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Name of Work: **Supply, installation, testing & commissioning of Water Cooled Central AC plant of capacity 3200 TR (4 nos. centrifugal Chillers each of capacity 800 TR) in IIT Kanpur.**

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NIT amounting to Rs. 18, 22, 64,573/- is approved.

**Executive Engineer
I.W.D. Elect. & AC Divn.
I.I.T., Kanpur**

**Superintending Engineer
Central Office, I.W.D.
I.I.T., Kanpur**

PART-A

INDIAN INSTITUTE OF TECHNOLOGY KANPUR
INSTITUTE WORKS DEPARTMENT
Electrical & Air-conditioning Division
E-TENDER NOTICE

NIT No.55/AC/2020/470

Dated: 27.02.2020

The Superintending Engineer, IWD, I.I.T., Kanpur on behalf of Board of Governors of IIT Kanpur invites online item rate tender from eligible air conditioning contractors for the following air-conditioning & refrigeration work:-

Sl. No	Name of work and location	Estimated cost put to tender (In Rs.)	Earnest Money (In Rs.)	Period of Completion (in Month)	Last date & time of submission of tender	Period during which EMD, Cost of Tender Document, e-Tender Processing Fee and other Documents shall be submitted	Time & date of opening of tender
1	Supply, installation, testing & commissioning of Water Cooled Central AC plant of capacity 3200 TR (4 nos. centrifugal Chillers each of capacity 800 TR) in IIT Kanpur.	18,22,64,573/-	28,22,646/-	6 Months	Upto 3.30 PM on 24.03.2020	After last date and time of submission of tender and upto 3:30 PM on 27.03.2020	At 3:30 PM on 03.04.2020

The E-tender documents is available on <http://eprocure.gov.in/eprocure/app>

Actg Superintending Engineer

Copy to:

1. Institute website: www.iitk.ac.in/iwd/tenderhall.htm
2. Notice Board

Information of e Tendering for Contractors

1. The intending tenderer must read the terms and conditions of FORM-6 for e-Tendering carefully. He should only submit his tender if he considers himself eligible and he is in possession of all the documents required.
2. Information and Instructions for tenderer posted on website shall form part of tender document.
3. The tender document consisting of plans, specifications, 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 <https://eprocure.gov.in/eprocure/app> or www.iitk.ac.in free of cost.
4. But the tender can only be submitted after uploading the mandatory scanned documents as per list given below.
5. Those contractors not registered on the website mentioned above, are required to get registered beforehand. If needed they can be imparted training on online bidding process as per details available on the website.
6. The intending bidder must read the terms and conditions carefully. He should submit his bid only if he considers himself eligible and he is in possession of all the documents as required
7. The intending bidder must upload all the documents as detailed in this tender document .
8. Applicants are advised to keep visiting www.iitk.ac.in/iwd/tenderhall.htm, <http://eprocure.gov.in/eprocure/app>, www.tenderhome.com, and www.eprocure.gov.in/cppp/latestactivetenders, 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.
9. The EMD shall be prepared in favour of **“The Director, IIT Kanpur” payable at Kanpur** as detailed in the tender document. A part of EMD is acceptable in the form of bank guarantee as per the details in the tender document. This bank guarantee shall also be in favour of **“The Director, IIT Kanpur”**.
10. The defect liability period is 24 months from the date of handing over the completed building to the Engineer- in-charge. Other related details are elaborated in the tender document.
11. Site inspection, if desired, by the intending bidders will be arranged on **16/03/2020** at 11:30 AM. The intending bidders must reach the O/o the Executive Engineer (Elect.& AC), IWD, IIT Kanpur -208016. The construction site is inside the IIT Kanpur Campus. The intending bidders shall arrange for the conveyance themselves.
12. The indicative drawings are enclosed.

13. The following condition pertains to GST of Clause 37 & 38 of General Condition of contracts and corresponding amendments should be read as follows:-
- a) The quoted rates should be exclusive of GST
 - b) The GST as applicable shall be paid extra.

BID DOCUMENT

Online bids (Technical & Financial) from eligible bidders which are valid for a period of 90 days from the date of financial Bid opening (i.e.03.04.2020 tentative) are invited for and on behalf of the Board of Governor (BOG), IIT Kanpur for “**Supply, installation, testing & commissioning of Water Cooled Central AC plant of capacity 3200 TR (4nos. centrifugal Chillers each of capacity 800 TR) in IIT Kanpur.**”

Notice Inviting Tender No.	55 /AC/2020/470 dated 27/02/2020
Name of Work	Supply, installation, testing & commissioning of Water Cooled Central AC plant of capacity 3200 TR (4 nos. centrifugal Chillers each of capacity 800 TR) in IIT Kanpur.
Estimated Cost	Rs.18,22,64,573/-
Earnest Money	Rs. 28,22,646/-
Date of Publishing	29.02.2020 (15:30 hrs)
Clarification Start Date and Time	03.03.2020 (working days only)
Clarification End Date and Time	16.03.2020 (working days only)
Queries (if any)	No queries will be entertained after clarification end date and time
Bid Submission Start Date	03.03.2020 (17:00 hrs)
Pre Bid Meeting Date and Time	16.03.2020 (at 12:00 hrs.)
Last Date and time of uploading of Bids	24.03.2020 (15.30 hrs)
Last Date and time of submitting , EMD and other documents at IWD, IIT Kanpur	27.03.2020 (15:30 hrs)
Date and time of opening of Technical ,Bids	27.03.2020 (16.00 hrs)
Date and time of opening of Financial Bids	03.04.2020 (15.30 hrs) (Tentative)

Interested parties may view and download the tender document containing the detailed terms & conditions from the website <http://eprocure.gov.in/eprocure/app>

(The bids have to be submitted online in electronic form on www.eprocure.gov.in only. No physical bids will be accepted.)

INSTRUCTION FOR ONLINE BID SUBMISSION

The bidders are required to submit soft copies of their bids electronically on the Central Public Procurement (CPP) Portal ie <http://eprocure.gov.in/eprocure/app> , using valid Digital Signature Certificates. 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.

REGISTRATION

- (i) Bidders are required to enroll on the e-Procurement module of the Central Public Procurement Portal (URL:<https://eprocure.gov.in/eprocure/app>) by clicking on the link “Online Bidder Enrollment” option available on the home page. **Enrolment on the CPP Portal is free of charge.**
- (ii) During enrolment/ registration, the bidders should provide the correct/ true information including valid email-id & mobile no. All the correspondence shall be made directly with the contractors/ bidders through email-id provided.
- (iii) As part of the enrolment process, the bidders will be required to choose a unique username and assign a password for their accounts.
- (iv) For e-tendering possession of valid Digital Signature Certificate (Class II or Class III Certificates with signing key usage) is mandatory which can be obtained from SIFY /nCode/eMudra or any Certifying Authority recognized by CCA India on eToken/ SmartCard.
- (v) Upon enrolment on CPP Portal for e-tendering, the bidders shall register their valid Digital Signature Certificate with their profile.
- (vi) Only one valid DSC should be registered by a bidder. Bidders are responsible to ensure that they do not lend their DSCs to others which may lead to misuse and should ensure safety of the same.
- (vii) Bidders can then log into the site through the secured login by entering their userID/ password and the password of the DSC/ eToken.

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. These 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 tender, in case they want to obtain any clarification / help from the Helpdesk.

PREPARATION OF BIDS:

- (i) For preparation of bid Bidders shall search the tender from published tender list available on site and download the complete tender document and should take into account corrigendum if any published before submitting their bids.

After selecting the tender document same shall be moved to the 'My favourite' folder of bidders account from where bidder can view all the details of the tender document.

- (ii) Bidder shall go through the tender document carefully to understand the documents required to be submitted as part of the bid. Bidders shall note the number of covers in which the bid documents have to be submitted, the number of documents – including the names and content of each of the document that need to be submitted. Any deviations from these may lead to rejection of the bid.
- (iii) Any pre-bid clarifications if required, then same may be obtained online through the tender site, or through the contact details given in the tender document.
- (iv) Bidders should get ready in advance the bid documents in the required format (PDF/xls/rar/jpg formats) to be submitted as indicated in the tender document/schedule. **Bid documents may be scanned with 100 dpi with black and white option which helps in reducing size of the scanned document.**
- (v) Bidders can update well in advance, the documents such as experience certificates, annual report, PAN, EPF & other details etc., under "My Space/ Other Important Document" option, which can be submitted as per tender requirements. This will facilitate the bid submission process faster by reducing upload time of bids.

SUBMISSION OF BIDS:

- (i) 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.
- (ii) Bidder should prepare the EMD as per the instructions specified in the NIT/ tender document. The details of the DD/BC/BG/ others physically sent, should

tally with the details available in the scanned copy and the data entered during bid submission time. Otherwise the uploaded bid will be rejected.

- (iii) While submitting the bids online, the bidder shall read the terms & conditions (of CPP portal) and accepts the same in order to proceed further to submit their bid.
- (iv) Bidders shall select the payment option as offline to pay the EMD and enter details of the DD/BC/BG/others. The intending tenderer has to fill all the details such as Banker's name, Demand Draft/Fixed Deposit Receipt /Pay Order/ Banker's Cheque/Bank Guarantee number, amount and date.
- (v) The amount of EMD can be paid by multiple Demand Draft / Pay Order / Banker's Cheque / Deposit at call receipt / Fixed Deposit Receipts along with multiple Bank Guarantee of any Scheduled Bank.
- (vi) Bidder shall digitally sign and upload the required bid documents one by one as indicated in the tender document.
- (vii) Bidders shall note that the very act of using DSC for downloading the tender document and uploading their offers is deemed to be a confirmation that they have read all sections and pages of the tender document without any exception and have understood the complete tender document and are clear about the requirements of the tender document.
- (viii) Bid documents may be scanned with 100 dpi with black and white option which helps in reducing size of the scanned document. For the file size of less than 1 MB, the transaction uploading time will be very fast.
- (ix) **If price quotes are required in XLS format, utmost care shall be taken for uploading Schedule of quantities & Prices and any change/ modification of the price schedule shall render it unfit for bidding.**

Bidders shall download the Schedule of Quantities & Prices i.e. Schedule-A, in XLS format and save it without changing the name of the file. Bidder shall quote their rate in figures in the appropriate cells, thereafter save and upload the file in financial bid cover (Price bid) only.

If the template of Schedule of Quantities & Prices file is found to be modified/corrupted in the eventuality by the bidder, the bid will be rejected and further dealt as per provision of clause no 23.0 of ITB including forfeiture of EMD.

The bidders are cautioned that uploading of financial bid elsewhere i.e. other than in cover 2 will result in rejection of the tender.

- (x) Bidders shall submit their bids through online e-tendering system to the Tender

Inviting Authority (TIA) well before the bid submission end date & time (as per Server System Clock). **The TIA will not be held responsible for any sort of delay or the difficulties faced during the submission of bids online by the bidders at the eleventh hour.**

- (xi) After the bid submission (i.e. after Clicking “Freeze Bid Submission” in the portal), the bidders shall **take print out of system generated acknowledgement number** and keep it as a record of evidence for online submission of bid, which will also act as an entry pass to participate in the bid opening.
- (xii) Bidders should follow the server time being displayed on bidder’s dashboard at the top of the tender site, which shall be considered valid for all actions of requesting, bid submission, bid opening etc., in the e-tender system.
- (xiii) All the documents being submitted by the bidders would be encrypted using PKI (Public Key Infrastructure) 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.

ASSISTANCE TO BIDDERS:

- (i) Any queries relating to the tender document and the terms and conditions contained therein should be addressed to the Tender Inviting Authority for a tender or the relevant contract person indicated in the tender. The contact number for the helpdesk is 0512-2597059 between 10:30 hrs to 17:00 hrs. The email id for the helpdesk is : vktiware@iitk.ac.in.
- (ii) Any queries relating to the process of online bid submission or queries relating to CPP Portal in general may be directed to the 24X7 CPP Portal Helpdesk. The 24 x 7 Help Desk Number 0120-4200462, 0120-4001002 and 0120-4001005. The helpdesk email id is support-eproc@nic.in

INSTRUCTION FOR e-PROCUREMENT

1. PREPARATION AND SUBMISSION OF BIDS :

- a. The detailed tender documents may be downloaded from <http://eprocure.gov.in/eprocure/app> till the last date of submission of tender. The Tender may be submitted online through CPP Portal <http://eprocure.gov.in/eprocure/app>
- b. The bidder should submit the bid online in two parts viz. Technical Bid and Financial Bid. Technical Bid should be upload online in cover- 1 and Financial Bid in “.Xls” should be upload online in cover- 2

2. SUBMISSION OF THE BID : All interested eligible bidders are requested to submit their bids online on CPP Portal: <http://eprocure.gov.in/eprocure/app> as per the criteria given in this document:

- a. Technical Bid should be upload online in cover-1.
- b. Financial Bid should be upload online in cover-2

Both Technical and Financial Bid covers should be placed online on the CPP Portal (<http://eprocure.gov.in/eprocure/app>).

3. TECHNICAL BID: Signed and Scanned copies of the Technical bid documents as under must be submitted online on CPP Portal: <http://eprocure.gov.in/eprocure/app> .

List of Documents to be scanned and uploaded (Under Cover-1) within the period of bid submission:-

- Copy of Registration with the Department if any or specialized agencies.
- Required experience / completion certificates of similar nature of works.

The works certificates submitted by the bidder clearly indicate that:

1. The completion certificate of the water cooled central AC plant with tonnage of installation against the air conditioning works.
2. Actual date of completion of the air-conditioning work.

- Copy of EPF & ESI No.
- Details of turn over during the last five years.
- Copy of bank solvency certificate
- Scan copy of E.M.D. as to be submitted in hard copy.

- Copy of GST Registration.
- Technical data sheets for the major equipments/BMS software as specified at Annexure 1 to 7 of Appendix I in PQ Document.
- The documents as specified for the Pre-Qualification

Note: The hardcopy of above documents along with earnest money deposit receipt shall be submitted in the office of Superintending Engineer, Central Office, IWD within last date and time of submission as specified in the above bid document.

Please note that no indication of the rates/amounts be made in any of the documents submitted with the TC-BID.

4. Financial Bid

- a. The currency of all quoted rates shall be Indian Rupees. All payment shall be made in Indian Rupees.
- b. In preparing the financial bids, bidders are expected to take into account the requirements and conditions laid down in this Tender document. The financial bids should be uploaded online as per the specified “.Xls” format i.e. Price Bid in Excel sheet attached as ‘.Xls’ with the tender and based on the scope of work, service conditions and other terms of the Tender document. It should include all costs associated with the Terms of Reference/Scope of Work of the assignment.
- c. Being an individual work contract no other tax is payable other than GST. The GST shall be paid extra as applicable.

5. Last Date for Submission of Tender:

- a. Online bids complete in all respects, must be submitted on or before the last date and time specified in the schedule of events.
- b. The IIT, Kanpur may, at its own discretion, alter/extend the last date for submission of tenders.

6. Bid Validity

- a. All the Bids must be valid for a period of 90 days from the date of financial bid opening of the tender for execution of Contract. However, the quoted rates should be valid for the initial/ extended period of the Contract from the effective date of the Contract. No request will be considered for price revision during the original Contract period.
- b. A bid valid for a shorter period shall be declared as non-responsive.
- c. In exceptional circumstances, prior to expiry of the original time limit, the IIT may request the bidders to extend the period of validity for a specified additional period beyond the original validity of 90 days. The request and the bidders' responses shall be made in writing. The

bidders, not agreeing for such extensions will be allowed to withdraw their bids without forfeiture of their Bid Security.

7. Modification / Substitution/ Withdrawal of bids:

- a.** No Bid shall be modified, substituted or withdrawn by the Bidder after the Bid 's due Date.
- b.** Any alteration/ modification in the Bid or additional information supplied subsequent to the Bid's due Date, unless the same has been expressly sought for by the Authority, shall be disregarded.

8. Rejection of the Bid: The bid submitted shall become invalid if:-

- a) The tenderer is found ineligible.
- b) The tenderer does not upload all the documents as stipulated in the tender document.
- c) If any discrepancy is noticed between the documents as uploaded at the time of submission of tender and hard copies as submitted physically in the office of tender opening authority.

FORM -6 FOR e-Tendering

The Superintending Engineer, IWD, I.I.T., Kanpur on behalf of Board of Governors of IIT Kanpur invites online item rate tenders for the following works from eligible Air conditioning contractors: ***“Supply, installation, testing & commissioning of Water Cooled Central AC plant of capacity 3200 TR (4nos. centrifugal Chillers each of capacity 800 TR) in IIT Kanpur..***

The work is estimated to cost **Rs. 18, 22, 64,573/-** This estimate, however, is given merely as a rough guide.

1.1 The authority competent to approve NIT for the combined cost and belonging to the major discipline will consolidate NITs for calling the tenders. He will also nominate Division which will deal with all matters relating to the invitation of tenders.

2. Initial Eligibility & Technical Criteria: Contractors who fulfill the following requirements shall only be eligible for pre-qualification. Joint ventures are not accepted. **The bidders satisfying the initial eligibility & Technical criteria shall only be considered for pre-qualification. The financial bid of only pre-qualified bidders shall be opened. The PQ(Pre-Qualification) document is attached separately.**

a) Should have satisfactorily completed the works as mentioned below during the last seven years ending previous day of last date of submission of bids.

* 3 (three) similar completed works costing not less than **Rs. 729.06 Lacs or 2 (two) similar completed works, not less than Rs 1093.59 Lacs or 1 (one) similar completed work of aggregate cost not less than Rs 1458.12 Lacs.**

And

One completed work of similar nature (either part of (a) or a separate one) costing not less than Rs. 729.06 Lacs with some Central Government Department / State Government Department / Central Autonomous Body / Central Public Sector Undertakings).

Note: 1. The similar nature works means experience of Supply, installation, testing & commissioning of at least 1200 TR Capacity water cooled central AC Plant with at least 1 no. chiller of minimum capacity 400 TR along with chilled water pumps, condenser pumps, cooling towers , Chiller plant manager and associated controls in the same project of water cooled central AC plant.

2. The value of executed works shall be brought to current costing level by enhancing the actual value of work at simple rate of 7% per annum; calculated from the date of completion to the previous day of last date of submission of bids.

b) Should have average annual financial turnover of **Rs. 1822.64 Lacs** construction works during the last three years ending **31-03-2019**.

c) Should not have incurred any loss in more than two years during the last five years ending **31-03-2019**.

d) Should have solvency of **Rs. 729.06 Lacs**.

- e) Should have valid registration of EPF, ESIC and GST.
- f) **Technical Datasheets:** The bidder's proposed equipment's technical parameters/specification shall be matching with the required parameters/specifications by IIT Kanpur as per the Technical Datasheet for all major items as specified at Annexure- 1 to 7 under Appendix-I of PQ Document.
- g) **The tenderer shall have to furnish an affidavit on non judicial stamp paper of Rs. 10.00 as under:**
“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 light, then I/We shall be debarred for tendering in IIT Kanpur contracts in future forever. Also, if such a violation comes to light before date start of work, the Superintending Engineer shall be free to forfeit the entire amount of Earnest Money Deposit / Performance Guarantee.”

Note: Pls. refer the Pre-Qualification Document and submit all required documents online as well in hardcopy for Pre-qualification evaluation as mentioned.

3. Agreement shall be drawn with the successful tenderers on prescribed Form No. CPWD 7 (or other Standard Form as mentioned) which is available as a Govt. of India Publication and also available on website www.iitk.ac.in Tenderers shall quote his rates as per various terms and conditions of the said form which will form part of the agreement.
4. The time allowed for carrying out the work will be 6 **Months** 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, if any, indicated in the tender documents.
5. The site for the work is under construction & shall be made available before the delivery of the equipments.*
6. The tender document consisting of plans, specifications, 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 except Standard General Conditions of Contract Form can be seen on website <http://eprocure.gov.in/eprocure/app>, <https://eprocure.gov.in/cppp/latestactivetenders> or www.iitk.ac.in other necessary documents also can be seen in the office of the EE , IWD Electrical and Air conditioning Division, IIT, Kanpur between hours of 11:00 AM to 3:00 PM from **04.03.2020 to 24.03.2020** free of cost.
7. After submission of the tender the contractor can re-submit revised tender any number of times but before last time and date of submission of tender as notified.
8. While submitting the revised tender, 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 tender as notified.

9. When tenders are invited in three stage system and if it is desired to submit revised financial tender then it shall be mandatory to submit revised financial tender. If not submitted then the tender submitted earlier shall become invalid.
10. Earnest Money can be paid in the form of Treasury Challan or Demand Draft or Pay order or Banker`s Cheque or Deposit at Call Receipt or Fixed Deposit Receipt (drawn in favour of **Director, IIT, Kanpur** along with Bank Guarantee of any Scheduled Bank wherever applicable.
A part of earnest money is acceptable in the form of bank guarantee also. In such case, 50% of earnest money or Rs. 20 lac, whichever is less, will have to be deposited in shape prescribed above, and balance in shape of Bank Guarantee of any scheduled bank.

Treasury Challan or Demand Draft or Pay Order or Banker`s Cheque or Deposit at Call Receipt or FDR or Bank Guarantee against EMD shall be placed in single sealed envelope superscripted as “Earnest Money with name of work and due date of opening of the tender also mentioned thereon.

Copy of Enlistment Order and certificate of work experience wherever applicable and other documents as required and specified in this bid document shall be scanned and uploaded to the e-Tendering website within the period of tender submission and certified copy of each shall be deposited in a separate envelop marked as “Other Documents”.

Both the envelopes shall be placed in another envelope with due mention of Name of work, date & time of opening of tenders and to be submitted in the office of Superintending Engineer after last date & time of submission of tender and up to 03:30 PM on **27.03.2020**. The documents submitted shall be opened at 4.00 PM on **27.03.2020**.

Online tender documents submitted by intending tenderers shall be opened only of those tenderers, whose Earnest Money Deposit, and other documents as mentioned above placed in the envelope are found in order.

The financial bid of only pre-qualified eligible bidders shall be opened at 03:30 PM on **03.04.2020 (tentative)**.

11. The tender submitted shall become invalid if:
- (i) The tenderers is found ineligible.
 - (ii) The tenderers does not upload all the documents as stipulated in the tender document.
 - (iii) If any discrepancy is noticed between the documents as uploaded at the time of submission of tender and hard copies as submitted physically in the office of tender opening authority.
12. The contractor whose tender is accepted will be required to furnish performance guarantee of 5% (Five Percent) of the tendered amount within the period specified in Schedule F. This guarantee shall be in the form of cash (in case guarantee amount is less than ` 10000/-) 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 ` 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. **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 Earnest Money deposited by the contractor shall be forfeited automatically without any notice to the contractor.

13. Intending Tenderers are advised to inspect and examine the site and its surroundings and satisfy themselves before submitting their tenders as to the nature of the ground and sub-soil (so far as is practicable), the form and nature of the site, the means of access to the site, 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 tender. A tenderers shall be deemed to have full knowledge of the site whether he inspects it or not and no extra charge consequent on any misunderstanding or otherwise shall be allowed. The tenderers 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 tender by a tenderer 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 and local conditions and other factors having a bearing on the execution of the work.
14. The competent authority on behalf of the Board of Governors, IIT, Kanpur does not bind itself to accept the lowest or any other tender and reserves to itself the authority to reject any or all the tenders received without the assignment of any reason. All tenders in which any of the prescribed condition is not fulfilled or any condition including that of conditional rebate is put forth by the tenderers shall be summarily rejected.
15. Canvassing whether directly or indirectly, in connection with tenderers is strictly prohibited and the tenders submitted by the contractors who resort to canvassing will be liable for rejection.
16. The competent authority on behalf of Board of Governors, IIT, Kanpur reserves to himself the right of accepting the whole or any part of the tender and the tenderers shall be bound to perform the same at the rate quoted.
17. The contractor shall not be permitted to tender for works in the IIT Kanpur responsible for award and execution of contracts, in which his near relative is posted a Divisional Accountant or as an officer in any capacity between the grades of Superintending Engineer and Junior Engineer (both inclusive). 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 IIT Kanpur. Any breach of this condition by the contractor would render him liable to be removed from the approved list of contractors of this Department.
18. 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 cancelled 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 tender or engagement in the contractor's service.

