloto/ Honeywell
123	Balancing valve	Advance /Audco/ Honeywell/Danfoss
124	Centrifugal pump / Monobloc Pump	Grundfoss/Armstrong/Willo/Xylem
125	Water Softening Plant	Ion Exchange Ltd. / Milton Royal

126	Pressure switch	Indfoss / Honewell Indfoss / Honeywell
127	Bronze ball valve	Emerald/ Zolto / Leader/ Sant
128	Bronze ball valve with Y strainer	Emerald / Rapid control/ BAP
129	Suction guide	Anergy instrument Pvt.Ltd./Johnson
130	Water cooled screw chilling unit	Trane/Carrier/York/Daikin
131	Chemical reagent	Eco friendly bio clean pond clarifier/ Volga
132	Sand filter	M/s Ion Exchange (I) Ltd / Pentair.
133	Compressor	Emerson/Tecumsheh/Bohn/Danfoss
134	Cold room/Deep freezer	Danfoss/Blue Star/Bohn
135	Air-cooled ductable split/ceiling mounted Cassette type air-conditioning unit	Voltas/Hitachi / Carrier/Panasonic/Blue star/ Toshiba/Daikin
136	PVC water tank	Syntex/ Polycon
137	Water Cooler	Blue Star/Usha/Sidwal/Voltas
138	Control cables	CCI/ Fort Gloster/ Universal/ Incab/ Havells/KEI
139	Modular type Variable Refrigerant Flow/ Variable Refrigerant Volume air cooled Outdoor units with specification as per BOQ.	Voltas/Hitachi/carrier/Panasonic/Blue star/Daikin/Mitsubishi Electric
140	High static pressure VRF/VRV ceiling mounted ductable type Indoor Unit with specification as per BOQ.	Voltas/Hitachi/carrier/Panasonic/Blue star/Daikin/Mitsubishi Electric
141	Copper refrigerant piping with specification as per BOQ.	Mandev/Rajco/ Maxflow
142	uPVC plumbing drain pipe with specification as per BOQ.	Supreme /Finolex
143	Fabricated GSS Sheet with specification as per BOQ.	Jindal/Tata/SAIL
144	80Amp, 4P, 300 Ma Weather proof RCB with specification as per BOQ.	L&T, Schneider, ABB

145	XLPE Class-O tubular insulation with specification as per BOQ.	Supreme / K-Flex/ A-Flex
146	PAC Unit with specification as per BOQ	Schneider (Uniflair)/StulzChspl (India) Pvt.Ltd /Emerson Climate Technologies/ Bluebox
147	Electrical Panel with specification as per BOQ.	Siemens /L&T/Schneider / Legend/Tecnic / ABB/ C&S/Neptune
148	Portable type dehumidifier with Specification as per BOQ.	White Westinghouse/Power Pye Electronics/Bryair/Munter
149	GI volume control duct damper with specification as per BOQ.	Airmaste Equipment Emirates/Omega/Airflow
150	Soft duct (Fabric Duct)	Duct Sox/Prihoda
151	Smoke cum fire damper (Bare Damper)	Dynacraft/Mapro/Servex/Ruskin
152	Smoke cum fire damper (Actuator)	Belimo/Joventa/Hneywell/Siemens

Any other item not covered in the above list shall be ISI marked and as approved by Engineer In Charge.

8 Special Conditions of Contract

8.1 Timely Completion

1. The work included in this tender is of urgent nature.
2. The work of all components must be started simultaneously and has to be delivered together or early within the given time schedule.
3. The contractor has to deploy the labor and supervisory staff in shifts to meet the targeted completion date. The work may be executed in extended shifts or two shifts.
4. Number of days from the date of issue of letter of acceptance for reckoning date of start shall be as per Schedule. *If the Contractor commits default in commencing the execution of the work as aforesaid, the performance guarantee shall be forfeited.*
5. The detailed program chart approved by the engineer-in-charge shall indicate how the resources will be deployed by the contractor to maintain desired progress and for the completion of the work within the specified period. If the submitted program is approved, the milestone shall be redefined accordingly by the Dean of Infrastructure and Planning, IITK. The amount to be withheld in such a case, for non-achievement of milestone(s), shall remain unaltered. Any delay in achieving the milestone must be compensated within the limitations of time imposed in the Contract document
6. The contractor shall procure the required materials in advance so that there is sufficient time for testing of the materials and approval of the same before use in the work, as

required.