19. The tender for the works shall remain open for acceptance for a period of **ninety (90) days** from the date of opening of tenders if any tenderer withdraws his tender before the said period or issue of letter of acceptance, whichever is earlier, or makes any modifications in the terms and conditions of the tender which are not acceptable to the department, then the Government shall, without prejudice to any other right or remedy, be at liberty to forfeit 50% of the said earnest money as aforesaid. Further the tenderers shall not be allowed to participate in the retendering process of the work.

20. This Notice Inviting Tender shall form a part of the contract document. The successful tenderers/contractor, on acceptance of his tender by the Accepting Authority shall within 15 days from the stipulated date of start of the work, sign the contract consisting of:-

- a) The Notice Inviting Tender, all the documents including additional conditions, specifications and drawings, if any, forming part of the tender as uploaded at the time of invitation of tender and the rates quoted online at the time of submission of tender and acceptance thereof together with any correspondence leading thereto.
- b) Standard C.P.W.D. Form 7 or other Standard C.P.W.D. Form as applicable.

20.1.1 The tender document will include following three components:

Part A:-

CPWD-6, CPWD-7 including schedule A to F for the major component of the work, Standard General Conditions of Contract for CPWD 2014 as amended/modified up to

24.03.2020.

Part B:-

General/specific conditions, specifications and schedule of quantities applicable to major component of the work.

Part C:-

Schedule A to F for minor component of the work. (SE/EE in charge of major component shall also be competent authority under clause 2 and clause 5 as mentioned in schedule A to F for major components), General/specific conditions, specifications and schedule of quantities applicable to minor component(s) of the work.

20.1.2 The tenderers must associate himself, with agencies of the appropriate class eligible to tender for each of the minor component individually.

20.1.3 The eligible tenderers shall quote rates for all items of major component as well as for all items of minor components of work.

20.1.4 Entire work under the scope of composite tender including major and all minor components shall be executed under one agreement. Whereas a supplementary agreement with the same rate, terms & conditions as specified in the original bid have to executed with IIT Kanpur for the

Operation and Non comprehensive AMC part of the tender after successful commissioning of the Central AC plant as per para 5.20 of CPWD Works Manual 2019 , updated upto 24.03.20. The form of supplementary agreement is at Appendix-VI

- 20.1.5 Security Deposit will be worked out separately for each component corresponding to the estimated cost of the respective component of works. The Earnest Money will become part of the security deposit of the major components of work.
21. The EPF & ESI contribution paid to the contract workers shall be reimbursed on actual basis.

Superintending Engineer
For & on behalf of the Board of Governors, IIT, Kanpur

ITEM RATE TENDER AND CONTRACT FOR WORK

- (A) **Tender for the work of:** *Supply, installation, testing & commissioning of Water Cooled Central AC plant of capacity 3200 TR (4nos. centrifugal Chillers each of capacity 800 TR) in IIT Kanpur.*

TENDER

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, Conditions of Contract, 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, IIT, Kanpur within the time specified in Schedule 'F', viz., schedule of quantities and in accordance in all respects with the specifications, designs, drawings 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 respects in accordance with, such conditions so far as applicable.

We agree to keep the tender **open for (90) ninety days from the date of opening of tender (financial bid)** and not to make any modifications in its terms and conditions.

A sum of **Rs. 28,22,646/-** is hereby forwarded in Cash/Receipt Treasury Challan/Deposit at call Receipt of a Scheduled Bank/Fixed deposit receipt of scheduled bank/demand draft of a scheduled bank/bank guarantee issued by scheduled bank as earnest money. If I/we, fail to furnish the prescribed performance guarantee or fail to commence the work within prescribed period I/we agree that the said Board of Governors, IIT, Kanpur or his successors in office shall without prejudice to any other right or remedy be at liberty to forfeit the said earnest money absolutely. Further, if I/we fail of commence work as specified, I/we agree that Board of Governors, IIT, Kanpur or his successors in office shall without prejudice to any other right or remedy available in law, be at liberty to forfeit the said earnest money and the performance guarantee absolutely, otherwise the said earnest money shall be retained by him towards security deposit to execute all the works referred to in the tender documents upon the terms and conditions contained or referred to therein and to carry out such deviations as may be ordered, up to maximum of the percentage mentioned in Schedule 'F' and those in excess of that limit at the rates to be determined in accordance with the provision contained in Clause 12.2 and 12.3 of the tender form.

Further, I/We agree that in case of forfeiture of earnest money or both Earnest Money & 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 IIT, Kanpur in future forever. Also, if such a violation comes to the notice of

Department before date of start of work, the Engineer-in-Charge shall be free to forfeit the entire amount of Earnest Money Deposit/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 of the State.

Dated _____ ** _____

Witness: **
Address: **
Occupation: **

**
Signature of contractor
Postal Address **

ACCEPTANCE

The above tender (as modified by you as provided in the letters mentioned hereunder) is accepted by me for and on behalf of the Board of Governors, IIT, Kanpur for a sum of Rs. _____ (Rupees _____)

The letters referred to below shall form part of this contract Agreement:-

- a) _____
- b) _____
- c) _____

For & on behalf of the Board of Governors,
IIT, Kanpur

Dated _____

Signature _____
Designation _____

Operative schedules shall be supplied separately to each intending tenderer)

SCHEDULE 'A'

Schedule of Quantities:

SCHEDULE 'B'

Schedule of materials to be issued to the contractor:

S. No.	Description of item	Quantity	Rates in figures & words at which the material will be charged to the contractor	Place of issue
1	2	3	4	5
-----NIL-----				

SCHEDULE 'C'

Schedule of Tools and Plants to be hired to the contractor

S. No.	Description	Hire charges per day	Place of issue
1	2	3	4
-----NIL-----			

SCHEDULE 'D'

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

As attached in tender form.

SCHEDULE 'E'

Schedule of component of other Materials, Labour, POL etc. for price escalation on SITC part: N.A.

SCHEDULE 'F'

Reference to General Conditions of contract.

Name of Work:	<i>Supply, installation, testing & commissioning of Water Cooled Central AC plant of capacity 3200 TR (4nos. centrifugal Chillers each of capacity 800 TR) in IIT Kanpur</i>		
Estimated cost of the work:	Air-conditioning Items of Work	182264573/-	
Earnest money	2822646/-		
Performance Guarantee	5% of the tendered value of the work		
Security Deposit	2.5% of the tendered value of the work		
General rules and direction :			

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Definitions:

2(v)	Engineer-in-Charge	For Air-conditioning & Refrigeration/Electrical items of work	Executive Engineer, Institute Works Department IIT, Kanpur
2(vi)	Accepting Authority		Superintending Engineer, Institute Works Department IIT, Kanpur
2(vii)	Percentage on cost of materials and labour to cover all overheads and profits		15%
2(viii)	Standard Schedule of Rates:		
	Electrical Items of Work:		D.S.R. 2018 with up to date correction slips
2(ix)	Department:		Central Public Works Department
2(x)	Standard CPWD contract Form:		GCC 2019, CPWD form-7 as modified & corrected up to 24.03.2020 (Whether correction vide latest circulars are incorporated or not in this document).
Clause 1	i)	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 there off from the date of issue of letter of acceptance	15 Days
	ii)	Maximum allowable extension with late fee @.01% per day of Performance Guarantee amount beyond the period as provided in i) above	7 Days
Clause 2	Authority for fixing Compensation under Clause 2		Superintending Engineer, Institute Works Department IIT, Kanpur. Or successor thereof
Clause 2	Whether Clause 2 shall be applicable		Yes
Clause 5	i)	Number of days from the date of issue of letter of acceptance for reckoning date of start	22 Days
	ii)	Time allowed for execution of work	6 Months
Authority to decide	Extension of time		Superintending Engineer, Institute Works Department IIT, Kanpur
Clause 6			applicable.

Clause 7	Gross work to be done together with net payment/Adjustment of advances for material collected, if any, since the last such payment for being eligible to interim payment	Not applicable <i>Applicable</i>
<i>Clause 7A</i>		
Clause 10A	Material to be provided by the contractor.	Applicable
Clause 10B (i),(ii), (iii),iv	Whether clause 10-B (ii) and 10-B (iii) shall be applicable.	Applicable
Clause 10 C	Component of labour expressed as percentage of value of work	Not Applicable
Clause 10 CA	Materials covered under this clause.	Nearest material(other than cement, reinforcement bars and structural steel) for which All India Whole sale price Index is to be followed. Not Applicable
	1. Cement (PPC)	Nil NIL
	2. Steel	Nil Nil
Clause 10 CC	Increase/Decrease in Price of materials/wages except Annual operation part	Not Applicable
Clause 11	Specification to be followed for execution of work:	
For electrical works	CPWD specifications 2013 internal and 2013 external electrical works	
For Air conditioning & Refrigeration item of works	CPWD Specifications 2017 HVAC for Air-conditioning & refrigeration works with up to date correction slips.(Hereinafter called CPWD specifications also)	
Clause 12		
12.2 & 12.3	Deviation limit beyond which clause 12.2 & 12.3 shall apply for building work	Applicable
Clause 16	Competent Authority for Deciding reduced rates:	
	For electrical/civil/Air-conditioning& refrigeration items of work	Superintending Engineer, Institute Works Department IIT, Kanpur
Clause 18	List of mandatory machinery, tools & plants to be deployed by the contractor at site.	Hydra Crane, Chain Pulley block, welding machine with safety kit, Gas cutter machine with safety kit, Hydro Testing Equipment, Ultra Sonic Flow meter, Multimeter, drill machine, crimping tools, spanner set, blower, welding torch etc
Clause 32		Requirement of technical Representative(s)

Requirement of technical Representative(s)

Requirement of Technical Representative (S) and recovery Rate

Sl. No	Minimum Qualification of Technical Representative	Discipline	Designation (Principal Technical / Technical representative)	Minimum Experience	Number	Rate at which recovery shall be made from the contractor in the event of not fulfilling provision of clause 36(i)	
						Figures	Words
1.	B.E./B.Tech	Electrical / mechanical	Project Manager	5	2	Rs.25,000/- p.m	Twenty Five Thousand per month
2.	B.E/B. Tech or Diploma in Engg.	Electrical / mechanical	Site Engineer/ Billing Engineers	2 or 5	2	Rs.15,000/- p.m	Fifteen Thousand per month

For supervision of air-conditioning as well as electrical items of work, technical representatives of the respective disciplines will be required to be deployed.

SALIENT/MANDATORY REQUIREMENTS FOR THE TENDER

Name of Work: *Supply, installation, testing & commissioning of Water Cooled Central AC plant of capacity 3200 TR (4nos. centrifugal Chillers each of capacity 800 TR) in IIT Kanpur*

- 1 The tenderer is advised to read and examine the tender documents for the work and the set of drawings available with Engineer-in-charge. He should inspect and examine the site and its surroundings by himself before submitting his tender.
- 2 Separate schedule of quantity is included in this tender for air conditioning & refrigeration items of work. If the tenderer wants to offer any unconditional rebates on their rates, the same should also be offered in the respective components of schedule separately. The contractor shall quote the item rates in figures and words accurately so that there is no discrepancy in rates written in figures and words.
- 3 Time allowed for the execution of work is **6 Months.**
- 4 The contractor(s) shall submit a detailed program of execution in accordance with the master programme/milestone within ten days from the date of issue of award letter.
- 5 Contractor has to arrange and install field laboratory during the currency of work and nothing extra will be paid on this account.
- 6 Quality of the project is of utmost importance. This shall be adhered to in accordance with the provisions of CPWD specifications and guidelines given in the relevant paras.
- 7 Contractor has to deploy required Plant and machinery on the project. In case the contractor fails to deploy the plant and machinery whenever required and as per the direction of the Engineer-in-charge, he (Engineer-in-charge) shall be at a liberty to get the same deployed at the risk and cost of the contractor.
- 8 The contractor shall comply with the provisions of the Apprentices Act 1961, and the rules and orders issued there under from time to time. If he fails to do so, his failure will be a breach of the contract and the Superintending Engineer/Executive Engineer may in his discretion, without prejudice to any other right or remedy available in law, cancel the contract. The contractor shall also be liable for any pecuniary liability arising on account of any violation by him of the provisions of the said Act.
- 9 Temporary Electric connection shall be issued as per request and the water charges shall be recovered as per rule.

PART-B

QUALITY ASSURANCE OF THE WORK

Sampling of Materials:

1. 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.
2. 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.
3. 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.
4. There shall be pre dispatch factory inspection for all major equipment's like chiller's, pumps, cooling tower, expansion tank cum pressurization system & factory manufactured pre insulated pipe through duly constituted committee by the Institute for this inspection. The expenses shall be borne by the Institute and not to be loaded into the contract. The contractor shall only facilitate the inspection at manufacturing works.

ADDITIONAL TERMS AND CONDITIONS

- 1 Unless otherwise provided in the Schedule of Quantities/Specifications, the rates tendered by the contractor shall be all inclusive and shall apply to all heights, lifts, leads and depths of the work and nothing extra shall be payable to him on account of the same. Extra payment for centering/shuttering, if required to be done for heights greater than 3.5 m shall however be admissible at the rates arrived at in accordance with clause 12 of the agreement, if not already specified.
- 2 Other agencies doing works related with this project may also simultaneously execute their works and the contractor shall afford necessary facilities for the same. The contractor shall leave such necessary holes, openings etc. for laying/burying in the work, pipes cables, conduits, clamps, boxes and hooks for fan clamps etc. as may be required for the other agencies. Nothing extra over the Agreement rates shall be paid for doing these.
- 3 Some restrictions may be imposed by the security staff etc. on the working and for movement of labour, materials etc. The contractor shall be bound to follow all such restrictions/instructions and nothing extra shall be payable on account of the same.
- 4.1 The contractor shall fully comply with all legal orders and directions of the Public or local authorities or municipality and abide by their rules and regulations and pay all fees and charges for which he may be liable in this regard. Nothing extra shall be paid/reimbursed for the same.
- 4.2 The building work shall be carried out in the manner complying in all respects with the requirements of the relevant bylaws and regulations of the local body under the jurisdiction of which the work is to be executed or as directed by the Engineer-in-charge and nothing extra shall be paid on this account.
- 5 If as per local Municipal regulations, huts for labour are not to be erected at the site of work; the contractor shall be required to provide such accommodation at a place as is acceptable to the local body and nothing extra shall be paid on this account.
- 6 The structural and architectural drawings shall at all times be properly co-related before executing any work. However, in case of any discrepancy in the item given in the schedule of quantities appended with the tender and Architectural drawings relating to the relevant item, the former shall prevail unless otherwise given in writing by the Engineer-in-charge.
- 7.1 For the purpose of recording measurements and preparing running account bills, the abbreviated nomenclature indicated in the publications Abbreviated Nomenclature of Items of DSR 2018 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.

- 7.2 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.
- 7.3 For the final bill, however, full nomenclature of all the items shall be adopted in preparing abstract in the measurement books and in the bill forms.
8. The contractor shall take instructions from the Engineer-in-charge for stacking of materials. No excavated earth or building materials etc. shall be stacked/collected in areas where other buildings, roads, services, compound walls etc. are to be constructed.
- 9 Any trenching and digging for laying sewer lines/water lines/cables etc. shall be commenced by the contractor only when all men, machinery's and materials have been arranged and closing of the trench(s) thereafter shall be ensured within the least possible time. All the excavation and digging of the trenches shall be done manually as numbers of service line are passing inside the campus except in certain cases as approved by IITK. **No Hydraulic Excavator shall be allowed for earth digging work** except in certain cases as approved by IITK.
- 10 It shall be ensured by the contractor that no electric live wire is left exposed or unattended to avoid any accidents in this regard.
- 11 In case the supply of timber/steel frames/shutters for doors, windows etc. is made by some other agency, the contractor shall make necessary arrangements for their safe custody on the direction of the Engineer-in-charge till the same are fixed in position by him & nothing extra shall be paid on this account.
- 12 The contractor shall maintain in perfect condition, all portions executed till completion of the entire work allotted to him. Where however phased delivery of work is contemplated these provisions shall apply separately to each phase.
- 13 The entire royalty at the prevalent rates shall have to be paid by the contractor on all the boulders, metals, shingle sand etc. collected by him for execution of the work, directly to the Revenue authority or authorized agents of the State Government concerned or the Central Government, as the case may be.
- 14.1 The contractor shall bear all incidental charges for cartage, storage and safe custody of materials issued by the departments and shall construct suitable go downs, yards at the site of work for storing all materials as to be safe against damage by sun, rain, dampness, fire, theft etc. at his own cost and also employ necessary watch and ward establishment for the purpose, at his own cost. Materials to be charged directly to work and stipulated for issue free of cost shall also be issued to the contractor as soon as those are received at site or at the stipulated place of issue. The provision of this para shall apply equally and fully to those as well.
- 14.2 All materials obtained from the Institute Works Department store or otherwise on receipt shall be got checked by the Engineer-in-charge of the work or his representations before use.

- 14.3 Registers for the materials to be issued by the department shall be maintained as required by the Engineer-in-charge and these shall be signed by the contractor or his authorized agent and representative of Engineer-in-charge on each day of transactions.

SPECIAL TERMS & CONDITIONS

1. In the Contract (as hereinafter defined) the following definitions words and expressions shall have the meaning hereby assigned to them except where the context otherwise required.
 - i) Institute shall mean the Indian Institute of Technology (IIT), Kanpur
 - ii) The President shall mean the Board of Governor, IIT Kanpur.
 - iii) The Engineers In-charge, who shall administer the work, shall mean the Executive Engineer for electrical and Air-conditioning works.
 - iv) Government or Govt. of India shall mean the Indian Institute of Technology represented by its Director.
 - v) The term Director General of Works shall mean the Chairman, Building & Works Committee of the Institute.
 - vi) Accepting authority shall mean the Director, IIT Kanpur or his authorized representative.
 - vii) Superintending Engineer shall mean the Superintending Engineer of the Institute, who as overall In-charge and head of the Institute Works Department shall direct the contract.
 - viii) Site Engineers shall mean the Assistant Engineer & Jr. Engineer (AC) for Electrical & Air-conditioning works, appointed by the Institute Works Department.

2. Duties & Powers :

- i) **Site Engineers:**

The duties of the Site Engineer(s) are to watch and supervise the works and the workmanship employed in connection with the works, and to test and examine any materials to be used. He shall have no authority to relieve the contractor of any of his duties or obligations under the contract nor, except as expressly provided here under, to order any work involving delay or any extra payment by the Institute, nor to make any variation in the works.

The Engineer-in-charge, from time to time in writing, delegate to the Site Engineer (s) any of the powers and authorities vested in them. Any written instruction or written approval given by the Site Engineer (s) to the contractor within the terms of such delegation (but not otherwise) shall bind the contractor and the Institute as though it had been given by the Engineer-in-charge provided always as follows :

- a) Failure of the Site Engineer (s) to disapprove any work or materials shall not prejudice the power of the Engineer In-charge to subsequently

disapprove such work or materials and to order the pulling down, removal or breaking up thereof.

- b) If the contractor is dissatisfied by reason of any decision of the Site Engineer (s), he shall be entitled to refer the matter to the Engineer-in-charge, who shall thereupon confirm reverse or vary such decision.
3. The scope of contract comprises the supply, installation, testing & commissioning of 3200 TR water cooled central ac plants i.e. chillers, primary pumping, secondary variable pumping system, variable tertiary pumping system, automatic pressurization cum degassing system, cooling tower and associated valves and controls etc. , operation of the AC plant for 6 years (after commissioning and handing over of the system) and non comprehensive annual maintenance contract for 4 years (after expiry of 2 years of defect liability. The provision of all labour, materials, construction of plant equipment and transpiration, temporary works and everything, whether of temporary or permanent nature required in and for such construction, completion and maintenance so far as the necessity for providing the same is specified in or reasonably be inferred from the contract. The contractors shall make his own arrangements for the store storage of materials, accommodation for his staff etc. and no claim for the temporary accommodation from the contractor shall be entertained.

The contractor shall carry out and complete the said work in every respect in accordance with this contract and as per the directions and to the satisfaction of the Engineer-in-charge. Issue of further drawings and /or written instructions, detailed directions and explanations which are hereinafter collectively referred to as instructions of the engineer-in-charge in regards to:-

- a. The variation or modification of the design, quality, or quantity of works or the addition or omission or substitution of any work.
- b. Any discrepancy in the drawings or between the schedule of quantities and /or drawings and/or specifications.
- c. The removal from the site of any materials brought thereon by the contractor and the substitution of any other material thereof.
- d. The dismissal from the works of any persons employed thereupon.
- e. The opening up for inspection of any work covered up.
- f. The amending /making good of any defects.

The contractor shall forthwith comply with and duly execute any instructions of work comprised in such engineers-in-charge instructions, provided always that the verbal instructions and explanations given to the contractor or his representative upon the works shall, if involving a variation , be confirmed in writing by the contractor within seven days and is not dissented in writing within a further seven days by the Engineer-In-Charge, such shall be deemed to be instructions of the Engineer-In-charge within the scope of the contract.

4. **Contract Document:**

- 4.1 The several documents, forming the contract, are to be taken as mutually explanatory of one another and in case of ambiguities or discrepancies the same shall be explained and adjusted by the Engineer-In-Charge who shall thereupon issue to the contractor its interpretation directing in what manner the work is to be carried out. In case the contractor feels aggrieved by the interpretation of the Institute then the matter shall be referred to the Superintending Engineer and his decision shall be final, conclusive and bind on both parties.
- 4.2 The drawings etc. shall remain in the custody of the Institute. Two complete sets of drawings, specification and bill of quantities shall be furnished by the Engineer-In-Charge to the contractor in such time which must not delay the progress of the construction and the Institute shall furnish copies of any additional drawings, which in their opinion may be necessary for the execution of any part of the work. One complete set shall be kept on the work site and the Engineer-In-Charge and his representatives shall be, at all reasonable times, have access to the same. The contractor shall study the drawings thoroughly before the commencement of work. In case of any discrepancy, the contractor shall seek clarification before proceeding with the works. Figured dimensions are in all case to be accepted in preference to the scaled sizes. Large scale details shall take preference over small scale one.

The contractor shall give adequate notice in writing to the Engineer-in-charge of any further drawings or specification that may be required for the execution of the works or otherwise under the contract.

The Engineer-in-charge shall have full powers and authority to supply the contractor from time to time during the progress of the work such drawings and instructions as shall be necessary for proper execution and the contractor shall carry out and be bound by the same.

- 4.3 The successful tenderer shall be required to enter into an agreement with the Institute. The Bill of Quantities & rates filled by the successful tenderer in, the General Condition of the Contract for CPWD works 2014, CPWD specifications for Civil, Electrical & Air-conditioning works, the special conditions, additional specifications, negotiation letter and the award letter etc. shall form part of the agreement to be signed by the successful tenderer. The cost of stamp paper and stamp duty, required for the agreement, shall be borne by the contractor.

5. **Contract Agreement:**

The contractor shall, when called upon to do so, enter into and execute a contract agreement in the form annexed as Appendix VIII' with such modifications as may be necessary. The contract agreement, inclusive of its enclosures, shall remain in the custody of the Superintending Engineer, Institute Works Department, IIT Kanpur and the made available him as and when required contractor shall however be supplied, an attested copy there free of cost.

6. All tenderers are required to deposit earnest money in the form of FDR/CDR in the only duly endorsed in favour of Director, IIT Kanpur. Earnest money should be enclosed in a separate sealed envelope and tender documents should be enclosed in a another envelope superscribed “ **EARNEST MONEY- NAME OF WORK “ ITEM RATE-TENDER-NAME OF WORK”**” on the top of envelope. At the time

of opening of tender earnest money envelope will be opened first and in case earnest money is not found in the requisite form or amount envelope containing item rate tender of the party concerned shall be opened and will be summarily rejected and documents submitted will be confiscated by the Institute.

7. Canvassing in connection with tenders is prohibited and the tenders, submitted by the tenderers who resort to canvassing, are liable for rejection.
8. Tenderers shall have to sign the attached declarations and if the declaration is not found to represent a true statement of facts the contract is liable to be cancelled, earnest money forfeited, and the contractor shall have no claim on the Institute.
9. Tenderers are not allowed to make additions and alterations in the tender document. Any additions and alterations, if incorporated in the tender, shall be at the tenderer's risk since the modified tender is liable for rejection.

Conditional tenders violative of the spirit and the scope or the terms & conditions of the tender, are liable to be rejected without assigning any reasons. Tenders with any form of rebate shall be rejected summarily.

10. Water and electricity required for electrical & air-conditioning works shall be supplied free of charge.
11. Stamps duty on the security money shall also be the borne by contractor as per prevailing notification of U.P Govt.
12. Income tax shall be deducted as per prevalent law.
13. **Conditions for Electrical and Air-conditioning Works:-**

- 14.1 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.
- 14.2 All cuttings in cement plaster and brick shall be made good by using cement mortar 1:3 (1 part cement, 3 part coarse sand)
- 14.3 The cut surfaces shall be repaired by an experienced mason only so as to match the repaired plaster with the original.
- 14.4 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.

15. **Payment shall be regulated as under**
 - a.) 75% of the tendered rate on receipt of materials at site.
 - b.) 15% of the tendered rate on installation and connection.
 - c.) 10% of the tendered rate on testing and commissioning.
 - d.) The corresponding deducted security (2.5%) from the total completed cost item wise, shall be retained by IIT Kanpur till the completion of the

comprehensive warranty of the major equipment's or it may be released against the Bank Guarantee of same amount for the above said period. However, in addition to the above, during the operation & non comprehensive maintenance period of the central ac plant, 50% of the Performance Guarantee shall be retained as Security Deposit. The same shall be returned year wise proportionately.

16. Drawings/Data required prior to commencement of electrical/air-conditioning works:-

- 17.1 The following drawings shall be provided by the Engineer-In-Charge of the work:-
1. Plant room equipment layout, terrace cooling tower layout plan, tertiary pumping scheme layout, BMS architecture and chilled water connection drawings showing details of size, type, and mode of installation.
- 17.2 Following drawings shall be furnished by the contractor for the approval of the Engineer-In-charge after detailed design calculation before execution of the above work.
- a. Plant room detailed equipment layout, terrace cooling tower layout plan, tertiary pumping scheme layout, BMS architecture and chilled water connection drawings showing details of size, type, and mode of installation.
 - b. GFC for AC plant showing chilled water pipe header drawing showing details of size, insulation, cladding, type and mode of installation.
 - c. Detailed GA drawings of Chiller skid mounted pumps, PLC, expansion tanks, cooling tower, BMS software specifications with web base energy management software system and architecture. The detailed logic and architecture integrating the BMS of the new 6 nos. building BMS system, their tertiary pumping and chiller plant manager with the existing SCADA of IIT Kanpur.
 - d. Detailed typical connection drawings of Valves, Y strainers, piping and controls.

18. Completion drawings:

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

- i) As built GA and schematic layout drawings of the water cooled central AC plant.
- ii) Technical literature, test certificates, and operation and maintenance manuals for chillers, pumping system with their pump logic controllers, automatic pressurization system, cooling tower, valves, strainers and BMS system.

19. Works Inspection and Testing of Equipment:

5. Prior to dispatch of the Chillers, Pumps, expansion tanks & cooling towers, valves and other equipment's 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/International Standards. Contractor shall give a reasonable notice of about 15 days for the purpose of test, and witness of all major equipment's. The pre dispatch factory

inspection for all major equipment's like chiller's, pumps, cooling tower, expansion tank cum pressurization system & factory manufactured pre insulated pipe will be through duly constituted committee by the Institute for this inspection. The expenses shall be borne by the Institute and not to be loaded into the contract. The contractor shall only facilitate the inspection at manufacturing works.

One chiller with VFD will be factory tested at 4 points (100%, 75%, 50% & 25% Load) at constant condenser temperature.

- a.) Pre-commissioning test: All routine tests shall be carried out on the electrical & air-conditioning equipment. Protective & measuring devices should be checked for calibration. The checklists and pre commissioning tests for different equipment's have to be provided by the lowest tenderer at the time of equipment's specification approval.
20. Rates: The work shall be treated as on works contract basis and the rates tendered shall be for complete item of work and all charges for items contingent to the work, such as packing, forwarding, insurance, freight, testing charges and delivery at site for the materials to be supplied by the contractor, watch and ward of all materials at the site, labour related expenses as per relevant labour laws, testing of materials/samples etc. excluding Goods & Service tax (GST).

NOTE:- All the excavation and digging of the trenches shall be done manually as numbers of service line are passing inside the campus except in certain cases as approved by IITK. **No Hydraulic Excavator shall be allowed for earth digging work** except in certain cases as approved by IITK.

20.1. Taxes & Duties:

20.1.1 Being an indivisible works contract, no other tax is payable other than GST. The GST shall be as applicable to IIT Kanpur as per Government rules.

22. The earnest money of the unsuccessful tenderers shall be refunded on written request, within 1(one) month of the award of work. The earnest money of the successful tenderer shall however be adjusted towards the security deposit.
23. The tender document & drawings in respect of the work can be seen in the o/o Executive Engineer(Electrical & AC)
24. The tender document contains 170 pages. No page of the tender document shall be removed, mutilated, detached, or cancelled.
25. Rates for finished works shall be given for each items separately, in both words & figures. In the event of non-compliance, the tender shall be deemed incomplete and liable for rejection.
26. The work shall be executed on the basis of the following CPWD specifications:
- i) Electrical & HVAC Works:
- General specifications for Electrical Works Part-1 (Internal) 2013 with up to date corrections.

- General specifications for electrical works (external) 2013 with upto date corrections.
 - General specifications for electrical works Part-IV Sub-station- 2013with upto date corrections.
 - General specifications of HVAC works 2017 with up to date corrections.
28. For the purpose of clause 12 of the General conditions of contract the following schedule of rates shall be applicable.
- i) Electrical Works: Electrical Works, air-conditioning & refrigeration works:
Based upon prevailing market rates
29. The special conditions listed above shall take precedence over all above provisions of the contract. The General Condition of contract for CPWD works shall be generally followed including the clause 21 i.e. work shall not be sublet.
30. The contractor shall have to execute the work in such place and condition where other agencies will also be engaged for other works such as site grading, filling and leveling, interiors, landscape, and electrical and mechanical engineering works, etc. No claim shall be entertained due to work being executed in the above circumstances.
31. No contractor, to whom the provisions of the BOCW Act apply, shall be allowed to commence work on the campus unless he has produced the 'Registration Certificate' issued by the office of Dy. CLC (Central).
32. The contractor shall engage only such workers who are registered as beneficiaries with U.P. BOCW Welfare Board and in case of engagement of new workers; he shall ensure the submission of applications for registration of such workmen within appropriate time.
33. A certificate for administrative convenience shall be obtained from the contractor covered under BOCW Act whether he has engaged 10 or more workmen while working in the Institute and only thereafter, Cess @1% from the bills raised by him shall be deducted at source for all running works. Cess, so deducted shall be deposited with the BOCW Welfare Board.
34. As per clause 36 (I) of GCC: It should be noted that license & competent welder and fitter shall only be allowed for the piping work.

TERMS & CONDITIONS OF ANNUAL OPERATION OF AC PLANT FOR 6 YEARS (i/c 2 YEARS DEFECT LIABILITY) AND NON COMPREHENSIVE ANNUAL MAINTENANCE OF THE ENTIRE SYSTEM FOR 4 YEARS (AFTER 2 YEARS OF DEFECT LIABILITY PERIOD)

Scope of Work & Special Conditions

For the Annual Operation and Non Comprehensive Maintenance Contract (AOMC) of 4X800 TR new central AC plant, the following are the scope of works and special conditions of contract.

1. The under mentioned equipment are covered in the scope of Annual Operation and Non Comprehensive Maintenance Contract;
 - a) 4 Nos. Centrifugal Compressor of 800 TR capacity with Refrigerant gas complete with Motors, Condensers, Chillers, CPM with Microprocessor Controllers, Power & Control Cabling, Pipe Lines, and Valves also covered under the scope of work.
 - b) 5 Nos. skid mounted vertical inline Condenser Water Pumps along with motor.
 - c) 5 Nos. skid mounted variable vertical inline secondary Chilled Water Pumps along with motor, drives and Pump logic controller.
 - d) 5 Nos. skid mounted vertical inline Primary fixed Chilled Water Pumps along with motor.
 - e) 6 sets of skid mounted Tertiary variable Chilled Water Pumps along with motor, drives and Pump logic controller installed at various building end.
 - f) 4 Nos. induced draft Cooling Towers complete with direct drive fan motor assembly, pipes, strainer, makeup water tank supporting structures (overhead & underground and its pumps) etc.
 - g) Automatic Pressurization cum expansion tank.
 - h) Dirt Separator.
 - i) Main Electrical Panels for incoming/outgoing feeders to all drives in the AC plant room, auto transformer start for compressor & all starter panels etc. all repairs on electrical items are included. In case of replacement of major part/component because of normal wear & tear is required that shall be arranged by the Institute.
 - j) 1 No. Water Softening Plant outside the plant.
 - k) Dirt Separator
 - l) BMS System

2. The following works are covered in the Scope of work of Annual Operation and Maintenance Contract;
 - (i) To keep all the equipment's of central ac plant in neat & clean conditions,
 - (ii) Operation of the entire Central AC plant 24 X7 hrs. throughout year (including the BMS System), i.e. including holiday and Sunday) including tertiary pumping of the 8 no. buildings commissioned in the above project.

- (iii) The quarterly visit of the OEM of chiller for monitoring the health of chillers and will generate the reports accordingly, guidance/instructions/ maintenance advisory to the contractor for smooth and trouble free running of the system. OEM shall produce the reports and submit to the Engineer In Charge through the contractor. The OEM shall depute an Engineer at site whenever called by IIT Kanpur or if any need arises for their presence at site without any extra charges till the defect liability period and comprehensive warranty of the system.
 - (iv) The half yearly visit of the OEM of pumps, expansion tank, BMS System, water softening plant & Cooling tower for monitoring the health of pumps, expansion tank, BMS System & Cooling tower and will generate the reports accordingly, guidance/instructions/ maintenance advisory to the contractor for smooth and trouble free running of the system. OEM shall produce the reports and submit to the Engineer In Charge through the contractor.
 - (v) Recording the readings of pressure gauges and temperatures both at inlet and outlet, current voltage etc. all other relevant parameters in the logbook. Maintain a maintenance register for day to day maintenance of AC plant.
 - (vi) Generation of MIS reports on daily, weekly, fortnightly, monthly, yearly basis through BMS system and reporting to the site engineer.
 - (vii) Checking and recording of water level in cooling towers and make up water tank.
 - (viii) Checking, tightening of various connections for electrical, mechanical and air-conditioning items of HVAC system and lubrication of bearings.
 - (ix) Checking/attending the water level system for make up water tank and cooling tower so that the overflow of water/wastage of water can be stopped.
 - (x) Attending routine day to day maintenance and informing the Institute for civil work if required.
 - (xi) Checking & tightening all connection, remaining vibration, noise in equipments.
 - (xii) Tightening of nuts & bolts, coupling etc. of various equipments including greasing and oiling.
 - (xiii) The operation and day to day maintenance shall have to be carried out as per manufacturer's procedures/instructions for all measure equipment's.
 - (xiv) The contractor should submit the shift duty chart of staff deputed on AC plant to the site engineer on regular basis.
 - (xv) The contractor should submit maintenance detail carried out during the month at the end of each month.
 - (xvi) Salt charging of water softening plant at regular interval. The amount of salt required for charging as per the requirement is covered in the above scope of works.
- 3.** The plant shall be handed over on "as is where is" basis. All the four compressors are in working conditions. The contractor shall be solely responsible for operation, maintenance and upkeep of the plant in good running condition. The contractor shall take charge of the total inventory of the plant equipment.

Note: For any future expansion of the Central AC Plant in the same building, no any extra operation charges shall be admissible, whereas for non-comprehensive maintenance extra charges shall be paid to the contractor proportional to the capacity enhancement in the tonnage of the AC plant.

- 4. Any refrigerating gas or lubricating oil required for topping up/or during breakdown (upto defect liability period & comprehensive warranty period) in all the four machines shall be in the scope of contractor , at any time during the period of AOMC, shall be supplied by the contractor. However, the same shall be supplied by the contractor and charge shall be borne by IIT Kanpur after expiry of defect liability period and comprehensive warranty. The contractor has to supply compressor oil (52 gallon or as per requirement for 1 no. machine), refrigerant ,temperature sensors & oil filter's required by 1 no. machine as spare for Chiller machine of Central AC plant always in stock as inventory till the completion annual operation of the entire Plant.**

- 5. The Equipment's or machinery will be maintained free of charge by the supplier during the comprehensive warranty period and defect liability period.**

6. All minor indigenous spare parts required in routine maintenance are included in the scope of contract. However if any imported spare parts are to be changed or repaired of the main motor for the compressors requires rewinding and replacement and any major indigenous parts like PVC filling of cooling tower, cooling tower gear box, fan assembly, MS base frame, electric motor, electric switchgears in the existing panel/ starters and other modification works etc. because of normal wear & tear these shall be arranged by the AOMC agency during the 2 years of defect liability period and comprehensive warranty period. After the expiry of the warranty and defect liability period and the cost shall be borne by the Institute or the Institute may also procure directly where as the fixing, testing & commissioning charges shall be covered under AOMC.

7. Repair of all condenser, chilled water refrigerant, pipes and valve etc. is included in the scope of work. The re-insulation and cement plaster over the insulation and painting etc. of the AC plant are also included. However replacement of pipe lines/ valve of required shall be arranged by the AOMC agency and cost shall be borne by the Institute or the Institute may by the procure directly and pay only the installation charges.

8. The scope also covers the painting of the complete piping of AC plant once a year.

9. All type repairs/replacement of the parts of condenser pumps, chilled water pump, tertiary pumps, expansion tank, dirt separator and cooling tower including rewinding of its motor are also included in the scope of contract till the defect liability period & comprehensive warranty. However, in case of failure of the above motors, due to negligence in O&M will have to be borne by contractor after the expiry of DLP/comprehensive warranty.

10. The preventative maintenance schedule shall be prepared and submitted in advance and the necessary shutdowns may be taken with prior permission of the Institute. The list of preventive maintenance of various equipment's are listed as mentioned below:
 - i. Descaling of condenser from time to time to maintain the efficiency of the plant, as per direction of the engineer-in-charge.
 - ii. Regular salt charging of the softening water plant
 - iii. List of preventive maintenance activities alongwith the schedule have to be provided by the lowest tenderer at the time of specification approvals of the individual items through OEM.

9. A list of all components and consumable items replaced shall be maintained along with other records of plant maintenance and operation. Proper log sheets of running the plant and record for preventative maintenance of the plant shall be maintained. These recorded shall be put up to the engineers – in – charge on regular basis.

10. The standard Operating Procedures and Preventive Maintenance schedule shall be pasted inside the central AC plant along with the safety procedures, refrigerant leakage preparedness.

11. A suitable shutdown shall be given in winter for the annual preventative maintenance of the plant. All the equipments should be thoroughly checked and maintained for proper functioning of all the systems. All the major equipment, pipeline, supports & cooling towers etc. in the plant room shall be painted once in a year with approved colour. All relays installed in electrical panel shall be checked and tested once in a year. Which shall be duly checked by engineers-in-charge Changing of oil & oil filter also shall be done during the annual maintenance. Decaling of condensers & chillers shall be done during winter shutdown once in a year also shall be done as & when required.

12. It shall be responsibility of the contractor to supply adequately trained manpower necessary for the operation and maintenance of AC Plant as follows:-

There shall be four persons (3 Nos. operators (2s nos. semi-skilled, 1 no. skilled) and 1 No. electrician (skilled) in day shift) and 3 Nos. operators in second & third shift in AC Plant, round the clock for seven days a week.

The current minimum wages as per central Government labour commissioner as on 02.03.2020:

1. Unskilled : Rs. 603/day
2. Semi-skilled : RS.666/day
3. Skilled : RS.733/day

In addition to above 1 No. Electrical supervisor (8-10 year experienced diploma or 4-5 years experienced graduate engineer Electrical/mechanical) shall be available in day shift.

The contractor shall be responsible for all the requirement of labour laws governing such deployment. If any violation is noticed any time the contractor shall be solely responsible. Subletting of work in any manner shall not be allowed and if found at any later stage, the contract shall be terminated.

13. There shall be a penalty in case of short supply of manpower as specified & poor quality of maintenance and also for the not attending breakdowns within reasonable time. A penalty of Rs. 150/- per man shift shall be per month and this penalty shall increase to Rs. 300/- per man shifts if the shortage in more than 30 man shifts a month. For poor quality of maintenance and for not attending breakdowns within reasonable time. The contract may be rescinded as per contract agreement.

14. Only the quality and experienced staff for operation and maintenance of the Ac plant shall be engaged. The qualifications and experience of the staff shall be as under:-

Category	Qualifications and experience
1. Engineer	Degree(Electrical/Mechanical) with 4-5 years experience or diploma with 8-10 years experience in similar fields.
2. Supervisor/Operator	ITI in refrigeration & Air conditioning or 4-5 years experience in similar fields.
3. Electrician	ITI in electrician trade with 4-5 years experience in similar filed.

The proof of qualification & experience of staff has to be submitted to Institute and which shall be verified by the engineer- in charge.

15. Contactor shall abide by all the necessary requirement of labour laws while engaging the operating staff in the AC plant.
16. The contractor shall have to maintain proper log book on the prescribed form and shall make the record available for inspection by the Institute. The log book format will be given by the Institute.
17. The contractor shall be responsible to maintain proper discipline of the operating staff in the AC plant in discharge of their duties. However the Institute shall have the right to ask any of the operating staff to leave the premises if in the opinion of the institute the conduct/ behavior and activities of the individual concerned is subversive and not in the interest of Institute.
18. The schedule of preventative maintenance of the plant and its equipment shall have to be prepared and submitted to the engineer-in-charge well in advance so that shutdown program can be issued for maintenance works.
19. Any other piece of work not specifically mentioned above but essential for the normal operation and maintenance is also covered in the scope of work.
20. The payment against operation and non-comprehensive maintenance during the contract period of one year shall be made against monthly running bills equivalent to 1/12 of the accepted amount for AOMC.
21. The contribution of EPF & ESI by the contractor shall be reimbursed on actual basis and production of the receipt of deposit of the same in office of competent authority's. Administrative expenses deposited by the contractor shall not be reimbursed.
22. The minimum wages to be paid to the operators shall be as per Central Government , revised by the Labour Commissioner (Central) from time to time.
23. If the prescribed minimum wages are revised by the labour commissioner (Central), the contractor shall revise the wages of the workers accordingly. The difference in minimum wages, with respect to the wages applicable from the month of **start of operation** + 7.5% shall be reimbursed to the contractor, in addition to the contract amount against worker deputed for operation of the AC plant (round the clock).
24. No contractor, to whom the provision of the BOCW Act apply, shall be allowed to commence the work on the campus unless he has produced the registration certificate, issued by the office of Dy. CLC(Central)

25. The contractor shall engage only such workers, who are registered as beneficiaries with UP BOCW and in case of engagement of new workers: he shall ensure the submission of applications for registration of such work men within appropriate time.

26. A certificate for administration convenience shall be obtained from the contractor covered under the BOCW Act whether he has engaged 10 or more workmen while working in the Institute and only thereafter Cess @ 1% from bills raised by him shall be deducted at source for all running works. Cess, so deducted shall be deposited with the BOCW welfare board.

**DESIGN BASIS REPORT (DBR) – CONSTRUCTION OF
NEW 3200 TR WATER COOLED CENTRAL AC PLANT
IIT KANPUR**

It is proposed to construct additional 4000 TR capacity water-cooled Central AC plant to have chilled water for air conditioning of following under construction/planned buildings at IIT Kanpur as there is no capacity available in the existing AC plants to cater to the additional loads. The Total Plant capacity shall be 4000 TR (5 x 800 TR) out of this 3200 TR (4x800 TR) shall be installed in Phase –I. The balance 800 TR (1x800 TR) shall be provided in Phase-II later.

Under Construction/planned Buildings	Est. AC Load considering 65% diversity(TR)	Anticipated air-conditioning load with contingencies	Module of Chiller proposed
<ul style="list-style-type: none"> • Engineering Core Labs • Aerospace Engg Bldg. • Science & Technology Park • Research Complex Building • Earth Science Engineering Bldg. • CEM Building 	<ul style="list-style-type: none"> ➤ 573 ➤ 390 ➤ 585 ➤ 536 ➤ 195 ➤ 300 	2600 TR	4 x 800 TR Water Cooled Centrifugal Chillers (3X800 TR working and 1x800 TR as stand by)

A. Air-Conditioning System:

The nature of loads and period of operation being different for each building, it is proposed for installation of chilled water system comprising of energy efficient AHRI/Eurovent Certified water cooled centrifugal chillers with chiller plant manager, IKW/TR at AHRI Conditions shall be 0.54 and part load IPLV shall be less than 0.35 NPLV less than 0.37 , to work in conjunction with constant speed condenser water recirculation pumps, induced draft cooling towers, fixed speed primary chilled water pumps, variable speed secondary chilled water pumps, variable speed tertiary chilled water pumps, automatic pressurization system with inbuilt expansion system cum degasser ,dirt separator with air separator unit & Building Management System (BMS) of the central ac plant with Energy Management System to facilitate year round efficient air-conditioning system with energy saving features.

Entire high side equipment, such as Centrifugal chillers with chiller plant manager, constant speed condenser water recirculation pumps, fixed speed primary chilled water pumps, variable speed secondary pumping, variable speed tertiary chilled water pumps, automatic pressurization system, motor control centre & Building Management System shall be installed in a AC plant room of size 42X21 m2 and cooling towers on the terrace of the plant room. Water filtration and softening plant near the plant room

building to generate chilled water required for air conditioning of the new upcoming buildings. Variable speed tertiary chilled water pumps associated with each building shall be installed in the respective building, which will not only isolate different buildings from main ac plant but also would save energy.

The space required for 3 nos (2 working + 1 standby) tertiary pumps in each building shall be planned during detailed engineering. The space in each building have been earmarked for pumps installation.

Chilled water thus generated in the central ac plant shall be pumped to the tertiary pump room in each building and from there, to various air handling units and fan coil units located at various levels thru risers designed for uninterrupted recirculation in the buildings.

Design Parameters for selection of Centrifugal Chillers: The design data for IIT Kanpur has been considered as given below

Site Location	Kanpur
Geographic Location	26.26 Deg. N
Altitude	126 M above mean sea level
Ambient Temperature	109° F (42.8° C)
Temperature of Water entering chiller	54° F (12.2° C)
Temperature of Water leaving chiller	44° F (6.7° C)
Temperature of Water entering condenser	90° F (32.2° C)
Temperature of Water leaving condenser	100° F (37.8° C)
Fouling factor of condenser (FPS)	0.001
Fouling factor of chiller (FPS)	0.0005
Type of refrigerant	HFC (R134A) or HFO (Hydro Fluoro Olefins) as per ASHRAE/NBC 2016 allowed safety standard
Certification	AHRI/Eurovent

The salient features of design proposed for centrifugal central ac plant contributing to energy saving & their brief specifications shall be as under:

- i. Centrifugal Chiller (800 TR) with Chiller Plant Manager for automatic operation shall be with unit mounted factory supplied VFD (Variable Frequency Drive) with COP greater than 6.5 (under AHRI/ Eurovent condition) and NPLV shall be less 0.37, The refrigerant will be HFC (R134A) or HFO, as per ASHRAE/NBC 2016 allowed safety standard. The VFD and motor must have IP54 protection. Chiller shall be capable of unloading from 100% to 20% % without any surging. **The chiller shall be with variable flow across evaporator for energy saving.** The variable frequency drive will help in energy saving and enable the chiller to cater the variable ac load in the upcoming buildings. **One chiller with VFD will be factory tested at 4 points (100%, 75%, 50% & 25% Load) at constant condenser temperature .**
- ii. All the pumps shall be vertical inline skid mounting type for proper dynamic balancing, which will increase the life of the pumps and will increase the

running efficiency of the pumps. The skid-mounted pumps will help in proper hydronic balancing as per the design & will take lesser time in execution of the work.