8.2 Rates

1. Unless otherwise provided in the schedule of quantities of the work the rates tendered by the contractor shall be all inclusive and shall apply to all heights, lifts, leads and depths of the building (Exclusive of GST) and nothing extra shall be payable to him on this account.
2. The rates for all items of work shall, unless clearly specified otherwise, include cost of all labours, materials and other inputs involved in the execution of the item irrespective of whether they have been specifically mentioned in the tender document or not.
3. In case the same item (s) appear more than once in the schedule of work / BOQ under the same sub head or among the different subhead of works, the lowest rate quoted for that item (s) shall be considered for the particular item(s) wherever appeared in any part of BOQ / Schedule of works for the purpose of tender evaluation although web generated e-price bid may incorporate different quoted rate for same item(s) as per the quoting pattern of the tenderer. The tendered amount thus worked out shall be final & shall be binding on the contractor.
4. The rates quoted by the contractor will be deemed to be inclusive of any extra expenditure of this reason. The contractor has to increase the manpower or other tools etc. to do the work as per requirement of the work at his own expenses. Nothing shall be paid on this account.
5. The contractor shall provide at his own cost suitable weighing, surveying and leveling and measuring arrangements as may be necessary at site for checking. All such equipments shall be got calibrated in advance from laboratory, approved by the Engineer-in-Charge. Nothing extra shall be payable on this account.
6. Other agencies may also simultaneously execute and install the works and the contractor shall afford necessary facilities for the same. The contractor shall leave such recesses, holes, openings, trenches etc. as may be required for such related works (for which inserts, sleeves, brackets, conduits, base plates, clamps etc. shall be available as specified elsewhere in the contract) and the contractor shall fix the same at the time of casting of concrete, stone work and brick work, if required, and nothing extra shall be payable on this account.
7. All material shall only be brought at site as per program finalized with the Engineer-in-Charge. Any pre-delivery of the material not required for immediate consumption shall not be accepted and thus not paid for.
8. Water tanks, taps, sanitary, water supply and drainage pipes, fittings and accessories should conform to approved manufacturers specifications where CPWD Specifications are not applicable. The contractor should get the materials (fixtures/fittings) tested from approved labs wherever required at his own cost.
9. The contractor shall be responsible for the watch and ward / guard of the buildings, safety of all fittings and fixtures including sanitary and water supply fittings and fixtures provided by him against pilferage and breakage during the period of installations and thereafter till the building is physically handed over to the client department. No extra payment shall be made on this account.
10. The rates quoted by the Contractor are deemed to be inclusive of site clearance, setting out work, profile, establishment of reference bench mark(s), taking spot levels, construction of

all safety and protection devices, barriers, preparatory works, working during monsoon, working at all depths, height, lead, lift and location etc until / unless specified otherwise and any other incidental works required to complete this work. Nothing extra shall be payable on this account.

8.3 Quality and Workmanship

1. The contractor shall be entirely responsible and answerable for all the works done by him regarding quality, adherence to the laid down specifications, terms and conditions, warranty/guarantee etc. and he shall be liable to bear any compensation that may be levied by the department under any of the clauses of the agreement.
2. The materials having ISI mark shall have precedence over the one conforming to IS Specifications.
3. The proposed is for Institute premises and quality of work is paramount importance. Contractor shall have to engage well experienced skilled labour and deploy modern T & P and other equipment to execute the work.
4. Samples of all materials and fittings to be used in the work in respect of brand manufacturer and quality shall be approved from the Engineer-in-Charge, well in advance of actual execution and shall be preserved till the completion of the work.
5. All materials used in the work shall be new and of good quality, conforming to the relevant specifications as per good engineering practice. All the materials proposed to be used in the work should be approved from Engineer in Charge before use in work.
6. Articles bearing BIS certifications mark shall only be used unless no manufacturer has got BIS/ISI mark for the particular material. Any material/fitting whose sample has not been approved in advance and any other unapproved material brought by the contractor shall be immediately removed as soon as directed. Where the make of any particular material is not specified in the Contract document, the material shall be supplied as per makes desired by the engineer-in-charge.
7. It will be the responsibility of the contractor / bidder to ensure use of genuine materials in the work. The department reserves the right to get (any / all materials / components) inspected by the manufacturer or their authorized representatives at any stage of the execution of work. If any of the materials, supplied and used in work is found spurious at any stage, then the department reserves the right to ask the contractor to replace it by genuine one and make suitable recovery till it is done, even if any payment against that material is already made.
8. The contractor should get the make/TDS documents approved before procuring any material at site. The TDS/Make once approved shall not be changed without any valid recorded reasons. No material to be brought and used at site without the prior knowledge & approval of Engineer-in-Charge.
9. The department may ask for any valid document like manufacturer's test certificate, document for purchase of the material, document for import/shipment of imported materials etc. as deemed fit by the engineer-in-charge to ascertain genuineness of material supplied by/used in the work by the contractor. The contractor shall remain bound to submit all such documents to the department failing which payment may not be made or if already paid may be recovered/ withheld from subsequent running account payment.

10. All equipment and their components, and all the materials to be used in the work shall be suitable for the environmental conditions at the location of the work.
11. The contractor shall ensure quality control measures on different aspects of construction including materials, workmanship and correct construction methodologies to be adopted. He shall have to submit quality assurance programme within two weeks of the award of work. The quality assurance programme should include method statement for various items of work to be executed along with check lists to enforce quality control.
12. The contractor shall get the source of all other materials, not specified elsewhere in the document, approved from the Engineer-in-Charge. The contractor shall stick to the approved source unless it is absolutely unavoidable. Any change shall be done with the prior approval of the Engineer-in-Charge for which tests etc. shall be done by the contractor at his own cost. Similarly, the contractor shall submit brand/ make of various materials not specified in the agreement, to be used for the approval of the Engineer-in-Charge along with samples and once approved, he shall stick to it.
13. **Other Laboratories:** The contractor shall arrange carrying out of all tests required under the agreement through the laboratory as approved by the Engineer-in-Charge and shall bear all charges in connection therewith including fee for testing. The said cost of tests shall be borne by the contractor/department in the manner indicated below.
 - (a) By the contractor, if the results show that the test does not conform to relevant CPWD Specifications / BIS code or specification mentioned elsewhere in the documents.
 - (b) By the department, if the results conform to relevant CPWD Specifications / BIS code or specification mentioned elsewhere in the documents.