- iii. Variable speed primary CHW pumping with lower head (12 m) with flow rate of 1920 USGPM of each pump , secondary variable pumping with head (25 m) with flow rate of 1920 USGPM of each pump & tertiary CHW pumping system (20 – 25 mtr. Head and variable flow of each pump set) for chilled water modulation at source to establish energy savings on high side. The variable pumping have reduced the ratings of the motor of primary and tertiary pumps.
- iv. Other features of Energy efficient Centrifugal chillers :

Equipment	IKW/TR at AHRI Conditions	COP at AHRI Conditions
Water cooled Centrifugal	<0.54	>6.5

- v. Characteristics of green refrigerant HFO (Hydro Fluoro Olefins) or HFC (R134A) to be used with desired Ozone depletion potential (ODP) and Global warming potential (GWP):
 - a. HFO or HFC (R134A) Refrigerant shall be as per ASHRAE/NBC 2016 safety standard.
- vi. CTI certified induced draft type cooling towers with energy efficient motors of class IE-03 for energy saving.
- vii. Water filtration & softener plant integrated with the treated STP water for condenser water cycle will help in water saving.
- viii. Installation of Automatic pressurization system with water expansion tank facility, air degasser and air separator will help in maintaining g of the constant pressure, degassing of the dissolved gases in the chilled water. This will prevent the motor running on high load, thus saving energy, increases life of the chilled water piping by preventing corrosion from the dissolved gases. The air separator will also help in energy saving by removing air in the system and preventing motor running on high amperes. The automatic air release from the system will help in cooling efficiency of the entire system.
- ix. Building Management System (BMS) with energy management system will help in monitoring, control, energy auditing of the entire high side & low side ac equipment's. This will help in achieving minimum uptime of the ac services and planning for energy saving in the air-conditioning on regular basis.

The AC Plant energy scenario: The equipment for Central AC plant have been selected for maximum energy efficiency, which is also meeting the ECBC PLUS 2017 code of BEE , Government of India for Centrifugal chillers. However, our design meets in totality for the Water-cooled Chilled water AC plant Super ECBC 2017 building code norms as per BEE. The maximum threshold (kW/KWr) value for water cooled chilled water plant should be equal to or less than 0.20 kW/kWr to qualify for Super ECBC code 2017.

Designed water-cooled Chilled water AC plant kW/kWr is 0.20, which is as per Super ECBC 2017 code.

Sr.No.	Selected Equipment	IKW/TON at Max Load	NPLV	Min. COP or KW/KWr (Max) As per ECBC + Code	Designed COP or KW/KWr(max) at Max Load	Designed COP or KW/KWr (max) As per IPLV
			IKW/Ton			
1	Chiller	0.54	0.37	6.5	6.5	9.5
2	Primary Pump	0.0275	0.018425	-	-	-
3	Secondary Pump	0.04375	0.029313			
4	Condenser Pump	0.06875	0.046063			
5	Cooling Tower	0.0332	0.022244			
	Total IKW/Ton	0.7132	0.486044	0.23	0.20	0.14

TECHNICAL SPECIFICATION

Section 1: Chillers

Section 2: Pumps

Section 3: Cooling Tower

Section 4: Expansion Tank System

Section 5: Dirt Separator

Section 6: Water Softener Plant

Section 7: BMS (Building Management System)

Section 8: Piping

Section 9: Insulation

Section 10: Associated controls

Section 11: Water Plumbing

Section 12: Electrical Works

Section-1. Chiller Specification:

This chapter covers the requirements of chillers suitable for centrifugal types of refrigerating machines for air-conditioning.

1 Types

This section covers the shell and tube type water chillers. These may be again of the following types:-

- a) For reciprocating type units the chiller shall be Direct expansion (DX) type
- b) For centrifugal type units the chiller shall be of Flooded type or falling film type .
- c) For screw type units the chiller shall be of Direct expansion (DX) type or Flooded type or falling film type..

1.1 Shell and Tube Type Water Chillers

1.1.1 Rating

- i) In a package water chilling machine, the chiller shall match the compressor capacity specified in the tender specifications. The chiller shall be selected for 4.4 degree C temperature drop of water through the chiller for reciprocating/scroll compressor & 5.5 deg C for centrifugal & screw type compressors .
- ii) The fouling factor shall be 0.0001 hr. sq.mtr. degree C temperature difference/K. Cal. Unless otherwise specified in the tender specifications.

Material and Construction

- i) The water chiller shall be horizontal, shell and tube type, designed, constructed and tested for the refrigerant specified in the tender specifications.
- ii) The chiller shall be designed for a working pressure on the refrigerant side suitable for the refrigerant offered, and on the water side for 10 kg./sq.cm. gauge.
- iii) The end plates of chiller shall be made of MS of thickness not less than 25mm.
- iv) The shell of the chiller shall be made of MS of thickness not less than 8mm with electric fusion welded seams.
- v) The tubes shall be of seamless, hard drawn copper with a minimum tube wall thickness of 0.71 mm for plain tubes & minimum 0.63mm at the root of fins.

vi) The tubes shall be plain for DX type chillers and may be either plain or internally finned for flooded type chillers as per manufacturer's design.

vii) The tubes shall be rolled into grooves in the tube sheets and flared at ends.

viii) Intermediate tube supports of steel or polypropylene shall be provided at spacing not less than 1250 mm for flooded type chiller and 500mm for DX type chiller to prevent sagging / vibration of tubes.

ix) The flooded chillers shall have water boxes designed for multi pass flow. The DX type chillers shall be provided with adequate number of properly spaced baffles so that the water passes through the tube bundle many times.

x) The chiller shall be smooth finished with one coat of zinc chromate primer before the insulation is applied.

xi) The chiller shall be sand blasted from both inside (before insertion of tubes) & outside.

Connections and Accessories :For DX Type Chiller

Cycling shutdowns with a VSD shall include:

i) VSD shutdown – requesting fault data

ii) VSD – stop contacts open

iii) VSD initialization failed

iv) VSD - high phase A,B,C instantaneous current

v) VSD – phase A,B,C gate driver

vi) VSD – single phase input power

vii) VSD – high DC bus voltage

viii) VSD – pre charge DC bus voltage imbalance

ix) VSD – high internal ambient temperature

x) VSD – invalid current scale selection

xi) VSD – low phase A, B, C inverter heat sink temp.

xii) VSD – low converter heat sink temperature

xiii) VSD – pre-charge - low DC bus voltage

xiv) VSD – logic board processor

xv) VSD – run signal

xvi) VSD – serial communications

Motor starter

i) For constant speed compressor Starter for motor shall be as per details given under para —Motor Starterl.

ii) For variable speed compressor

a) In Case of VSD starter, it will vary the compressor motor speed by controlling the frequency and voltage of the electrical power to the motor. The adaptive capacity control logic shall automatically adjust motor speed and compressor pre-rotation vane position independently for maximum part-load efficiency by analyzing information fed to it by sensors located throughout the chiller

.b) To Limit Harmonic generation from VSD, Active Harmonic Filters as per IEEE 519 must be used at the source itself.

c) Drive will be PWM type utilizing IGBT's with a power factor of 0.95 or better at all loads and speeds.

d) Make of VSD shall be exactly same as per OEM/approved make list. The variable speed drive shall be with all power and control wiring between the drive and chiller factory installed and unit mounted, including power to the chiller oil pump.

e) Field power wiring shall be a single point connection and electrical lugs for incoming power wiring will be provided.

iii) The following features will be provided:

(a) Door interlocked circuit breaker capable of being padlocked.

(b) UL listed ground fault protection.

(c) Over voltage and under voltage protection.

(d) 3-phase sensing motor over current protection.

Sensing thermostat in each room. It shall sense room temperature and vary the supply air when cooling.

RADIANT COOLING SYSTEM

Scope This section describes the basic requirement of Radiant cooling system with embedded pipes inside the slab during casting of the floors/slab of a building.

Principle The principle of Radiant cooling system is based on the utilization of the thermal mass of building components. Due to the large thermal storage mass of walls,

cool room temperatures can comfortably be enjoyed even in the summer when the outside temperature is high. The heat loads arising in the room are absorbed by cool solid building elements. The storage characteristic of solid concrete parts is utilized by polymers pipes carrying cooling realizing "limitless" thermal storage.

Features i. The pipe shall be of high-quality and all central components of laying systems shall be pressure-resistant, rugged and impermeable to oxygen.

ii. For subsurface heating and cooling permanently sealed compression sleeve jointing technique shall be used.

iii. The system shall be corrosion resistance.

iv. The pipe shall have good abrasion resistance.

v. Even temperature profiles shall be maintained.

vi. The pipe material shall be such that minimum noise gets transmitted along the pipe.

1.1.2 System advantages and benefits

i. Easy and quick assembly

ii. Comfortably temperature-controlled floor surface

iii. Minimal air speeds

iv. No upsetting of dust

v. Optimum room arrangement flexibility

vi. Low operating temperatures

vii. Suitable for heat pump and solar power systems

viii. No maintenance costs

The DX type chiller shall be provided with the following connections and accessories and conforming to the Section —Refrigeration Piping where applicable: -

a) Refrigerant inlet and outlet connections

b) Thermostatic / Electronic type expansion valve(s) with adjustable superheat control and external equalizer part,

c) Line solenoid valve, or pilot solenoid valves as required.

d) Water inlet and water outlet connections

e) Drain connection with stop valve for water side only.

f) Vent connection with valve.

g) Flow switch in water line.

For Flooded Type Chiller The flooded type chiller shall be provided with the following connections and accessories and conforming to section —Refrigeration Piping where applicable:

a) Refrigeration inlet and outlet connections.

b) Liquid refrigerant float for level control/ expansion valve/ fixed or variable orifice.

c) Pressure relief device.

d) Charging connection with valve.

e) Eliminator plate.

f) Drain and vent connections with valves

g) Water inlet and outlet connections

h) Proper oil return system.

i) Flow switch/pressure switch/differential flow switch/ flow sensor in the water line (s).

Pressure Testing

a) The chiller shall be tested in the works to 1.5 times the maximum working pressure for the refrigerant specified in the tender specifications, or 21 kg./sq.cm. (Pneumatic), whichever is higher.

b) The water side of the chiller shall also be tested to a hydraulic pressure of 10 kg./sq.cm. at the works.

c) Pressure test certificates shall be produced in respect of each chiller.

Insulation

The insulation shall be done as per section 9.

Equipment Class	Maximum IkW/TR at ARI conditions	Minimum COP * at ARI conditions	Minim - um IPLV	Test Standard
Air Cooled Chiller <530 kW (<150tons)	1.21	2.9	3.16	ARI 550/590-1998
Air Cooled Chiller ≥530 kW (≥150 tons)	1.15	3.05	3.32	ARI 550/590-1998
Centrifugal Water Cooled Chiller <530 kW (<150tons)	0.61	5.8	6.09	ARI 550/590-1998
Centrifugal Water Cooled Chiller ≥530 kW and <1050 kW (≥ 150 tons and <300 tons)	0.61	5.8	6.17	ARI 550/590-1998
Centrifugal Water Cooled Chiller ≥1050 kW (≥300 tons)	0.56	6.3	6.61	ARI 550/590-1998
Reciprocating Compressor, Water Cooled Chiller all sizes	0.84	4.2	5.05	ARI 550/590-1998
Rotary Screw and Scroll Compressor, Water cooled chiller <530 kW (<150 tons)	0.75	4.7	5.49	ARI 550/590-1998
Rotary Screw and Scroll Compressor, Water cooled chiller ≥530 kW and <1050 kW (≥ 150 tons and <300 tons)	0.65	5.4	6.17	ARI 550/590-1998
Rotary Screw and Scroll Compressor, Water cooled chiller ≥1050 kW (≥300 tons)	0.61	5.75	6.43	ARI 550/590-1998

Chiller Plant Optimizer: Chiller Plant Optimizer shall be provided in the plant room for Chilling Unit (s), Chilled Water Pumps /Primary Chilled Water Pumps, secondary chilled water pumps, Condenser Water Pumps and Cooling Towers . The Chiller Plant Optimizer shall be of the same manufacturer/ OEM as that of the Chilling Unit.

REFRIGERANT PLUMBING Design aspects of Refrigerant Plumbing

i) Refrigerant piping shall be designed and installed so as to:

- a) ensure circulation of adequate refrigerant at all loads.
- b) ensure oil return to crank case of compressor positively and continuously.
- c) keep pressure losses within limits, especially in suction lines.

ii) Outdoor airflow rate/ floor area: 1.5-2.5 (6) l/s/m²

- iv) Outdoor airflow rate/ effective length: 5-12 l/s/mix) Cooling capacity / floor area: 120 (200) W/m²x) Cooling capacity / beam effective length: 350 (500) W/mxi) Heating capacity / floor area: 60 (80) W /m²) Heating capacity / beam effective length: 200 (300) W/m

v) Technical specifications

i) The active chilled beam shall have an integral recirculation air path through the perforated front panel. The induced room air flow rate shall be manually adjustable via three setting positions without influencing the primary air supply flow rate. The airflow rate of the chilled beam shall be adjustable without plugging or changing the nozzles.

ii) The primary air flow rate shall be adjustable over a wide range via a supply air unit integrated into the chilled beam.

iii) Outdoor air flow rate control shall not have any effect on coil cooling and heating capacities.

iv) The beam with adjustable air flow rate shall have only one duct connection. The appearance of the chilled beams with constant air flow and variable air flow rate shall be the same.

v) The front panel shall be openable from either side in order to allow general maintenance and cleaning. The front panel shall be removable without any special tools.

vi) The air supply to the room space shall be either unidirectional or bi-directional.

vii) The position of the duct connection shall be changeable without the use of any special tools.

viii) The frame, front, and side panels shall be made of galvanized steelplate.

ix) All visible parts shall be white/ painted to match the ceiling colour.

x) All pipes shall be manufactured from copper, and connection pipes with a wall thickness of 0.9-1.0 mm.

xi) The fins shall be manufactured from aluminum.

xii) Optionally, heating shall be incorporated within the heat exchanger by means of two 10-mm pipes, connected in series.

xiii) All joints shall be soldered and factory pressure-tested.

xiv) The pipework's operation pressure should be 1.0 MPa.

xv) The active chilled beam shall have an air flow adjustment damper as an option and a measurement tap to allow air flow measurement.

xvi) As an option, an exhaust valve shall be integrated into the chilled beam.

xvii) In tropical countries like India, The chilled beam should have drain pan and pump to collect and dispose-off the condensate.

VARIABLE AIR VOLUME SYSTEM The Variable air volume system uses Variable speed drives for fan volume control providing a great deal of flexibility for multiple zones in temperature control and efficiency, good control of ventilation air quantities, and opportunity for higher levels of filtration.

VAV Diffusers The modules shall vary the supply air volume to provide both VAV heating and VAV cooling in individual rooms controlled through a room temperature

All equipment shall be supplied as per manufacturer's standard finish painting.

CHILLED BEAMS System description Chilled beam system is an air conditioning system for cooling, heating and ventilation in spaces for good indoor climate and individual space control. The chilled beam system is an air/water system that utilizes the heat transfer properties of water and provides comfortable indoor climate energy efficiently.

System mounting: The Chilled Beams shall be ceiling mounted and consisting of a heat exchanger, a number of nozzles and a plenum in which dehumidified air is supplied.

System operation: Chilled beam systems are designed to use the dry cooling principle operating with conditions in which condensation is prevented by control applications. Ventilation using active chilled beams is an efficient mixing ventilation application that results in uniform air quality. Supply air is diffused from linear slots on either both sides or on only one side of the chilled beam. Ventilation in passive chilled beam systems is typically arranged using mixing ventilation with ceiling or wall diffusers. Alternatively, floor diffusers can be used. Cooling Active chilled beams use the primary air to induce and recirculate the room air through the heat exchanger of the unit, resulting in high cooling capacities and excellent thermal conditions in the space. Passive beam operation is based on free convection in the heat exchanger and supply air distribution is realized with separate diffusers. Heating Integration of heating into chilled beams is recommended when heating capacity is low enough (200-300 W/m) and the U-value of the windows prevent a down-draught under the window.

Typical input values and operation range i) Room temperature: 23-25 °C

ii) Supply air temperature: 16-19 °C

iii) Water inlet temperature: 14-16 °C

iv) Target duct pressure level: 70 -120 Pa

v) Target water flow rate: 0.02-0.08 kg/s

vi) Sound pressure level < 35 db (A)79

d)prevent oil/liquid refrigerant from entering the compressor when the compressor is working as well as when it has stopped.

i)prevent trapping of oil in evaporator or suction lines, which may return to the compressor in the form of slug.

ii)Hot gas lines: a)Oil shall be entrained and carried by hot gas under all load conditions likely to be encountered in normal operation .

iii)Liquid Lines :

a)Liquid lines shall be designed to ensure that flashing of liquid refrigerant does not occur by minimizing the pressure drop suitably, by avoiding long vertical risers, and appropriate sub cooling.

b)Each liquid line shall be provided with a permanently installed refrigerant drier of throw away or rechargeable type. The drier shall be installed in a valve line.

c)Flow indicator (moisture indicating type) shall be installed on all liquid lines.

iv)Suction Lines :

a)Oil shall be entrained and carried by the suction gas under all conditions of load likely to be encountered in normal operation.

b)Piping shall be designed for a suitable velocity of refrigerant(similar to hot gas line) to ensure that oil will not separate from the gas and drain to the compressor in slugs.

c)The refrigeration system shall be equipped with controls for pump down system so that the evaporator and suction line are emptied before the compressor shuts off, thus preventing liquid refrigerant and oil from entering the compressor when restarted.

d)Refrigerant lines shall be sized to limit pressure drop between evaporator and condensing unit to less than 0.2 kg. per sq.cm.(3 psi).

v)Isolating valve shall be provided to enable isolation of each compressor in case of multiple compressor units (as built in valves), strainer, drier and any other components as may be required for proper operation and maintenance.

vi)Thermostatic / Electronic type expansion valve/ float valve shall be provided in refrigerant circuit of DX system/ flooded system.

Material i)Refrigerant plumbing for reciprocating type refrigeration plant and packaged type AC plants shall be with copper tubes, with tube thickness

conforming to L type to ATM standards. The tubes shall be bright annealed copper upto and including 15 mm size. The tube shall be suitable for the duty involved.

Fittings like bends, tees, sockets etc. shall be of wrought copper or forged brass and shall be suitable for the duty involved. Flare type compression fittings of forged brass shall be allowed upto 15 mm piping size. Tubes upto and including 15 mm size may be bent to form 90 degree bends with inside radius not less than 3 tube diameters. For bigger sizes, bend fittings as mentioned above must be used.

Where specified in the tender specification, mild steel may be provided for refrigeration piping, with seamless MS tubes and fittings of heavy class conforming to IS: 1239. All liquid lines and instruments lines shall however be of copper only. Refrigerant plumbing for centrifugal/ screw type chilling machine shall be of mild steel or wrought iron / copper to manufacturer's standards. Valves shall be of the packed, back-seating type for both copper and MS refrigerant plumbing work, and these shall be of forged or cast brass construction.

Pressure Testing:

i) After completion of the piping installation, the entire chilling unit shall be pressure tested with dry nitrogen or any other inert gas at the following pressures for the particular refrigerant to be used: -Refrigerant Test pressure (Kg./Sq.cm. (Gauge)High pressure side Low pressure side R-134a This test shall be carried out as follows: -

a)The system shall be charged with nitrogen or inert gas to 1.0 Kg./sq.cm. gauge and all joints shall be checked for leakage with a mixture of four part water, one part liquid soap and a small amount of glycerin. Leaks shall be marked, pressure released and repairs done. Brazed joints, which leak, shall be opened and redone. These shall not be repaired by addition of brazing alloy to the joints.

b)The system shall now be charged with nitrogen or the inert gas to the pressure specified in the above table and the process of locating leaks and repairs shall be repeated.

ii)Final pressure test :After all the leaks have been repaired, the system shall be retested with the test pressure maintained for a period of not less than 8 hours. No measurable drop in pressure should be detected after the pressure readings are adjusted for temperature changes. Pressure gauges, controls and compressors may be valve off during pressure testing. coil circuit should be sized for adequate water velocity but not exceeding 1.8 m/s. The air velocity cross the coil shall not exceed 155 m/min.

Fan : This shall consist of two light weight aluminum impellers of forward curved type, both statically and dynamically balanced, along with properly designed

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

Drain Pan: Drain pan shall be fabricated out of minimum 1.00 mm thick stainless steel sheet covering the whole of coil section and extended on one side for accommodating coil connection valve etc. and complete with a 25mm drain connection. The drain pan shall be insulated with 10mm thick closed cell polyethylene foam insulation and jacketed from outside with single piece moulded FRP tray.

Air Filter : The filter shall be cleanable type 15mm thick with 90% efficiency down to 10 micron of dry cleanable synthetic type to be mounted behind the return air grill in the unit casing.

Speed control :A sturdy switch shall be provided with the unit complete with wiring, for ON/OFF operation and with minimum three speed control of the fan.

Automatic controls: Each unit shall have a room type thermostat and a solenoid 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 water valves on inlet line shall be of gun metal ball type with internal water strainers, having BSP female pipe thread inlet and flare type male pipe thread outlet connection. The valves on return line shall be as above, but without the water strainer.

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

INSULATION :The drain pan shall be insulated as per para PAINTING

Any pathogens growing in the stagnant tank will also be dispersed in the air. Ultrasonic humidifiers should be cleaned regularly to prevent bacterial contamination from being spread throughout the air. The amount of minerals and other materials can be greatly reduced by using distilled water, though no water is absolutely pure. Special disposable demineralization cartridges may also reduce the amount of airborne material,

Instruments and Valves The following instruments shall be provided at the specified locations in the AHUs for the chilled water / hot water system: -

i)Pressure gauges at the inlet and outlet of the coil with tubing and gauge cock.

ii)Stem type thermometers at the inlet & outlet of coil with tubing & gauge cock.

iii)Butterfly valve at the inlet and outlet of coil.

iv)Balancing valve at the outlet of coil.

v)Y-strainer at the inlet of coil.

vi)Motorised 2-way diverting/ mixing valve along with proportionate thermostat. Controls The air handling unit shall be so installed as to transmit minimum amount of vibration to the building structure. Adequate vibration isolation shall be provided by use of rubber/ neoprene pads and/or vibration isolation spring mountings.

FAN COIL UNITS: General -The fan coil units shall be floor/ wall/ ceiling mounted draw through type complete with finned coil, fan with motor, insulated drain pan, cleanable air filters and fan speed regulator and other controls as described. Casing The casing shall be fabricated out of minimum 1.25mm thick G.S.S. sheet. Cooling coil The coil shall be of seamless copper tubes with aluminum fins. The fins shall be uniformly bonded to the tubes by mechanical expansion of the tubes.

The MICROPROCESSOR CONTROLLER: Each chilling unit shall be complete with a microprocessor based interactive control console in a locked enclosure factory mounted (directly on the unit), prewired with all operating and safety controls and tested. It will provide start, stop, safety, interlock, capacity control and indications for operation of the chiller units through a alphanumeric / graphical display. Controls shall provide to view and change digital programmable essential set points, cause of shutdown and type of restart required. a)Leaving chilled water temperature, b)Percent current limit.c)Remote reset temperature range. All safety and cycling shutdowns shall be enunciated through the alphanumeric/ graphical display and consist of day, time, cause of shutdown and type of restart required. Cycling shutdown shall include low leaving chilled water temperature, chiller/ condenser water flow interruption, power fault, internal time clock and anti-recycle. Safety shutdowns shall include low oil pressure, high compressor discharge temperature, low evaporator pressure, motor controller fault and sensor malfunction.