If the tests, which were to be conducted in the site laboratory, are conducted in other laboratories for whatever the reasons, the cost of such tests shall be borne by the contractor.
14. Sample of building materials fittings and other articles required for execution of work shall be got approved from the Engineer-in-Charge. Articles manufactured by companies of repute and approved by the Engineer-in-Charge shall only be used. Articles bearing BIS certification mark shall be used in case the above are not available, the quality of samples brought by the contractor shall be judged by standards laid down in the relevant BIS specifications. All materials and articles brought by the contractor to the site for use shall conform to the samples approved by the Engineer-in-Charge which shall be preserved till the completion of the work.
15. The contractor shall ensure quality construction in a planned and time bound manner. Any sub-standard material/work beyond set out tolerance limit shall be summarily rejected by the Engineer-in-Charge.
16. BIS marked materials except otherwise specified shall be subjected to quality test at the discretion of the Engineer-in-Charge besides testing of other materials as per the specifications described for the item/materials. Wherever BIS marked materials are brought to the site of work, the contractor shall if required, by the Engineer-in-Charge furnish manufacturers test certificate or test certificate from approved testing laboratory to establish that the material produced by the contractor for incorporation in the work satisfies the provisions of BIS codes relevant to the material and/or the work done.
17. The contractor shall procure all the materials at least in advance so that there is sufficient time to testing and approving of the materials and clearance of the same before use in

work.

18. All materials brought by the contractor for use in the work shall be got checked from the Engineer-in-Charge or his authorized representative of the work on receipt of the same at site before use.
19. The contractor shall be fully responsible for the safe custody of the materials issued to him even if the materials are in double lock and key system.

8.4 Natural calamity:

No payment will be made to the contractor for any damage caused by rain, snow fall, floods, dampness, fire, sun or any other natural cause whatsoever during the execution of work. The damage to the work due to above reason, if any, shall have to be made good by the contractor at his own cost and no claim on this account shall be entertained.

8.5 Stocking and Disposal of Materials & Debris

1. The contractor shall take instructions from the Engineer-in-Charge regarding collection and stacking of materials at any place. No excavated earth or building rubbish shall be stacked on areas where other buildings, roads, compound wall, services etc. are to be constructed.
2. After completion of work the agency shall remove materials and debris etc. from site as per the direction of Engineer-in-Charge, at no extra cost.
3. Contractor's job will also include removing of all malba and debris arising in the process of painting including washing of floor to remove stains of paint, at no extra cost.
4. The contractor shall conduct work so as not to interfere with or hinder the progress or completion of the work being performed by other contractor(s) or by the Engineer-in-Charge and shall as far as possible arrange his work and shall place and dispose of the materials being used or removed so as not to interfere with the operations of other contractor or he shall arrange his work with that of the others in an acceptable and coordinated manner and shall perform it in proper sequence to the complete satisfaction of others.
5. For construction/renovation works which are likely to generate malba/rubbish to the tune of more than a tempo/truck load, contractor shall dispose of malba, rubbish & other unserviceable materials and wastes at their own cost to the notified/specified dumping ground and under no circumstances these shall be stacked/dumped, even temporarily outside the construction premises.
6. Dismantled but useful materials/components/equipment, if any, should be returned to the Institute as per the direction of Engineer-in-Charge.

8.6 Nondisclosure Agreement

1. The Agency shall take all precautions not to disclose, divulge and/or disseminate to any third party any confidential information, proprietary information on the Institute business or security arrangements (including but not limited to the Assignment instructions, Schedules and other subsequent Arrangements) and/or business of the Institute. The obligation is not limited to any Scope and the Agency shall be held responsible in case of breach of the confidentiality of Institute's information.

2. If the Agency receives enquiries from Press/Media/Radio/Television or other bodies/persons, the same shall be referred by the Agency to Institute immediately on receipt of such queries.

8.7 Indemnification:

1. The agency shall be directly responsible to indemnify the Institute against all charges, dues, claims, etc. arising out of the disputes relating to the dues and employment of the personnel deployed and further for any claim/compensation against all damages and accidents caused due to negligence on the part of the agents, employees and other personnel of the agency.
2. That the contractor shall keep the IITK indemnified against all claims whatsoever in respect of the employees deployed by the contractor. In case any employee of the contractor so deployed enters in dispute of any nature whatsoever, it will be the primarily responsibility of the contractor to contest the same. In case IITK is made party and is supposed to contest the case, IITK will be reimbursed for the actual expenses incurred towards Counsel Fee and other expenses which shall be paid in advance by the Contractor to IITK on demand. Further, the contractor shall ensure that no financial or Any other liability comes on IITK in this respect of any nature whatsoever and shall keep IITK indemnified in this respect.