The default display screen shall indicate the following minimum information

i)date and time

ii)return and leaving chilled water temperatures

iii)return and leaving condenser water temperatures

iv)differential oil pressure

v)percent motor rated current

vi)evaporator & condenser refrigerant saturation temperatures

- vii) chiller operating hours (hour run) and
- viii) number of compressor starts
- ix) oil sump temperature (not required for reciprocating compressor)
- x) status message

Security access shall be provided to prevent unauthorized change of set points, to allow local or remote control of the chiller and to allow manual operation of the prerotation vanes and oil pump. The chiller shall be provided with ports compatible with open protocol building management system offered, to output all system operating information, shutdown/ cycling message and a record of last four cycling or safety shutdowns to a remote printer (option) . The control centre shall be programmable to provide data logs to the printer at a set time interval. Control centre shall be able to interface with an automatic controls system to provide remote chiller start/ stop; reset of chilled water temperature, reset of current limit, and status messages indicating chiller is ready to start, chiller is operating, chiller is shut down on a safety requiring reset and chiller is shut down on a recycling safety.

The microprocessor control system shall include the interlocking of compressor motor with chilled and condenser water flows, guide vane position of compressor in case of centrifugal units and lubricating oil pump pressure. On initiation of start, the microprocessor control system shall check all pre-start safeties to verify that all prestart safeties are within limits. (If one is not, an indication of the fault will be displayed and the start aborted).

INSTALLATION: The complete chilling unit shall be installed over a RCC foundation and shall be adequately isolated against transmission of vibrations to the building structure. Special attention shall be paid to the alignment of the driving and driven shaft. Final alignment shall be checked at site in presence of the Engineer-in-charge using a dial indicator. Necessary foundation bolts, nuts, leveling screws etc wherever required for mounting the unit shall be provided by the contractor.

PAINTING: The equipment shall be supplied as per manufacturer's standard finish painting

CENTRIFUGAL COMPRESSORS (CONSTANT SPEED AND VARIABLE SPEED)

Type- Centrifugal compressor shall be open/ semi-sealed type. It shall be AHRI/Eurovent certified. It shall be working on CFC and HCFC free refrigerant. It shall work on HFC(R134A) or HFO refrigerant as per ASHRAE/NBC 2016 allowed standard. The impeller shall be of shrouded design and made of cast aluminium alloy of high strength and protected against corrosion. This shall be statically and dynamically balanced and over speed tested, so as to ensure vibration free operation. The impeller shaft or drive end of the gear shaft, as the case may be, shall be connected with the motor through a flexible coupling in case of open design and rotor shaft in case of

hermetic design. The compressor casing shall be of high strength ductile casting and of such design that servicing can be carried out without disturbing connections. Drive gear 49 made up of the evaporator & evaporator fan. The compressor can be provided along with the condenser or the evaporator depending upon the manufacturer's practice or the required application at site.

ii)The two portions shall be piped together at site. Separate fans along with their drives shall be provided for the condenser and evaporator portions. The compressor motor shall be interlocked with the following:

i)Air flow switch in the evaporator fan discharge.

ii)Air flow switch in the condenser fan discharge.

Interlocking : The compressor motor shall be interlocked with the following:

i)Air flow switch in the evaporator fan discharge

ii)Differential pressure switch in the condenser water line

iii)Condenser water pump

iv)Cooling tower fan motor

Filters

i)Cleanable aluminum wire mesh/ synthetic media type air filters, at least 25 mm thick, shall be provided, swung fit to prevent air by pass.

ii)Face velocity across the filters shall not exceed 100 m/min. Humidification Where close control of RH is required provision of pan type humidifier shall be made as per specifications. Micro process controller Each packaged units shall be equipped with a micro-processor controller having all operating & safety controls. Insulation of packaged units shall be as per specification. Power Consumption Rating for Packaged Air Conditioner under test conditions Cooling Capacity Maximum Power Consumption in Watts Tons of Refrigeration Water Cooled Air Cooled

AIRCOOLED PACKAGED TYPE PLANTS

Scope : This chapter covers the requirements of packaged type air-conditioning plants with air-cooled condensers of 5, 7.5, 10 ,15 and 20 TR capacities. General Construction The air-cooled package unit shall be supplied in two portions –outdoor portion made up of the condenser & condenser fan and indoor unit

i)The centrifugal compressor shall be preferably variable speed.

ii)The variable speed compressor shall have compressor/ chiller manufacturer's factory matched variable speed drive.

iii)Where the impeller is designed for operation at speed higher than the drive motor, necessary speed increasing gear shall be connected to the impeller shaft in a self aligning and balanced way. The gears and pinion shall be pressure lubricated.

iii) Variable speed drive (VSD) drive shall be installed with appropriate controls in accordance with section

iv) Bearings : The compressor shall incorporate the necessary design features to take both axial and radial thrusts. The bearings shall be of self aligning type. The bearing shall be pressure lubricated during operation and shall be completely sequenced and interlocked with the startup of the machine in such a way that oil pump should start earlier than the

machine and the machine should start after some time, provided the required oil temperature and pressure is maintained during the startup period.

- v) Shaft seal : The compressor shaft seal (in case of open type machines) shall be as per manufacturer's standard design. The seal should have small face area and low rubbing speed. It should provide an efficient seal under both vacuum and pressure lubricated during compressor operation. The seal must effectively prevent the leakage of refrigerant along the shaft during shut down periods. During operation an oil film should prevent outward leakage of refrigerant.
- vi) Lubrication system : Lubrication system must ensure complete forced and speed lubrication (at a pressure and controlled temperature) to all bearing surfaces under any speed conditions, at start up, at shut down and during operation at various loads. Adequate arrangement shall be provided to take care of lubrication during failure of power or abnormal shutdown. Full lubrication must be available to the machine during acceleration and deceleration periods through an automatic auxiliary motor driven pump. The lubrication system should include the following:

a) Filter mesh size shall be as per manufacturer's standard.

b) Oil level indicator: Oil coolers and oil heaters (with built-in thermostat to aid maintaining constant temperature) The compressor shall be complete with all accessories such as drive arrangement (for open drive machines), capacity control, safety controls.

Capacity Control :

a) The compressor shall be equipped for modulating the capacity from 100% upto the 20% at constant condenser entering water temperature without surging and hot gas bypass. The pre rotation vanes located at the impeller inlet for controlling the capacity shall be aero foil shaped and shall be made as per manufacturer's standard. The vane position shall be controlled through hydraulic/ linkage system.

b) The positioning of the vane shall be through microprocessor-based controller with its sensing elements in the outgoing chilled water lines. The automatic damper will enable maintenance of specified chilled water temperature within +0.11 deg C. Safety Control : Safety controls shall be provided as per specifications —Equipment Safety controls. Inter locking It shall be as per specifications Drive motor:

i) The drive motor shall be an independent and coupler type or semi-hermetic/ hermetic type depending on the design adopted by the manufacturer.

ii) The electric motor shall be of squirrel cage type and shall be suitable for operation on 400/415 V +10%, 3 phase, 50 Hz, AC supply. All Compressor motors in Screw and Centrifugal chillers with variable speed compressors shall be provided with VFD and shall also be suitably designed for use with Variable Frequency Drive.

iii) Synchronous speed of the motor shall not exceed 3000 RPM.

iv) Continuous BHP rating of the motor shall not be less than the maximum power requirement of the compressor and drive under specified design conditions.

v) The motor shall be TEFC or SPDP as per installation requirement for open type chiller unit and Totally Enclosed refrigerant cooled for hermetic / semi hermetic type chiller unit. For outdoor (exposed to atmosphere) chiller applications, TEFC motor shall be used .

vi) Motor protection during over current shall be provided through winding temperature sensor in case of refrigerant cooled motors/ current sensing in each phase through microprocessor in case of open type air cooled motors.

vii) Power factor correction capacitors as required to maintain a displacement power factor of 95% at all load conditions shall be provided.

Control Console : Drain valve, air vent, test cock connection, facility with valves for descaling of tubes etc. Cooling Coil

i) Cooling coil shall be 3 or 4 rows deep, as per manufacturer's standards, made of copper tubes of minimum 0.5 mm thickness and aluminium fins of minimum 0.15 mm thickness, mechanically bonded to the coils.

ii) No of fins per cm of tube shall be 4 to 5.

iii) Coil shall be fitted with equalizing copper distributor to ensure that each coil circuit receives equal amount of refrigerant.

iv) The coil shall be designed for a face velocity of not more than 155m/min. Coil shall be thoroughly evacuated, dried and pressure tested to 21 Kg /sq.cm (300 psi).

Refrigerant Plumbing:

i) The unit shall be complete with refrigerant plumbing using copper tubes. Plumbing work shall be in accordance of these specifications.

ii) The refrigerant circuit shall include thermo-static expansion valve and suction gas strainer.

iii) The work shall include provision of suction line insulation as per manufacturer standards.

Fan and Drive

i) Fan shall be statically and dynamically balanced single/double inlet centrifugal type, designed for quiet operation. The fan wheel shall be constructed of aluminium or galvanised steel. Self-oiling bearing easily accessible for maintenance, with thrust collar shall be provided. Preferably, the bearings shall be life lubricated sealed type, mounted on vibration absorbing resilient supports.

ii) The fan shall be belt driven through adjustable pulley permitting air quantity to be varied by adjusting the fan speed. Suitable fan belt tension adjusting arrangement shall be provided.

iii) The fan motor shall be mounted within the cabinet. This shall be of TEFC enclosure, squirrel cage, induction motor of suitable HP for the duty involved. This shall be located with proper alignment with fan pulley for the belt drive.

iv) Starter (DOL) and independent SPP shall be provided.

v) The CMH and static pressure of the fan shall be as specified in the schedule of work. A conditioned air outlet from the cabinet should be provided with suitable flanges in order to connect it to the canvas of the supply air ducting at the cabinet top.

vi) A return grill of streamlined design shall be provided in the elevation in front of the filter section. This grill should be easily removable for inspection / maintenance of filter.

Compressor:

i) Compressor shall be scroll hermetic or semi hermetic type suitable for CFC/HCFC free refrigerant.

ii) It shall be fitted with suction and discharge stop valves, permitting full servicing facilities, built in safety controls, filters, release valves, control valve and other standard accessories.

iii) The compressor shall be installed on vibration isolating resilient material, so as to ensure operation with the minimum noise and vibrations.

iv) Each compressor shall be provided with protection against high refrigerant pressure and low refrigerant pressure, anti-cycle timer, indication lamps, fault alarm etc through microprocessor controller.

v) Compressor shall be designed for 4.4 deg C suction temperature and 43.3 deg C discharge temperature.

Compressor Drive:

i) The compressor motor shall be squirrel cage induction motor capable of continuous operation at 415 V +10% , 50 Hz, 3 phase AC supply.

ii) The motor shall be suction cooled, in case of sealed semi-hermetic type units.

iii) The starter shall be as per para 13.9 and shall be provided on the packaged unit itself.

Condenser:

i) Condenser shall be of horizontal shell and tube construction with M.S. shell and integrally finned copper tubes. Thickness of tube shall be minimum 1.0 mm before finning.

ii) The end covers shall be removable type and suitable provision shall be made in the unit cabinet, enabling easy cleaning of condenser tubes.

iii) The condenser shall serve as liquid receiver for the refrigerant circuit & shall be complete with following: -

a) Inlet and outlet refrigerant connections.

b) Inlet and outlet water connections.

c) Relief / purge valve and connections.

The chiller shall be controlled by a stand-alone microprocessor based control center. The chiller control panel shall provide control of chiller operation and monitoring of chiller sensors, actuators, relays and switches. The chiller control panel shall also provide: 1. System operating information including:

i) return and leaving chilled water temperature

ii) return and leaving condenser water temperature

iii) evaporator and condenser saturation temperature

iv) differential oil pressure

v) percent motor current

vi) evaporator and condenser saturation temperature

vii) compressor discharge temperature

viii) oil reservoir temperature

ix) compressor thrust bearing positioning and oil temperature

x)operating hours

xi) number of compressor starts

Digital programming of set points through the universal keypad including:

i)leaving chilled water temperature

ii)percent current limit

iii)pull-down demand limiting

iv) six-week schedule for starting and stopping the chiller, pumps and tower

v)remote reset temperature range

Status messages indicating:

i)system ready to start

ii)system running

iii)system coast down

iv) system safety shutdown-manual restart

v)system cycling shutdown-auto restart

vi) system pre-lube

vii) start inhibit

The text displayed within the system status and system details field shall be displayed as a color coded message to indicate severity: red for safety fault, orange for cycling faults, yellow for warnings, and green for normal messages. Safety shutdowns enunciated through the display and the status bar, and consist of system status, system details, day, time, cause of shutdown, and type of restart required. Safety shutdowns with a fixed speed drive shall include:

i)evaporator – low pressure

ii)evaporator – transducer or leaving liquid probe

iii)evaporator – transducer or temperature sensor

iv) condenser – high pressure contacts open

v)condenser –high pressure

vi)condenser –pressure transducer out of range

vii)auxiliary safety –contacts closed

viii)discharge –high temperature

ix)discharge –low temperature

- x)oil –high temperature
- xi)oil –low differential pressure
- xii)oil –high differential pressure
- xiii)oil –sump pressure transducer out of range
- xiv)oil –differential pressure calibration
- xv)oil –variable speed pump –pressure set point not achieved
- xvi)control panel –power failure
- xvii)motor or starter –current imbalance
- xviii)thrust bearing –proximity probe clearance
- xix)thrust bearing -proximity probe out –of –range
- xx)thrust bearing –high oil temperature
- xxi) thrust bearing –oil temperature sensor
- xxii) watchdog –software reboot.

Safety shutdowns with a VSD Shall include:

- i)VSD shutdown –requesting fault data
- ii)VSD –stop contacts open
- iii)VSD –110 % motor current overload
- iv)VSD –high phase A, B,C inverter heat-sink temp.
- v)VSD –high converter heat-sink temperature

Cycling shutdowns enunciated through the display and the status bar, and consists of system status, system details, day, time, cause of shutdown, and type of restart required. Cycling shutdowns with a fixed speed drive shall include:

- i)multiunit cycling –contacts open
- ii)system cycling -contacts open
- iii)oil –low temperature differential
- iv)oil –low temperature
- v)control panel -power failure
- vi)leaving chilled liquid -low temperature

- vii)leaving chilled liquid -flow switch open
- viii)motor controller –contacts open
- ix)motor controller –loss of current
- x)power faultxi)control panel -schedule
- xii)starter –low supply line voltage
- xiii)starter –high supply line voltage
- xiv)proximity probe –low supply voltage
- xv)oil -variable speed pump -drive contacts open

For variable speed compressor

a)In Case of VSD starter, it will vary the compressor motor speed by controlling the frequency and voltage of the electrical power to the motor. The adaptive capacity control logic shall automatically adjust motor speed and compressor pre-rotation vane position independently for maximum part-load efficiency by analyzing information fed to it by sensors located throughout the chiller.

b)To Limit Harmonic generation from VSD, Active Harmonic Filters as per IEEE 519 must be used at the source itself.

c) Drive will be PWM type utilizing IGBT's with a power factor of 0.95 or better at all loads and speeds.

d)Make of VSD shall be exactly same as per OEM/approved make list. The variable speed drive shall be with all power and control wiring between the drive and chiller factory installed, including power to the chiller oil pump.

e)Field power wiring shall be a single point connection and electrical lugs for incoming power wiring will be provided.

iii) The following features will be provided:

- (a) Door interlocked circuit breaker capable of being padlocked.
- (b) UL listed ground fault protection.
- (c) Over voltage and under voltage protection.
- (d) 3-phase sensing motor over current protection.
- (e) Single phase protection.
- (f)Insensitive to phase rotation.
- (g)Over temperature protection.

Digital readout at the chiller unit control panel of output frequency, output voltage, 3-phase output current, input Kilowatts and Kilowatt-hours, self-diagnostic service parameters. Separate meters for this information will not be acceptable. 1For capacity > 300 TR, IKW/TR shall not exceed 0.56 . For variable speed compressor IPLV of the compressor shall not exceed 0.35.

Section 2

I. Pumps

SCOPE: This chapter covers the general requirements of water circulating pumps for central air-conditioning, central heating, ETAC and cold room applications. This section does not cover either humidification pumps or spray pumps for spray over coils.

2.1 TYPE:

The pumps shall be skid mounted vertical inline centrifugal type direct driven with a 3 phase, 415 + 10%volts, 50 Hz., A.C. motor. The motor for Chilled Water Pumps shall be integrated/mounted with Variable Frequency Drive. The motor starter for Condenser Water Pump shall be in accordance. The motor shall be screen protected drip proof (SPDP) fan cooled or TEFC type. The efficiency class of motors shall be IE 3 class as per IS 12615. The pumps may be either of vertical split casing (HSC) type with operating speed not exceeding 1500 rpm, or solid casing, mono block type with operating speed not exceeding 3000 rpm as specified in the tender documents. Efficiency of the pumps at selection should be preferably 70 % or above.

2.2

RATING

The pumps shall be suitable for continuous operation in the system. The head and discharge requirements shall be as specified in the tender documents. The discharge rating shall not be less than the flow rate requirement of the respective equipments through which the water is pumped. The head shall be suitable for the system and shall take into consideration the pressure drops across the various equipments and components in the water circuit as well as the frictional losses. The pumps offered shall be of high efficiency. Pump motors greater than or equal to 3.7 kW (5 hp) shall be controlled by variable speed drives.

2.3

MATERIAL AND CONSTRUCTION

i)The centrifugal pumps shall conform to IS 1620. The motor for chilled water pumps shall be suitable for use with variable frequency drive. The motor starter for condenser water pump shall be in accordance with specifications. The motor shall be screen protected drip proof (SPDP) fan cooled type. The efficiency class of motor shall be IE 3.

ii)The pump casing shall be of heavy section close grained cast iron. The casing shall be provided with air release cock, drain plug and shaft seal arrangement as well as flanges for suction and delivery pipe connections as required.

ii) The impeller shall be of bronze or gunmetal. This shall be shrouded type with machined collars. Wear rings, where fitted to the impeller, shall be of the same material as the impeller.

iv) As far as possible, long radius elbows and gradual changes in shape shall be used to maintain uniform velocity accompanied by decreased turbulence, lower resistance and minimum noise. The ratio of the size of the duct to the radius of the elbow shall be normally not less than 1:1.5.

v) Flanged joints shall be used at intervals not exceeding 2500 mm. Flanges shall be welded at corners first and then riveted to the duct.

vi) Stiffening angles shall be fixed to the sides of the ducts by riveting at 1.25 meters from joints for ducts of size 600 mm to 1500 mm, and 0.6m from joints for ducts of size larger than 1500 mm. Bracings for ducts larger than 1500 mm can alternatively be by diagonal angles.

vii) Plenums for filters shall be complete with suitable access door of size 450 mm x 450 mm.

viii) All factory fabricated duct shall be supplied in L sections, the length of any piece shall not be more than 1800 mm for duct with longest side of cross section as 600 mm and above and 3000 mm for rest.

Air Outlet and Inlets (Supply and Return)

i) All air outlets and intakes shall be made of extruded aluminium sections & shall present a neat appearance and shall be rigid with mechanical joints.

ii) Square and rectangular wall outlets shall have a flanged frame with the outside edges returned or curved 5 to 7 mm and fitted with a suitable flexible gasket between the concealed face of the flanges and the finished wall face. The core of supply air register shall have adjustable front louvers parallel to the longer side to give up to 22.5 degrees vertical deflection and adjustable back louvers parallel to the shorter side to achieve a horizontal spread air pattern to at least 45 degrees. Return air grilles shall have only front louvers. The outer framework of the grilles shall be made of not less than 1.6 mm thick aluminum sheet. The louvers shall be of aero foil design of extruded aluminum section with minimum thickness of 0.8mm at front and shall be made of 0.8mm thick aluminum sheet. Louvers may be spaced 18 mm apart.

iii) Square and rectangular ceiling outlets/intakes shall have a flange flush with the ceiling into which it is fitted or shall be of anti-smudge type. The outlets shall comprise an outer shell with duct collar and removable diffusing assembly. These shall be suitable for discharge in one or more directions as required. The outer shell shall not be less than 1.6mm thick extruded section aluminum sheet. The diffuser assembly shall not be less than 0.80 mm thick extruded aluminium section.

iv) Circular ceiling outlets/intakes shall have either flush or anti smudge outer cone as specified in the tender specifications. Flush outer cones shall have the lower edge of the cone not more than 5 mm below the under side of the finished ceiling into which it is fitted. Anti smudge cones shall have the outer cone profile designed to

reduce dirt deposit galvanized steel sheets, in case of G.I. sheet ducting or 1.8 mm thick aluminium sheet, in case of aluminium sheet ducting and shall be stiffened with 25 mm x 25 mm x 3 mm angle iron braces.

v) Circular ducts, where provided shall be of thickness as specified in IS:655 as amended upto date.

vi) Aluminium ducting shall normally be used for clean room applications, hospitals works and wherever high cleanliness standards are functional requirements.

Associated Items i) Supply/ return air outlets, F.A. grilles and accessories shall be constructed from extruded aluminium sections.

ii) Flanges for matching duct sections, stiffening angles (braces) and supporting angles shall be of rolled steel sections, and shall be of the following sizes.

Application	Duct Width	Angle size	Flanges
Upto 1000 mm	35 mm x 35 mm	3 mm-do-	
1001 mm to 2250 mm	40 mm x 40 mm	3 mm-do-	
More than 2250 mm	50 mm x 50 mm	3 mm	

Bracings Upto 1000 mm 25 mm x 25 mm x 3 mm-do- More than 1000 mm 40 mm x 40 mm x 3 mm Support angles Upto 1000 mm 40 mm x 40 mm x 3 mm-do- 1001 mm to 2250 mm 40 mm x 40 mm x 3 mm-do- More than 2250 mm Size and type of RS section shall be decided in individual cases

iii) Hanger rods shall be of mild steel and of at least 10 mm dia for ducts upto 2250 mm size, and 12 mm dia for larger sizes.

iv) All nuts, bolts and washers shall be zinc plated steel. All rivets shall be galvanized or shall be made of magnesium - aluminium alloy. Self tapping screws shall not be used.

CONSTRUCTION Ducts i) Ducts shall be fabricated at site or factory fabricated and shall be generally as per IS: 655 "Specifications for metal air ducts", unless otherwise deviated in these General Specifications.

ii) The interior surfaces of the ducting shall be smooth.

iii) All the ducts upto 600 mm longest side shall be cross broken between flanges by a single continuous breaking. Ducts of size 600 mm and above shall be cross broken by single continuous breaking between flanges and bracings. Alternatively, beading at 300 mm centres for ducts upto 600 mm longest side, and 300 mm centers for ducts above 600 mm size shall be provided for stiffening shall be smooth finished for minimum frictional loss. The impeller shall be secured to the shaft by a key.

iv) The shaft shall be of stainless steel and shall be accurately machined. The shaft shall be balanced to avoid vibrations at any speed within the operating range of the pump.

v) The shaft sleeve shall be of bronze or gunmetal. This shall extend over the full length of the stuffing box or seal housing. The sleeve shall be machined all over and ground on the outside.

vi) The bearings shall be ball or roller type suitable for the duty involved. These shall be grease lubricated and shall be provided with grease nipples/cups. The bearings shall be effectively sealed against leakage of lubricant.

vii)The shaft seal shall be stuffing box type unless otherwise specified, so as to allow minimum leakage compatible with the operation of the seal. The stuffing box shall be of adequate length and shall be packed with graphite asbestos or any other suitable material for the operating temperature. A drip well shall be provided beneath the seal.

viii)In the case of HSC pumps, the same shall be directly coupled to the motor shaft through, a flexible coupling protected by a coupling guard. In case of mono block pumps with solid casing, the motor and pumps shall be on a common shaft.

ix)The pump and motor shall be mounted on a common base plate either of cast iron or fabricated from rolled steel section. The base plate shall have rigid, flat and true surfaces to receive the pump and motor mounting feet.8.5 ACCESSORIES Each pump shall be provided with the following accessories: -

a)Pressure gauges at suction and discharge sides,

b)Butterfly valves on suction and discharge, and

c)Reducers, as may be required to match the sizes of the connected pipework.

d)Non—return valve at the discharge.