8.8 Force Majeure:

If at any time, during the continuance of this contract, the performance in whole or in part by either party of any obligation under this contract is prevented or delayed by reasons of any war, hostility, acts of public enemy, civil commotion, sabotage, fires, floods, explosion, epidemics quarantine restriction, strikes, lockouts or acts of god (hereinafter referred to as events) provided notice of happenings of any such event, is served by party seeking concession to the other as soon as practicable, but within 21 days from the date of occurrence and termination thereof. Provided the Party satisfies Institute adequately of the measures taken by it. Neither party shall, by reason of such event, be entitled to terminate this contract, nor shall either party have any claim for damages against the' other in respect of such non-performance or delay in performance. Further, the services under the contract shall be resumed as soon as practicable after such event has come to an end or ceased to exist and the decision of Institute as to whether the services have to resume or not shall be final and conclusive, provided further, that if the performance in whole or in part of any obligation under this contract is prevented or delayed by reason of any such event for a period exceeding 60 days, Institute may at his option, terminate the contract.

8.9 Dispute resolution

1. The institute reserves the right to amend rules whenever and wherever considered necessary and appropriate. The same shall be intimated to the agency in due course.
2. Any dispute arising out of and in relation to this agreement shall be referred to the arbitration by sole arbitrator to be appointed by Director of the Institute. The arbitration would be conducted and governed by and under the provisions of Arbitration Act, 1996 and its amendments. Any legal dispute will be subject to jurisdiction of Kanpur Courts only and no other court shall have the jurisdiction.
3. Any dispute arising out of and in relation to this agreement shall be referred to the arbitration by sole arbitrator to be appointed by Director of the Institute. The arbitration

would be conducted and governed by and under the provisions of Arbitration Act, 1996. Any legal dispute will be subject to jurisdiction of Kanpur Courts only and no other court shall have the jurisdiction.

8.10 Arbitration

1. Except as otherwise provided anywhere in this Agreement, if any dispute, difference, the question of disagreement or matter, whatsoever, arises between the parties, as to the meaning, operation or effect of the Agreement or out of or relating to the Agreement or breach thereof, the same shall be referred to a Sole Arbitrator, to be appointment by the Director of the Institute at the time of the dispute.
2. If the Arbitrator, to whom the matter is originally referred, dies or refuses to act or resigns for any reasons from the position of arbitration, it shall be lawful for the Director of the Institute to appoint another person to act as Arbitrator in the manner aforesaid. Such person shall be entitled to proceed with the reference from the stage at which it was left by its predecessor, provided both the parties consent to this effect, failing which, the arbitrator shall be entitled to proceed on the matter de- novo.
3. It is a term of the Agreement that the party invoking the arbitration shall specify all disputes to be referred to arbitration at the time of invocation of arbitration under the clause.
4. It is a term of the contract that the cost of arbitration shall be borne by the parties themselves.
5. The place of the arbitration shall be Kanpur Nagar, Uttar Pradesh, India.
6. Subject as aforesaid, the provisions of the Arbitration and Conciliation Act, 1996 and any statutory modifications, amendments or re-enactment thereof and rules made thereunder and for the time being in force, shall apply to the arbitration proceeding under this clause.
7. Except as otherwise provided anywhere in this Agreement, the Arbitration proceedings shall be conducted in English and the Agreement shall be constructed, interpreted and governed by the law of India, for the time being in force.

8.11 Jurisdiction of Courts

The court(s) at Kanpur Nagar, Uttar Pradesh, shall have the exclusive jurisdiction to try any as all the disputes(s) between the parties arising out this Agreement.

8.12 Safety and Security

1. The contractor has to follow all safety norms as laid down in National Building Code of India. All the workers shall be equipped with the required safety gadgets while working at site such as ISI marked helmets, Shoes and safety belts, gumboots, gloves etc.
2. The contractor, the authorized representative(s), workmen etc., shall strictly observe orders pertaining to fire precautions prevailing in the area.
3. The contractor shall be fully responsible for the safe custody of materials brought by him/ issued to him even though the materials may be under double lock key system.
4. Contractor will arrange proper metal ladders, M.S. double scaffolding (for working, painting, etc. at higher levels) at his own cost and will take all safety measures like double harness

safety belt, mechanized electrically operated platform etc. If it is observed that work is proceeding without adequate safety precautions, work may be stopped by Engineer-in-charge and in such cases, contractor will be solely responsible for delay and its consequences thereof.

5. The contractor shall be responsible for the watch and ward/guard of the buildings, safety of all fittings and fixtures including sanitary and water supply fittings and fixtures provided by him against pilferage and breakage during the period of installations and thereafter till the building is physically handed over to the department. No extra payment shall be made on this account.
6. The contractor shall take all precautions to avoid accidents by exhibiting necessary caution boards day and night speed limit boards red flags, red lights and providing barriers. He shall be responsible for all dangers and incidents caused to existing / new work due to negligence on his part. No hindrances shall be caused to traffic during the execution of the work.
7. It shall be ensured by the contractor that no electric live wire is left exposed or unattended to avoid any accidents in this regard.
8. The Institute shall not have any responsibility or liability in case of any accident injury to the personnel to the contractor at work site or to the general public at the work site due to mishandling equipment by the personnel of the contractor or any other similar reason. The responsibilities and liabilities for such accidents and incidents shall be borne by the contractor.

8.13 Approach to Site

1. The tenderer shall see the approaches to the site. In case any approach from main road is required at site or existing approach is to be improved and maintained for cartage of materials by the contractor, the same shall be provided, improved and maintained by the contractor at his own cost.
2. Contractor shall take all precautionary measures to avoid any damage to adjoining property. All necessary arrangement shall be made at his own cost.

8.14 Water and Flooding

1. The contractor shall have to arrange water of desirable quality for the construction purpose for which he may have to install water purifier at site or might have to bring/ purchase water from outside as per decision of Engineer-in-charge. Nothing extra shall be paid on this account.
2. For works below ground level the contractor shall keep that area free from water. If dewatering or bailing out of water is required the contractor shall do it and nothing extra shall be paid except otherwise provided in the items of schedule of quantities.
3. In case of flooding of site on account of rain or any other cause and any consequent damage, whatsoever, no claim financially or otherwise shall be entertained notwithstanding any other provisions elsewhere in the contract agreement. Also, the Contractor shall make good, at his own cost, the damages caused, if any.
4. The water charges (for water connection as well as tanker water) shall be borne by the contractor. Also, if the contractor obtains water connection for the drinking purposes from

the Institute or any other statutory body, the consequent sewerage charges shall be borne by the contractor.

8.15 Acts and Laws

1. The Contractor shall keep himself fully informed of all acts and laws of the Central & State Governments, all orders, decrees of statutory bodies, tribunals having any jurisdiction or authority, which in any manner may affect those engaged or employed and anything related to carrying out the work. All the rules & regulations and bye-laws laid down by Collector / MC etc. and any other statutory bodies shall be adhered to, by the contractor, during the execution of work.
2. The Contractor shall also adhere to all traffic restrictions notified by the local authorities.
3. All statutory taxes, levies, charges (including water and sewerage charges, charges for temporary service connections and / or any other charges, as applicable) payable to such authorities for carrying out the work, shall be borne by the Contractor.
4. The Contractor shall arrange to give all notices as required by any statutory / regulatory authority and shall pay to such authority all the fees that is required to be paid for the execution of work. He shall protect and indemnify the Institute and its officials & employees against any claim and /or liability arising out of violations of any such laws, ordinances, orders, decrees, by himself/herself or by his/her employees or his/her authorized representatives. Nothing extra shall be payable on these accounts.
5. The fee payable to statutory authorities for obtaining the various permanent service shall be borne by the Institute.

8.16 Labour and Laws

1. The Contractor shall display all permissions, licenses, registration certificates, bar charts, other statements etc. under various labour laws and other regulations applicable to the works, at his site office.
2. Huts for labour are not permitted within the premises of the Institute. No extra cost shall be payable even if the contractor provides such accommodation at a place as is acceptable to the local body.

8.17 E& M Works

1. In interpreting the specifications, the following order of decreasing importance shall be followed in case of contradictions:

- Schedule of quantities
- Technical specifications of the NIT
- Approved Drawing (If any)
- CPWD General specifications Part-I (Internal) 2014, BIS Codes amended up to date, practices.
- CPWD General Specifications for Electrical Works Part-II (External), 2014 amended up to date.

- Relevant IS or other international code in case IS code is not available.
 - Indian Electricity Act 2003 and Indian Electricity Rules 1956 amended up to date.
 - Local Fire Regulations applicable at the place of installation. Relevant and applicable foreign standards and specifications amended up to date.
 - Any other relevant act or rules and local by-laws.
2. contractor will identify one of the supervisors for taking care of implementation of Safety systems.
 3. Smoking is strictly prohibited at workplace.
 4. Nobody is allowed to work without wearing safety helmet. Chinstrap of safety helmet shall be always on. Drivers, helpers and operators are no exception.
 5. No one is allowed to work at or more than three meters height without wearing safety belt and anchoring the lanyard of safety belt to firm support preferably at shoulder level.
 6. No one is allowed to work without adequate foot protection.
 7. Usage of eye protection equipment shall be ensured when workmen are engaged for grinding, chipping, welding and gas-cutting. For other jobs as and when site safety co-coordinator insists eye protection has to be provided.
 8. All safety appliances like Safety shoes, Safety gloves, Safety helmet, Safety belt, Safety goggles etc. shall be arranged before starting the job. .
 9. All excavated pits shall be barricaded & barricading to be maintained till the backfilling is done. Safe approach to be ensured into every excavation.
 10. Adequate illumination at workplace shall be ensured before starting the job at night.
 11. All the dangerous moving parts of the portable / fixed machinery being used shall be adequately guarded.
 12. Ladders being used at site shall be adequately secured at bottom and top. Ladders shall not be used as work platforms.
 13. Material shall not be thrown from the height. If required, the area shall be barricaded and one person shall be posted outside the barricading for preventing the trespassers from entering the area.
 14. Other than electricians no one is allowed to carry out electrical connections, repairs on electrical equipment or other jobs related thereto.
 15. All electrical connections shall be made using 3 or 5 core cables, having a earth wire.
 16. Inserting of bare wires for tapping the power from electrical sockets is completely prohibited.
 17. A tools and tackles inspection register must be maintained and updated regularly.
 18. Debris, scrap and other materials to be cleared from time to time from the workplace and at the time of closing of work every day.
 19. All the unsafe conditions, unsafe acts identified by contractors, reported by site supervisors and/ or safety personnel to be corrected on priority basis.
 20. No children shall be allowed to enter the workplace.
 21. All the lifting tools and tackles shall be stored properly when not in use.
 22. Clamps shall be used on Return cables to ensure proper earthing for welding works.
 23. Return cables shall be used for earthing.
 24. All the pressure gauges used in gas cutting apparatus shall be in good working condition.
 25. Proper eye washing facilities shall be made in areas where chemicals are handled.
 26. Connectors and hose clamps are used for making welding hose connections.
 27. All underground cables for supplying construction power shall be routed using conduit pipes.
 28. Spill trays shall be used to contain the oil spills while transferring / storing them.
 29. Tapping of power by cutting electric cables in between must be avoided. Proper junction