INSULATION The thermal insulation of the pump casing for hot/chilled water circulating pumps shall be of the same type and thickness as provided for the connected pipe work

INSTALLATION i)The pump and motor assembly shall be mounted and arranged for ease of maintenance and to prevent transmission of vibration and noise to the building structure or excess vibration to the pipe work.

ii)More than one pump and motor assembly shall not be installed on a single base or cement concrete block. The mass of the inertia blocks shall not be less than the combined mass of the pump and motor assembly. The inertia block shall be vibration isolated from the plant room floor by 25 mm. neoprene or any other equivalent vibration isolation fittings. Where spring mountings are used for vibration isolation, these shall be complete with leveling screws and lock nuts and shall be placed over a concrete plinth for distribution of the mass of the assembly over the plant room floor. The pump motor sets shall be properly aligned to the satisfaction of the Engineer-in-charge.

PAINTING The pumps shall be supplied with the manufacturer's standard finish painting.

VARIABLE FLOW HYDRONIC SYSTEMS

Variable Fluid Flow in Chilled or Hot Water System Secondary Chilled or hot-water systems shall be designed for variable fluid flow and shall be capable of reducing pump flow rates to no more than the larger of: a)50% of the design flow rate, or the minimum flow required by the equipment manufacturer for proper operation of the chillers, or boilers.8.9.2Automatic Isolation Valves Water cooled air-conditioning or heat pump units with a circulation pump motor greater than or equal to 3.7 kW (5 hp) shall have two-way automatic isolation valves on each water

cooled air-conditioning or heat pump unit that are interlocked with the compressor to shut off condenser water flow when the compressor is not operating .

II. SKID MOUNTED SYSTEM FOR PUMPING SYSTEM

The all pumping system shall be factory designed, built, tested and assembled Skid Mounted.

The Skid shall be including following items,

1. Pump as per below specification
2. Concentric Expander-Delivery
3. Non Return Valve-Delivery
4. Spool pipe-Delivery
5. Butterfly Valve-Delivery
6. Delivery Manifolds
7. Eccentric Expander-Suction
8. Suction Diffuser (Manifold)
9. Spool pipe-Suction
10. Butterfly Valve-Suction
11. Suction Manifold
12. Base Frame with Wheel
13. Pressure Transmitter
14. Pressure Gauge
15. Pipe Support
16. Trolley Wheel
17. Panel Stand

PUMP TECHNICAL SPECIFICATION (PRIMARY/CONDENSER/SECONDARY/TERTIARY PUMP)

1.0 Scope:

This specification covers the design, materials of construction, features, performance and testing of the vertical In-line pumps. Pump shall be suitable for the purpose they are intended.

2.0 Codes and Standards:

The design, material, construction, manufacture, inspection, testing and performance of vertical Inline pumps shall comply with all currently applicable statutes, regulations and safety codes in the locality where the Equipment will be installed. The Equipment supplied complies with the latest applicable Indian, American or equivalent Standards.

3.0 General:

The pumps shall be single-stage, close/split coupled, in-line suction and discharge ports of identical diameter with top-pull-out design. Hence, the rotating unit can be removed and serviced without disconnecting the suction and discharge piping.

The pump and motor shall be factory assembled at the pump manufacturer's facility. Installation instructions shall be included with pump at time of shipment. The pump manufacturer shall have complete unit responsibility.

For Tertiary pumping system, the pump shall be close-coupled only.

4.0 Features of Construction:

4.1) Pump Casing:

Pump spiral volute casing shall be of in-line design robust construction with integrally-cast base at bottom in order to transmit pipe load to the base and foundation (Small pumps can be without base). Liquid passages in the casing shall be smooth finish to ensure high Efficiency. Pump casing shall capable of withstanding 1.5 times the design pressure.

Pump casing shall be EN-GJL-250 Grey Cast Iron and capable of withstanding to the maximum pressure developed by the pump.

Flange dimensions are in accordance with EN 1092-2 or ISO 7005-2.

Pump casing shall be fitted with bronze wear ring.

4.2) Impeller:

The impeller shall be cast bronze enclosed type with smooth surface finish for minimum frictional loss. This ensures high Efficiency. Impeller shall be keyed to the shaft and secured by impeller lock nut. All impellers are dynamically balanced to ISO 1940-1: Grade G6.3. The thrust balancing can be of balancing holes or back vanes.

The direction of rotation of the impeller is clockwise when viewed from the drive end.

4.3) Shaft:

Pump shaft shall be Austenitic stainless steels according to EN 1.4301 / AISI 304 stub shaft and the same shall be, ground and polished to final dimensions and be adequately sized to with stand all stresses, hydraulic loads, vibrations and torques coming in during operation.

Shaft run-out shall be limited at the seal face and at the impeller to 0.05 mm.

Shaft shall be provided with Mechanical seal as default fitment to provide leak free operation.

4.4) Wear Rings:

A renewable type bronze wearing ring shall be provided in the pump casing to maintain close running clearance and to minimize leakage and recirculation losses and to ensure high pump efficiency.

4.5) Mechanical Seals:

The stuffing box cavity shall be sealed off at the pump shaft by an internally or externally-flushed mechanical seal with carbon / Silicon carbide face material, suitable for continuous operation up to 140 Deg C.

4.6) Bearings:

As radial and axial forces are absorbed by the fixed bearing in the motor drive-end, the pump requires no bearing.

Bearing shall be effectively sealed to prevent loss of lubricant or entry of dust or water.

4.7) Coupling:

The pump coupling should be of close-coupled type with stub shaft. And in case of Split coupled, it should be Long coupled.

4.8) Motors:

Motor shall be a flange mounted, totally enclosed fan-cooled motors with main dimensions

according to IEC standards. Electrical tolerances are to IEC 60034. Motor shall be high-efficient type.

Motor shall be to with IP 55 enclosure. The class of insulation shall be F with temperature rise limited to Class B.

Motor shall be suitable for operation on a 415 V ($\pm 10\%$ variation), 50Hz $\pm 5\%$, 3phase, or 240V-1phase AC supply. Motor shall be suitable for both DOL and / or STAR/DELTA starting

Pump and motor shall be factory aligned and shall be realigned by the contractor as per factory recommendations after installation.

For Primary and Condenser, the pump motor shall be 4 pole and in case of Secondary pump, the pump motor shall be 2 pole/4 pole and frequency converter mounted on pump motor for secondary pump.

And for Tertiary pump upto 11 Kw, The pump is fitted with a fan-cooled, permanent-magnet synchronous motor. The motor efficiency is classified as IE5 in accordance with IEC 60034-30-2. The motor includes a frequency converter and PI controller in the motor terminal box. This enables continuously variable control of the motor speed, which again enables adaptation of the performance to a given requirement.

And for Above 11 Kw, the tertiary pump is fitted with a fan-cooled asynchronous induction motor. which the frequency converter shall be integrated/mounted on the pump motor.

Tertiary pump motor shall be 2 pole.

4.9) Name plates:

Each pump shall be provided with a name plate indicating the following details:

1. Pump type designation
2. Pump Model
3. Rated flow
4. Rated head
5. Pressure rating/max temperature
6. Rated speed

4.10) Working pressure:

Maximum allowable working pressure (MAWP) for all the pressure containing parts shall in no case be less than the maximum discharge pressure produced by the pump at shut off (including tolerances), at the max suction pressure, for the maximum impeller diameter and the maximum continuous speed.

Pump shall be rated for minimum of 10 bar working pressure.

4.11) Vibration:

The pump(s) vibration limits shall conform to Hydraulic Institute ANSI/HI 1.1-1.5-1994; section 1.4.6.1.1 or ISO 10816 for recommend acceptable unfiltered field vibration limits (as measured per HI 1.4.6.5.2) for pumps with rolling contact bearings.

4.12) Sound Level:

Sound pressure level of the pump driver shall be max 78 dbA* measured at 1.8m distance from pump for the duty points.

(* Note: Based on the motor kW and speed according to ISO 3743)

4.13) Painting:

The equipment shall be thoroughly cleaned and greased. All rust sharp edges and scales shall be removed. All external and exposed cast iron parts of pumps have an epoxy-based coating made in a cathodic electro-deposition (CED) process which is high-quality dip-painting process and which would prevent rusting and corrosion. The colour code for the finished product is NCS 9000/RAL 9005.

The pump shaft shall not be painted.

5.0 PUMP & MOTOR SELECTION:

The pump(s) selected shall for Preferred Operating Region (POR) unless otherwise approved by the engineer.

The pumps shall be factory manufactured, assembled and hydrostatically tested as per Hydraulic Institute standards in an ISO 9001 approved facility.

Motor should be of variable frequency drive compatible.

Motor should be selected as non-over-loading type.

Note: The motor nameplate rating for pumps under parallel operation shall not be less than the max BKW indicated on the pump data sheet (the power at the END of the curve for the rated impeller) or shall have the specified margin as per this clause whichever is greater. The pump motors shall also be suitable for Start-up under open discharge valve condition.

6.0 Inspection & Testing of Various Items:

Before effecting delivery of the equipment, following inspections and tests as per relevant

ISO/IS/HI standards shall be carried out.

For Pumps:

1. Hydrostatic Testing
2. Performance Test (Single point / Duty point or 5 point / 7 point)
3. Dynamic balancing for pump impeller.

7.0 Tender Drawings:

The following drawings shall be submitted by the Contractor / Vendor along with their Bids.

1. Preliminary outline dimensional drawing of pump and motor (Suction and discharge connections and foundation details shall also be indicated).
2. Performance curves (capacity Vs total head, efficiency, NPSH and KW requirement) ranging from zero to maximum capacity.
3. Technical Data sheet for Pumps

VARIABLE SPEED PUMPING SYSTEM-(FOR SECONDARY/TERTIARY PUMP)

1. General

1.1 Variable Speed Pumping System

- a. Individual system components
- b. Pump logic control panel
- c. Variable frequency drive (VFD)
- d. Differential pressure transmitters (DPT)
- e. Method of operation

1.2 Submittals shall consist of the following

- a. Pump data sheets
- b. System summary sheet
- c. General arrangement drawing of the control panel indicating dimensions,

required clearances and location of the field connection

Submittals must be project specific. General submittals will not be accepted.

1.3 Vendor prerequisites:

a) A system integrator/representative/agent not actively engaged in the design and manufacturing of centrifugal pumps shall not be considered as the pump manufacturer. The pump manufacturer shall assume "Unit Responsibility" for the complete VSPS. Unit responsibility is defined as the responsibility to interface and commission all system components supplied to meet tender requirement

b) The pump manufacturer shall have a minimum of 20 year's experience in the design and construction of Variable Speed Pumping Systems (VSPS)

c) The pump manufacturer who is the supplier of VSPS system must have relevant expertise in all aspects of pre-sales activities like system design, application engineers and post sales activities like installation, commissioning and after sales service. VSPS supplier must have commissioned minimum 200 such projects of Secondary chilled water VSPS in India

d) The manufacturer should have ISO (International Standards Organization) per ISO 9001:2000. Proof of this certification shall be furnished during the time of submittal

e) Bidders shall comply with all sections of this specification relating to variable speed pumping system. Any deviation from this specification shall be mentioned clearly in writing. If no deviations for the specifications are noted, it is construed that the supplier shall bound by these specifications.

2. Pump Logic Controller Package

a) Approved Manufacturers

The manufacturers shall be acceptable as per Approved Make list.

b) Components of Pump Logic Control Panel

a) To supply and install Multi Pump Controller as per the design

b) The control system should include the Pump logic controller, Variable frequency drive(s) and Differential pressure transmitters as indicated in the design

c) Pump logic control panel should house dedicated Multi Pump Controller, Variable frequency drive(s) and associated switchgears

d) Pump logic controller, Variable frequency drive(s), Differential pressure transmitters and related equipment shall be installed by the mechanical contractor as shown in the design

e) Input power wiring to the pump logic control panel and the output wiring to the motors shall be the scope of electrical contractor and to be done as indicated in the electrical drawings submitted for the specific project

f) Low voltage wiring for the Building Management System to be done by the BMS contractor from the pump logic control panel to the IBMS system

c) Specifications

Pump Logic Controller

a) Multi Pump Controller shall be listed by and bear the label of Underwriter's Laboratory Inc (UL). The controller shall be specifically designed for variable speed pumping applications

- b) Pump logic controller in built in Variable frequency drives are not accepted. Logic controller should be external to the drives used in the system
- c) Multi Pump Controller shall have programs to safeguard the system against the following conditions
 - Pump flow surges
 - System Hunting
 - End of curve protection
- m) Multi Pump Controller shall have an installation wizard to enable the user to configure the system with minimum assistance
- n) Multi Pump Controller shall have minimum 2 level password protection to safeguard the settings against unwanted / unauthorized changes
- o) Display should have menu driven function for the operation easiness
- p) Multi Pump Controller shall be capable of performing the following pressure boosting function:
 - Low suction pressure cut out to protect the pumps against operating with insufficient suction pressure
 - High system pressure cutout to protect the piping system against high-pressure conditions
- q) The following communication features shall be provided to the BMS
 - Remote start/stop of the VSPS through potential free contact from BMS
 - Individual pump start/stop/trip status from VSPS through potential free contact to BMS
- r) The following communication features shall be provided to BMS system via RS-485 port utilizing Modbus protocol
 - Individual analog input
 - Individual pump/VFD on/off status
 - System percent reference
 - System start/stop command
 - System operating mode
 - Individual pump kW consumption
 - Individual pump operating hours
 - Individual pump running speed in Hz/percentage reference
 - System flow, when optional flow sensor is provided
- s) Multi Pump Controller shall have on board Ethernet port for connecting the VSPS to BMS. If given static IP address, Multi Pump Controller should be accessible over Intranet or Internet.
- t) The pump logic controller shall be Multi Pump Controller or approved equal housed in a NEMA 1 enclosure

Variable Frequency Drive:

- a) The variable frequency drive(s) shall be pulse width modulation (PWM) type, microprocessor controlled design
- b) VFD, including all factory-installed options, is tested to UL standard 508. VFD shall also meet C-UL and be CE marked and built to ISO 9001:2000 standards
- c) VFD shall comply EMC directives as per IEC 61800-3:2004, category C1 with 50 meter motor cable (for power less than or equal to 90 Kw) & category C2

with 50 meter motor cable (for power more than 90 Kw)

- d) VFD shall be housed in IP21 enclosures for indoor applications. Wall mounted/VFDs with plastic enclosures shall not be acceptable. For out door applications, VFDs shall be housed in IP 54 enclosure.
- e) VFD shall employ an advanced sine wave approximation and voltage vector control to allow operation at rated motor shaft output speed with no derating. This voltage vector control shall minimize harmonics to the motor to increase motor efficiency and life. Power factor shall be near unity regardless of speed or load.
- f) VFD shall have balanced DC link chokes to minimize power line harmonics. VFDs without a DC link choke shall provide a 3% impedance line reactor
- g) Automatic motor adaptation (AMA) algorithm shall be available in the VFD. This feature shall allow for automatic adaptation of drive to meet the characteristics of the motor to have increased efficiency leading to additional energy savings. AMA feature should be able to configure without disconnecting the motor from the VFD
- h) Output power switching shall be done without interlocks or damage to VFD
- i) The following user adjustable parameters shall be provided in the VFD
 - Acceleration time
 - Deceleration time
 - Minimum frequency
 - Maximum frequency
- j) VFD shall be compatible for ModBUS protocol as standard

- k) VFD shall have Automatic Energy Optimization (AEO) function. This feature shall reduce voltages when the drive is lightly loaded to provide a 3% to 10% additional energy savings
- l) VFD shall be suitable for elevations to 1000 meters above sea level without derating. Maximum operating ambient temperature shall not be less than 40 deg Celsius. VFD shall be suitable for operation in environments up to 95% non-condensing relative humidity
- m) VFD shall be capable of displaying the following data in plain English via 40 character alphanumeric display:
 - Frequency
 - Voltage
 - Current
 - Kw per hour consumption
 - Running hours
 - Run mode (remote/local)
 - Active power
 - RPM
- n) VFD(s) shall be warranted for a period of 12 / 18 months
- o) For Secondary pump, VFD shall be pump motor mounted.
- p) For Tertiary pump, the VFD shall be integrated upto 11Kw and for above 11 Kw, it shall be integrated/mounted on pump motor.

Differential Pressure Transmitters

Differential pressure transmitters shall be field mounted and shall transmit

an isolated 4-20mA DC signal indicative of process variable to the pump logic controller via standard three wire 24 DC system with Emission/Immunity confirming to EN61000-6-2/3.

Unit shall have stainless steel wetted parts with two 7/16" process connections. It shall be protected against radio frequency interference and shall have water tight, IP 55 electrical enclosure. Sensor should be capable of withstanding a burst pressure of 25 bar. Accuracy shall be within 2.5% BFSL (Best Fit Straight Line)

Differential pressure transmitters shall be of approved make or approved Equivalent

3. Sequence of operation

- a) The system shall consist of Multi Pump Controller (MPC), multiple pump/VFD sets, with manual and automatic alternation and pump staging
- b) The pumping system shall start upon the start command from the BMS when the Multi Pump Controller (MPC) is configured in "Remote" mode
- c) If the Multi Pump Controller (MPC) is configured in "Local" mode, the system is started via the "Control Unit" at the panel and the pumping system shall operate automatically
- d) Differential pressure transmitters shall be provided as indicated in the design
- e) Each DPT shall send a 4-20 mA signal to the pump logic controller, indicative of the field condition
- f) Multi Pump Controller shall compare each DPT signal against the set point and consider the most deviated signal for engineering the VFD/Pumps speed
- g) Multi Pump Controller shall continuously scan the DPT signals and compare with the set point to control the most deviated zone
- h) If the actual process variable (PV) is not met by the lead pump, Multi Pump Controller shall initiate a timed sequence to bring in a lag pump into operation
- i) The lag pumps shall accelerate in tandem with the lead pump decelerating until both the pumps settle at same speed to meet the set point. (Process Variable PV = Set Point SP)
- j) Further if the Process Variable (PV) changes, both the pump(s) speed should change together
- k) During normal running sequence, Multi Pump Controller should attempt to destage pumps so that optimum number of pumps is always running in terms of energy consumption
- l) In the event of lead pump/VFD fault, Multi Pump Controller automatically initiates a timed sequence to start the standby pump/VFD set in the variable speed mode. The standby variable speed pump shall be controlled by the Multi Pump Controller
- m) VFD fault indication shall be continuously displayed on the display screen graphically until the fault is rectified and the controller has been manually reset
- n) In the event of failure of zone differential pressure transmitter, its process variable signal shall be removed from the scan/compare sequence. Alternative zone differential pressure transmitter if available, shall remain in the scan/compare sequence
- o) Upon differential pressure transmitter failure a plain English warning message shall be displayed on the Control Unit of Multi Pump Controller screen with a fault code

p) In the event of failure to receive all zone differential pressure transmitter signals, a user selectable number of VFD/Pump sets shall run at a user adjustable speed. Same shall be reset upon correction of the zone failure.

Control System for Variable Speed Secondary/Tertiary Chilled Water Distribution:

Variable Speed control system will have the following as minimum: (See details below)

1. Dedicated Pump Logic Controller (DPLC).
2. VFD – One VFD per pump
3. DPT .
4. Enclosure to house VFD's and other required electrical components as per below specification.
4. Necessary software duly downloaded.

Detailed specifications of System components:

1. Dedicated Pump Logic Controller

1.1 Approval

DPLC has been approved by major international bodies like U/L and will be marked as CE as minimum.

1.2 Number of Pumps

DPLC will be able to control minimum 5 pumps. However, DPLC should have provision for future expansion (modular type) to control upto maximum 6 pumps.

1.3 Analog Input Processing

DPLC will continuously scan the incoming signal from DPT's all the time and keep on processing the output. Output will be the most deviated one compared to the set point, which will be fed by the user, in DPLC.

1.4 Two Additional Analog Inputs

DPLC has provision for two additional analog inputs for:

- a. Taking input signal from Flow sensor (if provided by BMS contractor). This will help the system to protect the pumps against End Of Curve condition.
- b. Taking the input from any external sensor (e.g. return temperature sensor, supply temperature sensor, ambient temperature sensor etc). This input can be used to influence the system externally. DPLC should have provision to influence the main signal upto 8 steps.

1.5 Set Point

DPLC can be set for separate “set points” as per real time clock. DPLC should have a min of 7 alternate setpoints to be activated by external digital inputs.

If a lower differential pressure is acceptable during certain periods, for instance after normal working hours or weekends, the set point can be lowered to minimize power consumption.

DPLC should have night set back facility to enable the system to run at lower set point during night time.

DPLC should use digital inputs to switch between set points automatically at any point of time.

1.7 Automatic cascade control of pump

DPLC will start other pumps, which are available for operation, whenever system is not able to meet the demand for chilled water. Once demand is met then all the pumps will cut out with changeover, except for one pump. At least one pump will run at minimum 25% speed if DP value is satisfied.

1.8 Automatic Sequence Change

DPLC will have automatic changeover facility based on:

- a. Fault – When any pump/motor/VFD/starter fails.
- b. Operation – While running/cascading.
- c. Time – As per the time set in the DPLC (daily or weekly).

To ensure equal number of hours run by each pump and to control the number of starts (to avoid hunting) on each pump, the system will alternate the sequence of the pumps used each time the system starts.

Additionally, should the demand not allow the pump set to completely shut down over a 24 hr. Period, the DPLC will stop the pumps that are running and start the pump/pumps with the lowest number of operating hours.

1.9 Auto Testing

DPLC will start the pumps, which have not been cut-in because of lower load, for 2 seconds each day, to ensure that all the rotating elements do not bind. DPLC should have an option to set the same on 24 hrs / 48 hrs / weekly basis.

1.10 Friction Loss Compensation

It is possible to allow for the friction loss component of the system, calculated at full flow and set as a percentage of the set point. A linear approximation of system resistance curve is therefore allowed for, and differential pressure must automatically increase as system flow and subsequent frictional losses increase. As such power consumption will get reduced because of this.

1.11 Displays

Through the monitor keypad, all variable parameters are adjustable, current status of settings and measured values to be displayed on the minimum 320 pixels X 240 pixels VGA display with backlight

Individual menus are available for monitoring individual pumps, settings, alarms and ON/OFF functions.

PUMP STATUS

- * Running Hours of each pump
- * Actual pump status, (running, not available, standby, fault)

ZONE STATUS

This menu is the main operating menu where all the setting and operating parameters can be viewed e.g.

- * Current operating set point
- * Measured values in the system
- * Operating capacity in terms of total output
- * Mode of operation for the zone
- * Clock programs (relating to set point differential pressure value)
- * Standby pumps (if any)
- * Pump change over time
- * Friction loss compensation
- * System response times

SETTING MENU

In this menu all parameters for the operation of the pump set can be adjusted as required

- * Set points (up to 7)
- * On/Off function (used to prevent unnecessary cycling at low demands)
- * Displayed differential pressure units (Meter, Bar, PSI, mBar, kPa)
- * Real time clock programming for any time of the day, week, or weekend)
- * Friction loss compensation

1.12 ALARM

The alarm menu to display all faults / warnings that occur during operation, logging the time and date of when the fault occurred and when it was corrected, or whether it is still an actual fault, and up to 24 faults to be maintained as history in the controller.

Examples of faults

- * Mains failure
- * VFD fault

- * Analogue input (differential pressure transducer) fault
- * High discharge pressure fault
- * Low discharge pressure fault
- * Motor thermal overload fault

1.13 Communication features:

- *DPLC (Control MPC) can be hooked to a BMS computer through Ethernet for remote monitoring and control of the entire Variable Speed Secondary Chilled Water Pumping System*
- *Communication protocol MODBUS will be provided to Display the system values in BMS such as an option:*
 - a. *VFD speed.*
 - b. *DP value(s).*
 - c. *Current drawn by each pump.*
 - d. *Power consumed by each pump.*
 - e. **POWER CONSUMED BY THE SYSTEM PER HOUR.**

BMS vendor will bring his RS – 485 (MODBUS) link directly to this DPLC communication port. We will provide only port and register addresses of the various data, which can be given. We will also provide a potential free contact for remote start/stop.