boxes must be used.

30. All the E & M works shall be carried out as per direction and to the satisfaction of the Engineer-in-charge.

31. If the specifications for any item or its component are not available in the CPWD specifications cited above, relevant BIS specification as amended up to date shall be followed, whether or not the specific reference of a particular BIS specification has been made in this specification/ tender document.

32. Wherever any reference to any Indian Standard specification occurs in the document relating to this contract the same shall be inclusive of all amendments issued there to or revisions thereof, if any, up to the date of opening of tenders.

33. All materials should conform to relevant BIS specifications wherever the same exists in absence of stipulation in this tender document.

34. Where manufacturers furnish specific instructions / recommendations relating to the materials used in this job and/or their installation, covering points not specifically mentioned in these documents, these instructions shall be followed in all cases and shall be deemed to be included in the schedule of work whether they have been specifically mentioned or not.

35. All chase cuttings in the wall, for recessed conduits & boxes and drilling the holes shall be done with power operated machines only. No chase shall be allowed to be cut manually with the use of hammer & chisel.

36. All cuttings in cement plaster and brick shall be made good by using cement mortar 1:3 (1 part cement, 3-part coarse sand) The cut surfaces shall be repaired by an experienced mason only so as to match the repaired plaster with the original. All such repaired surfaces shall be cured for 3 to 4 days to keep the surfaces wet, using water spray machine (hand/motor operated) and avoid unnecessary flooding of the area.

37. The structural and architectural drawings shall at all times be properly co-related before executing any work.

38. For the purpose of recording measurements and preparing running account bills, the abbreviated nomenclature indicated in the publications Abbreviated Nomenclature of Items of DSR 2022 shall be accepted. The abbreviated nomenclature shall be taken to cover all the materials and operations as per the complete nomenclature of the relevant items in the agreement and relevant specifications. In case of items for which abbreviated nomenclature is not available in the aforesaid publication and also in case of extra and substituted items for which abbreviated nomenclature are not provided for in the agreement, full nomenclature of item shall be reproduced in the measurement books and bill forms for running account bills. For the final bill, however, full nomenclature of all the items shall be adopted in preparing abstract in the electronic measurement books and in the bill forms.

39. Drawings/Data required prior to commencement of electrical/air-conditioning works and must be submitted to Office of Infrastructure and Planning seven days of award of work. Following drawings shall be furnished by the contractor for the approval of the Engineer-In-charge before execution of the work.

i) G.A and schematic drawings of equipments etc.

ii) Technical particulars/specifications of the equipments from approved makes.

40. Completion drawings:

On completion of works and before issuance of completion certificate, the contractor submit completion drawings in the form of three complete set of originals (reproducible)

- i) As built G.A and schematic drawings of equipments etc.
- ii) Technical literature, test certificates, and operation and maintenance manuals for equipments.

41. Works Inspection and Testing of Equipment: Prior to dispatch of equipment the Institute reserves the right to inspect the same at the manufacturer's works and the contractor shall provide and secure every reasonable access and facility at the manufacturers works for inspection, for witness of all acceptance and routine tests as per relevant Indian Standards. Contractor shall give a reasonable notice of about 15 days for the purpose of test, and witness of all major equipments.

42. Pre-commissioning test: All routine tests shall be carried out on the electrical equipment. Protective & measuring devices should be checked for calibration of MCCB's/MCB's, panel & cable meggering , earthing measurements etc.

43.The defect liability shall be for **One year** from the actual date of completion of the work. And after that DLP, the annual comprehensive maintenance of the installed VRF system for 1 year will be applicable strictly as per the terms and conditions detailed in BOQ.

8.18 INSPECTION, TESTING AND COMMISSIONING OF HVAC WORK

1. SCOPE

This chapter covers initial inspection and testing of AHUs, FCUs at manufacturer's works, initial inspection of other equipments/ materials on receipt at site, final inspection testing & commissioning of all equipment at site & description of testing requirements & procedure.