2. VARIABLE FREQUENCY DRIVE

VFD shall be Pulse Width Modulation (PWM) type, microprocessor controlled design labeled CE. The enclosure shall be ventilated for installation as a wall mounted or freestanding depending on amp rating. Drive shall have customer modifiable adjustments of 2 to 600 seconds accel & decel time, Minimum & Maximum frequency, V/f ratio and Carrier frequency. Speed reference signal shall be customer selectable for 4-20 mA, 0-5 VDC and 0-10 VDC. The VFD shall be suitable for elevations up to 1005 mts above sea level without de-rating. Maximum operating ambient temperature shall be to 45 C. shall be suitable for environment condition up to 95% non-condensing.

- *Built-in DC link filters to avoid power factor correcting devices like capacitors, line reactors etc.,*
- *Energy saving mode with boost function (Sleep/ Wake Mode), Quick setup menu.*

3. TRANSMITTERS:

Differential pressure transmitters shall be field mounted and shall transmit an isolated 4-20mA DC signal indicative of process variable to the pump logic controller via standard two wire 24 DC system. Unit shall have stainless steel

wetted parts with two 0,25" male NPT process connections. It shall be protected against radio frequency interference and shall have watertight, NEMA 4 electrical enclosure capable of withstanding 14 bar static pressure with a 0.5" NPT conduit connection. Accuracy shall be within 0.25% of full span.

4. CONTROL ENCLOSURE

An IP41 powder coated steel enclosure shall house all the electrical components.

The enclosure will be supplied loose for remote mounting. It shall be adequately ventilated for use in conditions up to a maximum ambient temperature of 45 degrees Celsius. VFD's shall be mounted inside our VSPS panel.

Section-3 Cooling Tower

COOLING TOWERS

SCOPE

This chapter covers the general requirements of cooling towers for packaged units, central air-conditioning plants and cold rooms.

TYPE

The cooling tower shall be of Mechanical draft type. Fan on Mechanical draft towers may be on the inlet air side or exit air side. In case of former it is called forced draft type and in case of later it is called Induced draft type. On the basis of direction of air flow and water flow, Mechanical draft cooling tower can be counter flow or cross flow type as per the manufacturer design. This may be of any of the following construction as may be specified in the tender specifications:-

- a) In wooden construction with wood or PVC fill and RCC basin,
- b) In fiber glass reinforced plastic (FRP) construction with PVC fill and FRP basin,
- c) In masonry construction. The mechanical draft cooling towers of wooden construction and masonry construction, being un-common now, have been excluded from the scope of these specification.

DESIGN

- i) Rating :The cooling tower shall be rated for the heat rejection capacity specified in the tender specifications. All cooling towers shall be certified by CTI (Cooling Tower Institute).
- ii) Range: The Cooling tower shall be designed to cool the requisite quantity of water through 4.2 degree C or as specified in the tender specifications, against the prevailing wet bulb temperature.
- iii) Wet Bulb approach: The cooling tower shall be selected for a wet bulb approach of not more than 2.77 degree C.
- iv) Outlet temperature: The cold water temperature from the cooling tower shall match the entering temperature for which the condenser selection is made.
- v) Flow rate: The water flow rate through the cooling tower shall match that through the condenser.
- vi) Multi cell design :The induced draft cooling tower shall be of one or more cells.
- vii) Drive Motor : The fan motor shall be premium efficiency IE3 class , as per IS 12615.7.4

MATERIAL AND CONSTRUCTION : Fibre glass Reinforced Plastic (FRP) Cooling tower

i)The structural framework of the cooling tower including all members shall be designed for the load encountered during the normal operation of the cooling tower and its maintenance. The structure shall be rugged and rigid to prevent distortion and shall include tie arrangements as may be necessary.

ii)The cooling tower shall be induced draft type, with FRP casing in square/ rectangular/ octagonal/ circular shape, and with an FRP basin to match the shape of the casing.

iii)The air intake shall be from openings all along the circumference of the casing near its base in case of circular shape. Air Intake shall be along the sides in case of square or octagonal/ rectangular cooling tower. These openings shall be covered with hot dip galvanised expanded metal mesh screens.

iv)The basin shall have a holding capacity adequate for operation for at least 30 minutes without addition of make-up water to the basin. The construction should be such as to eliminate the danger of drawing air into the pump when operating with minimum water in the basin. v)The basin fittings shall include the following: -

a)Bottom /side outlet,

b)Drain connection with valve,

c)Ball type automatic make-up connection with valve,

d)Overflow connection,

e)Bleed off with valve, from inlet header to overflow pipe.

vi)The supporting framework for the tower casing and the water basin shall be made of hot dip galvanized steel and it shall be further protected with epoxy painting.

vii)The filling shall be of PVC. Thickness of PVC fills shall not be less than 0.2mm. These shall be of such construction as to provide low air resistance, large wetted surface for a high heat transfer efficiency, and easy replace ability.

viii)The water distribution may be either through self-rotating or fixed type sprinklers or through balancing, sub balancing and spreader troughs (unpressurised system) — open gravity type with polypropylene nozzle, 105. A bird wire screen made of 12 mm mesh in 1.6 mm steel wire held in angle or channel frame shall be fixed to the rear face of the louver frame by screens.

FIRE DAMPERS i)Fire dampers shall be provided in all the supply air ducts and return air ducts (where provided), return air passage in the air-handling unit room and at all floor crossings. Access door will be provided in the duct before each set of fire dampers.

ii)Fire dampers shall be multi blade louvers type. The blade should remain in the air stream in open position & shall allow maximum free area to reduce pressure drop & noise in the air passage. The blades and frame shall be constructed with minimum 1.6mm thick galvanised sheet & shall be factory fitted in a sleeve made out of 1.6mm galvanised sheet of minimum 400mm long. It shall be complete with locking device, motorized actuator & control panel.

iii) Fire dampers shall be motorized smoke & fire dampers type. It shall be supplied with spring loaded UL stamped fusible link to close fire damper in the event of rise in duct temperature. Fire damper shall also close on receipt of fire alarm signal to cut off air supply instantaneously. An electric limit switch shall also be operated by the closing of fire damper, which in turn shall switch off power supply to AHU blower motor as well as strip heaters.

iv) Fire dampers shall be CBRI tested & certified for 90 minutes rating against collapse & flame penetration as per UL 555-1995. (Underwriters laboratories) v) Fire dampers shall be compatible with the fire detection system of building & shall be capable of operating automatically through an electric motor on receiving signal from fire alarm panel. vi) Necessary wiring from fire alarm panel up to AHU electric panel shall be provided by the department & further from AHU electric panel to fire damper shall be provided by air conditioning contractor.

VARIABLE AIR VOLUME (VAV) BOXES

i) These shall be of the low velocity variable air volume boxes without re-heat coils, and shall be of open protocol as marketed by a firm specializing in this field. The contractor shall supply and install units to the quantity and locations as specified.

ii) The unit shall be complete with damper, airflow ring, and solid-state electronic controls to provide accurate room temperature control. The damper shall be aero foil type construction with bearings.

iii) Boxes shall be supplied with all internal attenuation treatment and acoustical damped casing necessary to achieve the required noise criteria. Casing shall be of 22G GSS minimum fitted with a completely sealed, on the ceiling adjacent to the air outlet. The metal sheet used for construction of these shall be minimum 1.6 mm thick extruded aluminium sheet.

v) Linear diffusers shall have a flanged frame with the outside edges returned 3.5 mm and shall have one to four slots as required. The air quantity through each slot shall be adjustable. The metal sheet used for the construction of these shall be minimum 1.6 mm thick extruded aluminium sheet.

vi) Grilles and diffusers constructed of extruded aluminium sections shall have grille bars set straight, or deflected as required. These shall be assembled by mechanical interlocking of components to prevent distortion. These grilles and diffusers shall have a rear set of adjustable blades, perpendicular to the face blades for deflection purposes.

vii) All supply air outlets shall be fitted with a volume control device, made of extruded aluminium gate section. The blades of the device shall be mill finish/ block shade pivoted on nylon brushes to avoid rusting & rattling noise, which shall be located immediately behind the outlet and shall be fully adjustable from within the occupied space without removing any access panel. The volume control device for circular outlets shall be opposed blade radial /shutter type dampers, or two or more butterfly

dampers in conjunction with equalizing grid. Opposed blade dampers shall be used for square and rectangular ceiling/wall outlets and intakes.

viii) All the products supplied by contractor should supplement in performance by selection curves of product ratings from the manufacturer.

ix) Laminar supply air diffusers shall be made of 2mm thick powder coated aluminium sheet duly insulated with 5mm thick closed cell polyethylene foam insulation having factory laminated aluminium foil and joints covered with self-adhesive aluminium tape and having holes 2/3 mm dia including frame work.

Fresh Air Intakes

i) Fresh air intake grills shall be made of extruded aluminium sections.

ii) A flanged frame using RS sections shall be provided on front face to conceal the gap between the louvers and the adjoining wall face. Corners of frame shall be welded. The frame shall be made structurally rigid.

iii) Louvers made from extruded aluminium section shall be in modular panel form for ease of handling. These shall be free from waves and buckles. Vertical blades shall be truly vertical and horizontal blades shall be truly horizontal. Butt joints in blades shall not be accepted.

iv) Additional intermediate equally spaced supports and stiffeners shall be provided to prevent sagging/ vibrating of the louvers, at not more than 750mm centres where the louver's length is longer than 750mm ensuring uniform water loading and distribution of water over the fill. All pipes and fittings shall be of PVC. The sprinklers shall operate from the residual velocity head at the headers. Due care shall be taken with regard to corrosive effects and maintainability in the design of the water distribution system.

v) Drift eliminators of PVC shall be provided for maximum removal of entrained water droplets. The spacers and tie rods used shall be of plastic material.

vi) The fan shall be multi-blade axial flow type, made of aluminium alloy or FRP. The fan assembly shall be statically and dynamically balanced.

vii) The fan drive shall be from a three phase induction motor of efficiency class IE3 as per IS 12615, either direct or through a spiral gear work. The entire drive arrangement shall be designed for a minimum noise and it shall be rigidly supported to the tower structure.

viii) The motor starter shall be in accordance with specification.

ix) To ensure safety of personnel at the time of working on cooling tower a steel ladder shall be provided in such a manner and location as necessary to give safe and complete access to all the parts of the cooling tower requiring inspection or adjustments. The ladder shall be bolted to the tower at the top and grouted in masonry at the bottom end.

INSTALLATION : The cooling tower shall be installed on pre FRP coated M.S. girders fixed in masonry foundations with cement concrete footing. Second class brick work and cement mortar having one part cement & six parts sand shall be used for the

masonry work. 12mm sand cement plaster shall be provided over the brick work. These may be located at a well-ventilated place either at ground level and contiguous to the plant room, or on the terrace of the building in consultation with the Architect. In case the cooling towers are located on the terrace of the building, the structural loading of the terrace shall be considered. For this respective columns are to be raised by two feet at the terrace. Cooling towers shall be installed in such a way that their load is transferred directly to the columns for which necessary Mild steel-I sections shall be provided by the air-conditioning contractor. The cooling towers shall be rested on Mild Steel-I sections & not on terrace slab. Sufficient free space shall be left all around for efficient operation of the cooling tower. Cooling tower shall be not less than 75cm above the ground/ floor level unless otherwise stated in the tender specifications. 6mm neoprene pads shall be placed between the tower and the girder for vibration isolation whereas directed by the Engineer-in-charge. Guy-wires of suitable sized shall be used to secure firmly to its base wherever necessary.

PAINTING: The cooling towers shall be supplied with the manufacturer's standard finish painting.

Section-4 EXPANSION TANKS

i) Expansion tanks for chilled water and hot water shall be of M.S. construction and of adequate capacity, to contain 200% of the maximum expansion likely to take place in the system. The tank shall be insulated and be complete with float valve, gauge glass, drain, overflow and make up connections, with gate valves and vent piping wherever required.

ii)The piping shall be enlarged at the connection to the expansion tank to permit entrained air to separate and to be vented through the tank. The expansion tank should be located at the pump suction side at the highest point of the system.

iii)Valves, strainers and traps must be omitted from the expansion line since these may be accidentally turned off or become plugged.

iv)Pressurized expansion tank with air separator, have to be used.

- Expansion, pressurization and de-aeration of the chilled water system to be provided by an integrated unit comprising of Pressure-less expansion tank, coalescing pall rings, Pressurization unit c/w Pump fittings and state of the art digital controller & with twin pumping system.
- Vessel volume shall be calculated according to the system expansion volume. Every vessel in the unit shall have the same size. Levelling of the vessel shall be facilitated by adjustable feet. Condensate drain cock shall be installed within the base of the vessel.

Efficiency of the vessel volume shall be minimum 80%. A coalescing (PALL RINGS) de-aerator shall be installed within the inlet of the expansion vessel providing removal of micro-bubbles >15 µm. An automatic air vent with air intake preventer must be installed on the top of the vessel. The expansion vessel(s) shall be fitted with a replaceable butyl rubber bladder with rupture sensor in accordance with DIN 4807-3. As unit is subject to atmospheric pressure, tank pressure rating should be 6 Bar. Maximum continual working temperature of the bladder shall be 70 °C (158 °F). Main vessel must have a weight sensor and therefore must be connected to the Pressurization unit using flexible hoses. RAL 3002 epoxy powder coating. The use of secondary vessel & level sensor is not necessary.

- The pressure-less expansion vessel(s) shall be cylindrical, welded and comply to EN 13831:2007.
- Manufactured and designed in accordance with European Pressure Equipment Directive PED 2014/68/EC.
- The pressurization unit shall be sized appropriate to the total system expansion volume and maximum operating pressure.
- System pressure shall be regulated within ± 0.2 bar (2.9 psi) of the set pressure. High and low pressure alarm setting shall be selectable by the user.
- Top-up function shall be programmed according to system requirements. The unit shall be fitted with an integral, adjustable flood limiter to shut down the system in the event of a serious leak. Water level in the expansion vessel(s) shall be maintained to a minimum value.
- Flexible Connection must include a de-aeration sensor for signaling the controller to continue/stop the active de-aeration.
- Backflow Preventer c/w, water meter, ball valve and non-return valve, strainer/Particle filter/ and shut-off valve according to DIN 1988 and DIN EN 1717 in top up connection.
- The pressurization unit shall have two Flow regulating, solenoid valve in spill lines with duty/standby/assist function to avoid pressure peaks in the system and a safety relief valve for protection of vessel, two multistage pumps (orientation vertical/horizontal) with non-return valve, The use of electrically actuated ball valve in the spill line is not permitted since it takes time to react and increases pressure peaks which leads to malfunctioning of the system.
- The controller shall display the vessel contents, system pressure and status of the main operating components in real-time on the graphical display. This acts as confirmation that pump(s) or valves are operating and responding as required, while also verifying the system setup.
- The controller shall regulate the pump unit to provide duty/standby or parallel/backup operation and shall be selectable in dual pump units.
- Controller shall display fault code and generate the alarm in case of any fault situation.
- Pressurization unit shall be factory assembled. The product shall be installed according to the manufacturer's instructions using manufacturer's approved components.
- The unit shall be BMS compatible with RS 485 communication protocol.
- The controller shall be Microprocessor based touch screen with IP54 protection class.

3.8 INSTALLATION

i)The installation work shall be carried out in accordance with the detailed drawings prepared by the Air-conditioning Contractor and approved by the Engineer-in-charge.

ii) Air-conditioning contractor shall utilize the structural provisions for Air-conditioning services wherever provided by the Department in the building and make his own arrangements for additional changes.

iii) Expansion loops or joints shall be provided to take care of expansion or contraction of pipes due to temperature changes.

iv) Tee-off connections shall be through equal or reducing tees, otherwise ferrules welded to the main pipe shall be used. Drilling and tapping of the walls of the main pipe shall not be resorted to.

v) Wherever reducers are to be made in horizontal runs, eccentric reducers shall be used if the piping is to drain freely, in other locations, concentric reducers may be used.

vi) Open ends of piping shall be blocked as soon as the pipe is installed to avoid entrance of foreign matter.

vii) All pipes using screwed fittings shall be accurately cut to the required size and threaded in accordance with IS: 554 and burs removed before laying.

viii) Piping installation shall be supported on or suspended from structure adequately. The Air-conditioning contractor shall design all brackets, saddles, clamps, hangers etc. and shall be responsible for their structure integrity.

ix) Pipe supports, preferably floor mounted shall be of steel, adjustable for height and prime-coated with zinc chromate paint and finish-coated gray. Spacing of pipe supports shall not be more than that specified below:

Nominal Pipe size (mm)	Spacing (Meters)
12 and 15	1.25
20 and 25	2.00
32, 40, 50 and 65	2.50
80, 100 and 125	2.50
150 and above	3.00

Extra supports shall be provided at the bends and at heavy fittings like valves to avoid undue stress on the pipes. Pipe hangers shall be fixed on walls and ceiling by means of metallic or rawl plugs or approved shear fasteners.

x) Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation.

xi) Anti vibration pads, springs or liners of resilient and non-deteriorating, material shall be provided at each support, so as to prevent transmission of vibration through the supports. xii) Pipe sleeves of diameter larger than the pipe by least 50 mm shall be provided wherever pipes pass through walls and the annular spaces shall be filled with felt and finished with retaining rings.

xiii) Vertical risers shall be parallel to walls and column lines and shall be straight and plumb. Risers passing from floor to floor shall be supported at each floor by clamps or collars attached to pipe with a 12 mm thick rubber pad or any other resilient material as approved by the Engineer-in-charge.

xiv) The space in the floor cut outs around the pipe work (after insulation work where applicable) shall be closed using cement concrete (1:2:4 mix) or steel sheet, from the fire safety considerations, taking care to see that a small annular space is left around the pipes to prevent transmission of vibration to the structure.

xv) Riser shall have suitable supports at the lowest point.

xvi) Where pipes are to be buried under ground, the top of the pipes shall be not less than 75 cms. From the ground level. Where this is not practicable, permission of the Engineer-in-charge shall be obtained for burying the pipes at lesser depth. The pipes shall be surrounded on all sides by sand cushion of not less than 15 cms. After the pipes have been laid and top sand cushion provided, the trench shall be refilled with the excavated soil and any extra soil shall be removed from the site of work by the Air conditioning contractors.

xvii) All pipes and their steel supports shall be thoroughly cleaned and given one primer coat of Zinc chromate before being installed.

xviii) After all the water piping has been installed; pressure tested in accordance with clause 10.10, all exposed piping in the plant room shall be given two finish coats of paint, approved by the Engineer-in

Charge. Similar painting work shall be done over insulated pipe work, valves etc. The direction of flow of fluid in the pipes shall be indicated with identifying arrows.

xix) 3 mm gasket shall be used for flanged joints.

xx) Cut-outs in floor slabs shall be sealed with cement concrete or steel plate after the plumbing work is done, from the fire safety point of view.

3.9 PRESSURE TESTING

(i) All piping shall be tested to hydrostatic test pressure of at least one and a half times the maximum operating pressure, but not less than 10 kg./sq.cm. for a period not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified to the satisfaction of the Engineer-in-Charge.

(ii) Piping repaired subsequent to the above pressure test shall be re-tested in the same manner.

(iii) System may be tested in sections and such sections shall be securely capped.

(iv) It shall be made sure that proper noiseless circulation is achieved through all the coils and other heat exchange equipments in the system. If proper circulation is not achieved due to air-bound connections, the contractor shall rectify the defective connections. He shall bear all the expenses for carrying out the above rectification, including the tearing up and refinishing of floors, walls, etc. as required.

(v) Pressure gauges may be capped off during pressure testing of the installation.

(vi) The contractor shall provide all materials, tools, equipments, instruments, services and labour required to perform the tests and to remove water resulting from cleaning after testing.

3.10 BALANCING

i) After completion of the installation, all water system shall be adjusted and balanced to first minimize throttling losses; then the pump impeller shall be trimmed or pump speed shall be adjusted to meet design flow conditions. Exceptions to above:

a) Where Variable frequency Drives are used as starter & capacity control. b) Impellers need not to be trimmed nor pump speed adjusted for pumps with pump motors of 7.5 kW (10 hp) or less, c) Impellers need not to be trimmed when throttling results in no greater than 5% of the nameplate horsepower draw, or 2.2 kW (3hp), whichever is greater.

ii) Automatic control valves (Pressure Independent Balancing cum Control Valve) and three way diverting valves shall be set for full flow condition during balancing procedure. Water circuit shall be adjusted by balancing cocks provided for balancing. These shall be permanently marked after the balancing is completed so that they can be restored to their correct positions, if disturbed.

3.11 MEASUREMENT

Measurements of plumbing work shall be on following basis: -

a) Piping shall be measured along the centre line of installed pipes including all pipe fittings and accessories but excluding valves and other items for which quantities are specifically indicated in the schedule of work. No separate payment shall be made for fittings and accessories.

b) The rates for piping work shall include all wastage allowances, pipe supports, hangers, nuts and check nuts, vibration isolators, suspension where specified or required, and any other item required completing the piping installation. None of these items will be separately measured nor paid for.

c) Piping measurement shall be taken before application of the insulation in the case of insulated pipe work.

Section 5:- DIRT SEPARATOR

Dirt Separators - Furnish and install In-Line (600 mm) Microbubble type flanged steel Dirt Separator suitable for maximum pressure of 1600 Kpa (16bar) and 110 deg C operating temperature and sized for the full capacity / flow. The MS tank shall be heavy duty with external anti corrosion painting.

The entering velocities not to exceed 1.2 meters per second at specified flow rate. Units specifically designed for high velocity systems may have an entering velocity of up to 3.0 meters per second. The separator must conform to design as per Pressure Equipment Directive PED (2014/68/EU) standards. The material standard shall be EN/ISO: S235JR

The core element is a tube mesh construction and the flow to be guided through an area with a greater cross-section than the connection dimensions in order to reduce the flow. The ensuing turbulence caused by the tube mesh causes heavy dirt particles to move to the bottom of the vessel from where they can be drained out and also be with magnetic separation facility. The Dirt separator shall be able to remove effectively dirt particles down to 4 microns. There shall be high capacity auto air vent.

The pressure drop across the dirt separator shall not exceed 0.5 bar.

Section -6 Water softener Plant

The lowest tenderer shall submit the complete design, engineering data along with the sizing of the pipings, valves and input water flow requirement as per specified in the tender BOQ as per the OEM, to the Engineer in charge for approval within 1 month of issue of letter of acceptance.

SOFTENER

- | | | |
|----------------------------------|---|---|
| 1) Model | : | As per BOQ specified. |
| 2) Diameter | : | As per design |
| 3) Height of straight | : | As per design |
| 4) Minimum Flow Rate | : | 60 M3/Hr |
| 5) Max Pressure drop across unit | : | 0.5 Kg/Cm2 |
| 6) Max Working pressure | : | 3.5 Kg/Cm2 |
| 7) Water Inlet Pressure | : | 1 Kg/Cm2 |
| 8) Source of water | : | From Sand filter |
| 9) Material of construction | : | MS, IS:2026 |
| 10) Shape | : | Cylindrical & vertical, suitable for Outdoor Installation |
| 11) Piping Size | : | As per design. |

12) Shell Thickness	:	8 mm (Min.)
13) Bed Plate	:	10 mm (min.)
14) Resin Quantity	:	As per manufacturer
15) Resin Make	:	INDION 220 Na+ or equivalent
16) Output per regeneration	:	More than. 6,00,000 Ltr of soft water
17) Outlet water Hardness after treatment:	:	Less than Five(5) PPM
18) Filling media	:	a) Resin b) Gravel
19) Brine Solution Tank	:	PVC Tank of minimum capacity 2000 ltrs
20) Duration of operation	:	Continuous operation, 24 x 7 Hours/ week
21) Supports	:	Mild steel structural legs with base plate
22) Painting approved	:	External: two coat Resin based Epoxy paint of make

SAND FILTER

1) Model	:	As per BOQ specified
2) Diameter	:	As per design
3) Height of straight	:	As per Design
4) Min. Flow Rate	:	60 M3/Hr
5) Max Pressure drop across unit	:	0.5 Kg/Cm ²
6) Max Working pressure	:	3.5 Kg/Cm ²
7) Water Inlet Pressure	:	1 Kg/Cm ²
8) Source of water	:	From Boring
9) Material of construction	:	MS, IS:2026
10) Piping Size	:	As per design
11) Shell Thickness	:	8 mm (min.)
12) Bed Plate	:	10 mm (min.)
13) Shape	:	Cylindrical & vertical, suitable for Outdoor
Installation		
14) Filter media	:	Complete as and graded
15) Filling media	:	Treated Sand & Graded Gravel
16) Supports	:	Mild steel structural legs with base plate
17) Painting approved	:	External: two coat Resin based Epoxy paint of make

Section -7 BMS (Building management System)

The Building Management System (BMS) to be provided shall perform the following general functions:

- i) Building Management and Control
- ii) Monitoring and Control of Controllers, Remote Devices and Programmable Logic Controllers
- iii) Operator Interface
- iv) Video display integration
- v) Data collection, Historization , Alarm Management & Trending
- vi) Report Generation
- vii) Network Integration
- viii) Data exchange and integration with a diverse range of other computing and facilities systems using industry standard techniques.