2. INITIAL INSPECTION AT MANUFACTURER'S WORKS AIR HANDLING UNITS

- i) Salient features such as model, size, physical dimensions, and other details of various sections, fan motor details, fan dia, static pressure etc. shall be verified against the contract requirements.
- ii) Manufacturer's internal test certificates for the motor and air handling unit shall be furnished and scrutinized as per contract requirements.
- iii) Test certificate for static and dynamic balancing of the fan/ blower should be furnished. Fan balancing may be witnessed by Engineer-in-Charge or his authorized representative.
- iv) Salient features like type, material, no. and gauge of fins and tubes and no. of rows of cooling coil shall be furnished and verified with reference to contract requirements during stage inspection.
- v) Hydraulic pressure to the extent of 10 Kgf/sq.cm or pneumatic pressure of 21kgf/ sq.cm shall be applied to cooling coil and this pressure should be maintained for 1 hour and no drop should be observed indicating any leaks.

3. INITIAL INSPECTION AT SITE

A. FOR ASSOCIATED WORKS AT SITE:

- i) Inspection of raw materials to be used for fabrication and assembly and inspection of Manufacturer's Certificates.
- ii) Inspection of welding including welders qualification as desired by inspection Engineers.

Inspection of fabricated items.

- iii) Pressure testing of pipe fittings used for the refrigerant and water services.
- iv) Pressure testing, leak testing of complete piping network for chilled water and condenser water.
- v) Vacuum missing and gas/oil charging for refrigeration system.
- vi) Checking of electrical circuits (power & controls) and checking functioning of controls of refrigerant systems and other circuits of air conditioning plant.
- vii) Checking of calibration of controls and instrumentation
- viii) Performances testing of complete
- ix) The above inspection procedure is given for general guidance and information of vendors and inspection of Purchaser is strictly not limited to these and Inspection Engineer of Purchaser shall have full right to have detailed inspection at any stage right from placement of order to completion of project as desired by Inspection Engineer, Co-ordination of Inspection Agency of Purchaser with his Factory/Subvendor's Factory/Erection Site shall be the sole responsibility of successful vendor after placement of order for complete

B. DUCTING

- i) The sheet used for ducting shall be checked for physical test at site. The physical test should include the sheet thickness and bend test as per relevant IS specifications.
- ii) Zinc coating of GSS sheet as mentioned in the tender documents may be got tested from a laboratory to verify that same meets the contract requirements.

C. SWITCH GEAR, CONTROL GEAR, AND MEASURING INSTRUMENTS

These should be of specified make. For air circuit breaker manufacturers test certificate shall be furnished by contractor and the same shall be verified as per contract requirements. Electric Motors Electric motors should be of specified make, manufacturer's test certificate for electric motor shall be furnished.

D. PIPES AND VALVES

- i) It should be checked that the same is as per makes specified in contract
- ii) Dimensions including weight shall be checked for pipes against the requirements contract.

E. INSULATION AND ACOUSTIC LINING

- a) Physical verification for thickness and make should be made as per contract before application of insulation.
- b) Manufacturer's test certificate for density should be furnished. Note: Accuracy of testing instruments shall be as mentioned in the final inspection procedure.

4. FINAL INSPECTION

i) After completion of the entire installation as per specification in all respects, the AC contractor shall demonstrate trouble free running of the AC equipments and installation for a period of minimum 120 hours of running.

ii) After the trial run, the AC contractor shall offer the plant for the seasonal test, namely test for summer or monsoon season whichever occurs earlier.

iii) The equipment capacity computations shall be carried out.

iv) All instruments for testing shall be provided by the AC contractor. The accuracy of the instruments shall be as follows:

a) Temperature: Liquid in glass thermometer having accuracy as per IS: 4825.

b) Wet bulb Temperature: Sling psychomotor conforming to IS:6017, c) Pressure Gauge: conforming to IS: 3695.

d) Water flow meter: Water flow shall be measured using the arrangement installed as per schedule of work, In case the tendering firms do not have testing instruments of the accuracy mentioned above, they should specify the accuracy of the instrument available with them for testing at the tender stage.

5. TESTING REQUIREMENTS AND PROCEDURES

Balancing of all air and water systems and all tests as called for in the specification shall be earned out by the HVAC contractor in accordance with the specifications and relevant local codes if any. Performance tests of individual equipment and control shall be carried out as per manufacturer's recommendation. All tests and balancing shall be carried out in the presence of Engineer-in-charge or his authorized representative.

The whole system balancing shall be tested with microprocessor based hi-tech instruments with an accuracy (+)(-) 0.5%. The instrument shall be capable of storing data and then downloading into a P.C. The HVAC contractor shall provide a minimum but not limited to the following instruments:

i) Microprocessor based calculation meter to measure DB and WB temperature, RH and Dew point

ii) Velo meter to measure air volume and air velocity

iii) Pitot tube -Electronic rotary vane Anemometer

iv) Accubalance flow measuring hood

The contractor shall be responsible to provide necessary sockets and connections for fixing of the testing instruments, probes etc.

A. AIR SYSTEMS

Systems are to be balanced by first adjusting the total flow at the fan, then by adjusting main dampers and branch dampers. Only final minor adjustments are to be made with register and diffuser dampers. Balancing of the air system shall be accomplished without causing objectionable air noise. Baffles and orifice plates required for proper air balance shall be furnished and installed by the contractor. Basically, the following tests and adjustments are required.

1. Test and balance all fan systems to provide proper cfm/ cmh.

2. Adjust fresh air return air and exhaust dampers to provide proper air quantities in all modes of control.
3. Test and record fresh air, return air and mixed air temperature at all air handling units. Test and record data at all coils after air and hydronic systems are balanced. Measure wet and dry bulb temperature on cooling coils.
4. Make point tube transverse at all main supply and return ducts to set proper air quantities. Adjust all zone and branch dampers to proper cfm/cmh.
5. Test and adjust each register, grills, diffuser or other terminals equipment to within 5% of design air quantity. Each opening shall be defined on the test report by size manufacturer's model, room location, design cfm and actual cfm. Outlets shall be adjusted to minimize objectionable drafts.
6. Test and record static pressure drop across all filters and major coils.
7. High velocity duct systems shall be tested for leakages. If excessive or audible leakage is detected, the defect shall be repaired by the contractor. Sufficient static pressure readings shall be taken from the air handling units to the terminal units to establish system static pressure.
8. Test and balance VAV boxes per design document to meet minimum and maximum airflows.

B. WATER SYSTEM

Systems are to be balanced by opening all valves, closing all by-pass and setting all mixing valves to full coil flow. Water systems shall be cleared of Verify that the system has been properly cleaned, flushed and treated before testing. Basically, the following tests and adjustments are required.

- i) Check the operation of all automatic valves.
- ii) Test and adjust correct water flow through chiller, major items of equipment and main water circuits. The balancing valves, provided on the equipment shall be used for adjustment.
- iii) Check capacity output of chillers and set water flow rate for proper data.
- iv) Check and adjust each coil to provide proper rpm. Record water and air temperature changes and water pressure drop.
- v) Set pressure drops across coil by-pass to match coil full-flow pressure drop.

Unit capacity in Tons Refrigeration shall be computed from the temperature readings, pressure readings and water/ brine flow measurements. Flow measurements shall be preferably through flow meters. Pumps shall be tested for the discharge head, flow and BHP. Where it is not possible to measure the flow, at least the discharge head and BHP (on the input side) shall be field tested.

Balancing Tolerance: Systems shall be balanced within the following tolerances

1. Duct leakage Rates (at operating pressures)
 - Low pressure ducts (0 to 0.5kPa) 5% of full flow
 - Medium Pressure Ducts (0.5 to 3kPa) 1% of full flow
 - High Pressure Ducts (Greater than 3kPa) 1% of full flow
2. Air flow rates
 - Under 70 L/S 10% of flow
 - Over/ at 70 L/S 5% of flow
3. Water flow rates
 - Chilled Water 2% of flow
 - Other 5% of flow

Procedure:

- i) Review all pertinent plans, specifications, shop drawings and other documentation to become fully familiar with the systems and their specified and intended performance.
- ii) Furnish equipment and instruct sheet metal trade on proper use for conducting duct leakage tests. Conduct first test as a way of instructing the above trades in the presence of the Departments representative.
- iii) Test relative barometric pressures in various building area, as deemed necessary by the Department's representative and at least in an areas served by different systems.
- iv) Test performance and continuously record on a 24 hour basis, temperature and humidity levels where control equipment is provided for that purpose in certain critical areas.
- v) Before commissioning of the equipment, the entire electrical installation shall be tested in accordance with relevant BIS codes and test report shall be furnished by a qualified and authorized person.

C. REPORTS

Provide 3copies of the complete balancing and testing reports to the department. Report shall be neatly typed and bound suitable for a permanent record. Report forms shall contain complete test data and equipment data as specified and safety measures provided.

D. FINAL DOCUMENTATION

a) The contractor shall leave the system operating in complete balance with water and air quantities as shown on drawings. Set stops on all balancing valves and lock all damper quadrants in proper position. Secure all automatic damper and valve linkages in proper positions to provide correct operating ranges. Proper damper positions shall be marked on ducts with permanent indication. Notify the department of any areas marginal or unacceptable system performance.

b) The above tests and procedures are mentioned herein, for general guidance and information only, but not by way of lamination to the provisions of conditions of contract and design/ performance criteria.

c) Upon commissioning and final handover of the installation, the HVAC contractor shall submit (within 4 weeks) to the engineer-in-charge! department 6 (six) portfolios of the following indexed and bound together in hard cover ring binder (300 x 450 mm) in addition to the completion drawings.

1. Comprehensive operation and maintenance manual
2. Test certificates, consolidated control diagram and technical literature on all controls.
3. Equipment warranties from manufacturers.
4. Commissioning and testing reports
5. Rating charts for all equipment
6. Log books as per equipment manufacturers standard format
7. List of recommended spares and consumables
8. Any special tools required for the operation or the maintenance of the plant shall be supplied free with the plant.
9. At the close of the work and before issue of final certificate of completion by the Engineer-in-charge, the contractor shall furnish a written guarantee indemnifying the department against defective materials and workmanship for the Defects liability period. The contractor shall hold himself fully responsible for reinstallation or replace free of cost to the department.
10. Any defective material or equipment supplied by the contractor

11. Any material or equipment supplied by the department which is proved to be damaged or destroyed as a result of defective workmanship by the contractor.