The scope of BMS here is for Air-conditioning applications only. It should be expanded type to connect it with other building services in future. The BMS software and supervising should have the capability to expand the system at least upto 50% of the present capability.

7.1 SYSTEM ARCHITECTURE

The system offered shall be completely modular in structure and freely expandable at any stage with 3 level architecture

- 7.1.1 The Management Level
- 7.1.2 The Automation Level
- 7.1.3 The Field Level

Each level of the system shall operate independently of the next level up.

The system shall fully be consistent with the latest industry standards, operating on Windows 2000 or Windows NT or later, allowing the user to make full use of the features provided with these operating systems.

To provide maximum flexibility and to respond to changes in the building use, the system offered shall support the use of BACnet, LON, Profibus and Ethernet TCP/IP communication technologies.

All plant and equipment requiring control and / or monitoring functions shall be fitted with all necessary interfacing equipment readable by the BMS network.

7.2.1 The Management Level

The management level and operation of the plant shall include process visualization, data analysis, and exchange of data. At the management level, it shall be possible for communication to flow in all directions, across networks and via direct connections. The management level of the system shall consist of one and shall be capable of handling more management station PCs and the associated software modules. The total number of management station PCs shall be as described elsewhere in the specifications.

7.2.2 The Automation Level

The level at which the actual processing takes place based on the logic written on the DDC. The processes are carried out at the DDC controllers for stand-alone control of all plant.

7.2.3 The Field Level

Individual room controllers for autonomous room – by – room comfort control, based on application specific logic written on the controllers.

7.3 INTERFACE AND INTEGRATION

7.3.1 Maintenance Management

7.3.1.1 Integrated

The system shall provide an integrated Maintenance Management function. The Maintenance Management function shall use specified breakdown alarms, equipment run hours or analog values from the BMS.

7.3.1.2 Third Party

The system shall be capable of integrating with external maintenance systems such as MS Excel, MS Access, BMS system, SCADA of IIT Kanpur. This integration shall consist of transferring specified breakdown alarms and equipment run hours from the BMS to the external maintenance system.

7.4 DIGITAL CONTROLLERS

7.4.1 General

Digital Control Processors / Direct Digital Controller (DDC) shall be as specified with capacity to accommodate input/ output (I/O) points required for the application plus spare points specified.

Each DDC will be a truly standalone controller with its own Input-Output capacity, control logic capability, time programming and energy management capabilities. All field equipment including the sensing element (inputs) and control elements (outputs) would be wired to the respective DDC. It shall be possible to hook up a DDC to a Portable Operator Terminal (POT) to enable monitoring and control of the DDC.

DDC shall be designed for complex DDC and energy management applications, true peer-to-peer communications with other DDC and with the Central Operator Stations. The DDC will be networked on a truly distributed intelligence concept where each DDC shall be a self-sustained intelligent device capable of all its functionality's without dependence on other devices

7.4.2 DDC Hardware:

7.4.2.1 Digital Control Processors (DDC) shall be 16 bit microprocessor types with Electrical Erasable Program Read Only Memory (EEPROM) based Operating System (OS) and shall use EEPROM or flash memory for all data file and control programs (DDC Programs) and using RAM only for operating data.

7.4.2.2 Each DDC shall have Nickel cadmium Lithium battery to support complete operation of the RAM for upto 30 days in the event of a power failure to the DDC. A low battery voltage status will generate an alarm condition.

7.4.2.3 DDC shall have internal real-time clocks with 30-day battery backup power. All time-based controls (time scheduling, integrations and other real-time based controls) shall be performed with this real-time resident clock. Clock synchronization of the DDC on the whole bus will be automatic

DDC using clocks generated by software or timers for clocking shall not be accepted.

7.4.2.4 The battery backup power shall support the real-time clock. Upon power restoration all clocks shall synchronize automatically.

- 7.4.2.5 The DDC's shall be capable of supporting 8 to 48 I/Os preferably in a combination of 8 AI (Analog input), 2 DI(Digital input), 4 AO(Analog output), 2 DO(Digital output) with minimum of 10% spares of each type per DDC.
- 7.4.2.6 The DDC would be dedicated standalone in nature and would be placed near the instrument they are controlling to reduce the installation and wiring cost.
- 7.4.2.7 Analogue input support of the following minimum types shall be provided:
 0/4-20mA
 0-10 volts
 0-5 volts 0/2-10 volts
 Resistance signals (Pt3000, Pt1000, Pt100, Ni1000)
- 7.4.2.8 Digital Inputs type shall be, but not limited to the following types: Normally open discrete contacts
 Normally closed discrete contacts
- 7.4.3 DDC POT functionality shall be as follows:
- 7.4.3.1 There will be an electrical socket/port in every DDC for accessing the data points and real time information via a portable plug-in type Portable Operator Terminal (POT).
- 7.4.3.1.1 The POT shall not have any EEPROM and shall not require any programming.
- 7.4.3.1.2 The POT will plug into the DDC for its power and data. The POT which are not plugged in to the DDC but are hard wired from the Interface unit, PC station or any other device shall not be acceptable.
- 7.4.3.2 The connection of the POT to a controller shall not affect normal operation of the controller or the bus communication in any way.
- 7.4.3.3 The connection of the POT to any controller on a bus shall provide display access to all controllers on the bus. Each DDC shall have provision for plugging of the POT.
- 7.4.3.4 It shall be possible for the POT to be connected to any controller on the bus to view and control any point on any other controller on the bus under password protected menus. POTs in which only a predefined number & set of points are available shall not be accepted.
- 7.4.3.5 A failure of any DDC on the bus, Interface unit or Central PC station or any other device of the system shall not affect the operation of the POT.
- Systems in which the POT is connected to only a single interface master port and hard wired to other controllers are not acceptable.
- 7.4.3.6 Use of a POT at DDC shall allow the user to display software information and via password control, modify DDC software.
- 7.4.3.7 All displays on the POT shall be in English language text and data points shall have customised descriptions as per application requirement.
- 7.4.3.8 The POT shall be equipped with a multiple lines (with minimum of 4 lines of 20 characters each) backlit alphanumeric LCD display and a control keypad. The keypad would include Command keys, data entry keys and cursor control keys
- 7.4.3.9 Access shall be through self-prompting menus with cursor controls for moving through the menus.

Menu selection would be with arrow key controls for moving to next/previous menu and to step forward backward within a menu

7.5 FIELD DEVICES

7.5.1 Electronic Data Inputs and Outputs

Input/output sensors and devices shall be matched to the requirements of the respective connected controller panel for accurate, noise-free signal input/ output. Control input response shall be high sensitivity and matched to the loop gain requirements for precise and responsive control.

7.5.1.1 Temperature Sensors

Temperature sensors shall be Resistance Temperature Detector types of Pt3000, Pt1000, Pt100 or Ni1000. These shall be two wire type sensors and shall conform to following:

- 7.5.1.1.1 Space temperature sensors shall be wall/surface mounted and shall be provided with blank commercial type looking covers
- 7.5.1.1.2 Duct temperature sensors shall be rigid stem or averaging type as specified and shall be suitable for duct installation
- 7.5.1.1.3 Immersion temperature sensors shall be provided with matching Stainless steel thermo- well of lengths as specified.
- 7.5.1.1.4 Outdoor air temperature sensors shall have weatherproof enclosures and shall be directly wall/surface mounted
- 7.5.1.1.5 Outside air, return air, discharge air, return air, space and well sensors shall have + 0.55 degrees C accuracy between 0 degree and 100 degree C.

7.5.1.2 Relative Humidity Sensors :

- 7.5.1.2.1 Relative humidity sensors shall be capacitance type with an effective sensing range of 10% to 90% .
- 7.5.1.2.2 Accuracy shall be +/-5% or better
- 7.5.1.2.3 Duct mounted humidity sensors shall be provided with a sampling chamber. Wall mounted sensors shall be provided with covers identical to temperature sensors. Sensor housing shall plug into the base such that the same can be easily removed without disturbing the wiring.

7.5.1.3 Differential and Static Pressure Switches

A. Differential pressure switches-air :

- i) They shall have field adjustable set-point capability for the specified range.
- ii) They shall provide a built-in switching differential at the set-point over the specified range.
- iii) Switches shall be piped to fan discharge except where fans operate at less than 25mm WC(water column), they shall be piped across the fan.
- iv) Maximum pressure rating shall be at least 300 mm WC.
- v) The electrical contacts shall provide dry contacts as specified and shall be rated for at least 300V A pilot duty @ 240V AC

B) Differential pressure switches-water :

- i) Switches shall be adjustable differential pressure type as specified in the sequence of operation or data point summary.
- ii) Devices shall be 10 kg/ sq.cm rated except chilled water flow switches shall be provided with totally sealed vapor tight switch enclosure on 20 kg/sq.cm body.
- iii) Differential pressure switches shall have valved manifold for servicing.
- iv) The electrical contacts shall provide dry contacts as specified and shall be rated for at least 300V A pilot duty @ 240V AC.

7.5.1.4 Differential Pressure Sensors

- A) Air Flow / Pressure sensors
 - i) Air flow and duct static pressure analog sensors shall be high accuracy suitable for the low pressures to be encountered, be selected for approximately 50% over range, and have a 4 to 20 ma/ 0-10 VDC output.
 - ii) Air flow measuring station sensors shall be with valved lines for testing and calibration, and shall have adjustments for zero and span.
- B) Water flow Sensors
 - i) Water flow analog sensors shall be provided complete with flow element and shall be an all solid state precision industrial type with stainless-steel body, maximum error of not more than 0.5% of span.
 - ii) Sensor shall be rated for 17 kg/sq.cm minimum and installed in strict accordance to the manufacturer's instructions complete with three- valve manifold for calibration and maintenance.

7.5.1.5 Water Hardness Analyser

7.5.1.5.1 The water hardness analyzer shall be on-line conductivity type and shall provide analog output proportional to specified range.

7.5.1.5.2 Control relays and analog output transducers shall be compatible with controller output signals. Relays shall be suitable for the loads encountered. Analog output transducers shall be designed for precision closed loop control with pneumatic repeatability error no greater than 2%.

7.5.1.6 Level Measurement

- A) Level Switches
 - i) Level switches shall be directly vessel mounted type either top mounted or side mounted as required.
 - ii) These shall be float type unless specified. Process connection shall be flanged. Wetted parts shall be made of stainless steel (SS316).
- B) Level Sensors
 - i) Level sensors shall be capacitance probe type.
 - ii) It shall be possible to mount the transmitter unit integral to the probe on the vessel or field mounted away from the probe
 - iii) Unless specified probe insulation shall be of PTFE and probe rod material SS316
 - iv) Process connection shall be flanged or BSP connections as specified.

7.5.2 Automatic Control Valves

- i) Automatic control valves upto 50mm and smaller shall be screwed type, and valves of 65 mm and larger shall be flanged type.
- ii) Valves shall be ANSI-rated to withstand the pressures and temperatures encountered. Valves shall have stainless-steel stems and spring loaded Teflon packaging with replaceable discs .
- iii) All modulating straight-through water valves shall be provided with equal-percentage contoured throttling plugs. All three-way valves shall be provided with linear throttling plugs such that the total flow through the valve shall remain constant regardless of the valve's position.
 - iv) Valves shall be sized as specified for a pressure drop equal to the coil they serve but not to exceed 0.2 kg/ sq.cm.
 - v) All modulating steam valves shall have linear characteristic for 90% of the closing stroke and equal-percentage for the final 10%. Valves shall be sized for 0.68kg/ sq.cm entering steam and 0.2 kg/ sq.cm pressure drop through valves.

- vi) All automatic control valves shall be actuated by a directly coupled proportional electric actuator. Eccentric linkages are not acceptable.

7.5.3 Electric Actuators for Valves and Dampers

- i) Unless specified, the electric actuator shall accept proportional input signal of 0/2- 10VDC or 0/4-20mA. Unless specified actuators shall provide modulating control. Actuators shall be powered 24VAC or 240VAC as specified.
- ii) The actuators shall be designed to deliver the required torque and have close off pressure ratings as required by the specified process data
- iii) The actuator shall incorporate magnetic coupling to ensure torque limitation which shall be independent of voltage supply.
- iv) Unless specified, in case of power failure the actuator shaft position will remain stay-put at the last position just before power off.
- v) It shall be possible to replace the actuator / remove the actuator / dismantle it from the valve body without having to remove the valve body.
- vi) The actuator shall have a built in electronic switch to enable switch- over of direct / reverse action of valve/damper. It shall be possible to change the direct/reverse action of valve without having to remove the actuator from valve body or change linkage assemblies.

7.6 BMS I-O (Input-Output) Summary

Table-1 gives Input-Output summary for a typical BMS application involving 1 no. chilling unit, 2 nos. primary chilled water pumps, 4 nos. secondary chilled water pumps, 2 nos. condenser water pumps, 2 nos. cooling towers & 12 nos. AHUs.

Note: The lowest tenderer have to submit the BMS I/O updated summary chart for integration of Chiller plant, tertiary pumping PLC of 6 nos. buildings, BMS of individual 6 nos. buildings within 15 days of award of work to Engineer In charge.

BMS I-O (Input - Output) Summary
(Typical)

S. No.	Description	Point Functions								Filed devices	Type of I/O
		AI	DI	AO	DO	Mon-itor	Cont-rol	Ala- rm			
A	HVAC Equipment										
	HIGH SIDE										
1.	Chilling Machines										
a.	Chiller On/ OFF				1		X			Relay Contact	Potential Free contact in Chiller Panel
b.	Chiller Run Status		1			X		X			Potential Free contact in Chiller Panel
c.	Chiller Auto/ Manual Status		1			X		X			Potential Free contact in Chiller Panel
d.	Chiller-Water Temp Reset			1			X				0-10 VDC signal from chiller panel

e.	Chiller trip/ fault		1			X				Potential Free contact in Chiller Panel
f.	Chiller chilled water supply temp in (1) + out	2				X			Immersion type sensor	Suitable Insertion provision
g.	Ambient Temperature	1				X			Outside air temp. & RH sensor	Suitable Installation Provision
h.	Ambient RH	1				X				Suitable Installation Provision
	Sub Total	4	3	1	1					
2.	Chilled Water Pumps									
a.	Primary Chilled Water Pump On/ OFF				2		X		Relay output	Potential Free contact in Pump Starter Panel
b.	Primary Chilled Water pump run Status		2			X		X		Potential Free contact in Pump Starter Panel
c.	Primary Chilled Water pump flow status		2			X			Differential pressure switch (water)	Suitable Insertion Provision
d.	Secondary CHW Pump On/ Off				4		X		0-10 VDC signal from controller	Potential Free contact in Pump Starter Panel
e.	Secondary CHW pump run Statue		4			X		X		Potential Free contact in Pump Starter Panel
f.	Secondary CHW pump flow status		4			X			Differential Pressure Switch (water)	Suitable Insertion Provision
g.	Secondary CHW variable speed control			4						Provision of VFD for pumps
	Sub Total	0	12	4	6					
3.	Condenser Water Pumps									
a.	Condenser pump On/ Off				2		X		Relay output	Potential free contact in starter panel
b.	Cooling tower air flow status		2			X		X	Air flow switch	Suitable Installation provision
c.	Cooling tower sump low water		2			X		X	Low level switch	Suitable Insertion provision
d.	Cooling tower `IN` valves/ status		2		2	X	X	X	Motorised B/F valves	Suitable Installation provision
e.	Water Temp.	2				X		X	Immersion type sensor	Suitable Insertion provision
f.	Fire signal input					X		X		Potential free contact from the fire panel
	Sub Total	2	6	0	4					

Table-1 contd...

S. No	Description	AI	DI	AO	DO	Mon-itor	Cont-rol	Ala- rm	Filed devices	Type of I/O
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B.	LOW SIDE									
1.	Air Handling units									
a.	AHU speed fan On/ Off			12		X		Relay contact	Potential free contact in the AHU panel	
b.	AHU air flow status		12			X		Differential Pressure switch	Suitable Insertion provision	
c.	AHU filter status		12			X		Differential pressure switch	Suitable Insertion provision	
d.	Return Air Temperature	12				X		Duct Temp. Sensor	Suitable Insertion provision	
e.	Motorised valve cooling			12			X	2 way motorised valve	Suitable Insertion provision	
f.	Fan speed control			12				Variable speed drive	6-10 volt signal to VFD	
g.	AHU Auto/ Manual status		12			X			Potential free contact from the fire panel	
	Sub Total	12	36	24	12					
	Grand Total	18	57	29	23					

Section-8: PIPING

PIPE MATERIALS

8.1 Pipes shall be of the following materials.

(i) Mild steel heavy class (ERWS Black steel) tube conforming to IS: 1239 for sizes up to 150 mm.

(ii) Welded black steel pipe, class 2, conforming to IS: 3589, for sizes greater than 150 mm. These pipes shall be factory rolled MS C class pipe. The thickness of MS pipe shall be minimum 8 mm for pipes of sizes 200 mm and above.

8.2 PIPE JOINTS

Seismic considerations shall be taken into account while planning joint details. Joints in black steel pipes shall be of any of the following types.

Screwed joints and union joints screwed to pipes, up to 25 mm size.

Butt welded joints for pipe sizes above 25mm. electric welding shall be used for sizes 100mm and above.

Flanges joints with flanges as per IS: 6392 for all sizes. Flanges may be steel welded neck type or slip on type welded to pipe, or alternatively screwed type. The item of flanges shall be measured and paid separately.

Flexible coupling V grooves joints.

Flexible connections shall be provided at the pumps, and other machine where requires as per following specifications-

a) The Flexible connections shall be flanged type expansion joint. Flanges shall be non-compressible and mechanically strong type and the Neoprene rubber shall be provided in between the flange ends.

b) The connections shall work for a temperature range of minus 10°C to 70°C. c) The length and working pressure of bellows shall be as follows:

Nominal Bore (mm)	Length (mm)	Pressure (Bar)
20-25	125	15
32-200	150	15
250-350	200	10

d) Connections shall be provided with control rods to control the excessive elongation or compression of piping systems.

e) These shall be capable to withstand torsional movement up to 3o without damage.

8.3 PRE INSULATED CHILLED WATER PIPES

All piping system for service reaching a maximum temperature of 254°F installed above ground with Aluminum or GI jacketing and underground with HDPE jacketing.

i) The pipe shall be MS ERW as specified in the Piping Section.

ii) The pipe insulation shall be rigid polyurethane foam with excellent heat-insulating properties, good mechanical properties and good resistance against aging with minimum density of 48 kg/cu m, 90% minimum closed cell content, minimum compressive strength of 2.7kg/cm², and initial thermal conductivity of 0.026W/mK and the insulation fulfills all technical requirements according to EN 253. The insulation shall completely fill the annular space between the service pipe and jacket and shall be bonded to both, the service pipe & jacket. Polyurethane foam made from Polyol and Isocyanate with 48 kg/ m³ density. Minimum thickness of insulation shall be 30mm.

Protective Jacket Material shall be as specified and shall be sufficiently sized to allow for desired insulation thickness for optimum performance of the system.

iii) The cladding shall be spirally wounded of G.I. or Aluminium as specified in tender documents for pipes installed on surface.

S.No.	Dia. Of MS Pipe		Minimum Thickness of PUF in (mm)	Minimum Thickness of G.I. Cladding	Minimum Thickness of Al. Cladding
1.	20mm		33	26 gauge	24 gauge
2.	25mm		33	26 gauge	24 gauge
3.	32mm		33	26 gauge	24 gauge
4.	40mm		33	26 gauge	24 gauge
5.	50mm		33	26 gauge	24 gauge
6.	65mm		36	26 gauge	24 gauge
7.	80mm		42	26 gauge	24 gauge
8.	100mm		42	26 gauge	24 gauge
9.	125mm		42	26 gauge	24 gauge
10.	150mm		42	26 gauge	24 gauge
11.	200mm		52	26 gauge	24 gauge
12.	250mm		62	26 gauge	24 gauge
13.	300mm		62	26 gauge	24 gauge
14.	350mm		62	26 gauge	24 gauge
15.	400mm		62	26 gauge	24 gauge
16.	450mm		62	26 gauge	24 gauge
17.	500mm		62	24 gauge	22 gauge
18.	550mm		62	24 gauge	22 gauge
19.	600mm		62	24 gauge	22 gauge
20.	650mm		62	24 gauge	22 gauge
21.	700mm		62	24 gauge	22 gauge
22.	750mm		62	24 gauge	22 gauge
23.	800mm		62	24 gauge	22 gauge

v) Underground systems shall be buried in a trench of not less than 600 mm deeper than the top of the pipe & not less than 450mm wider than the combined OD of all piping systems. A minimum thickness of 600mm of compacted backfill over the top of the pipe is desirable.

vi) Trench bottom shall have a minimum of 150mm of sand, pea gravel or specified backfill material, consolidated to suit operating weight & to act as a cushion for the piping.

vii) For pipes buried in ground outer protective insulation jacket shall be seamless, extruded, black, UV resistant, high-density polyethylene (HDPE). HDPE Jacket shall be of High-density polyethylene (HDPE) with > 944 kg/ m3 density Diameter from 90 to 1000mm with minimum 3 to 28mm wall thickness and compressive strength is 40 PSI as specified.

ix) All straight pipe lengths will have water tight end seal. All fittings will have square cut insulation cutback.

viii) For leak identification purpose 2 wire diagnostic wiring shall also be provided.

ix) Fitting can be fabricated at site over the carrier pipe and correct quantity of PUF shall be poured manually.

x) Field joints insulation shall consist of PUF poured manually in a site-fabricated GI cladding fixed around the joint

xi) For pipes buried in ground minimum thickness of the HDPE jacket and PUF shall be as follows:

S.No.	Dia. Of MS Pipe	PUF Thickness (mm)	Thickness of HDPE Cladding (mm)
1.	20mm	30	2.5
2.	25mm	36	2.5
3.	32mm	36	2.5
4.	40mm	36	2.5
5.	50mm	37	3.0
6.	65mm	39	3.0
7.	80mm	43	3.0
8.	100mm	43	3.2
9.	125mm	43	3.5
10.	150mm	53	4.4
11.	200mm	63	5.0
12.	250mm	63	6.3
13.	300mm	63	7.0
14.	350mm	64	7.8
15.	400mm	68	8.8
16.	450mm	77	9.8
17.	500mm	77	11.1
18.	550mm	77	11.1
19.	600mm	83	12.5
20.	650mm	83	12.5
21.	700mm	83	13.0
22.	750mm	104	15.0
23.	800mm	104	15.0

The pre insulated pipe shall be manufactured at factory. The insulation shall completely fill the annular space between the carrier pipe & jacket and shall be bonded to both, carrier & jacket. The preinsulated pipes must be manufactured using High pressure PUF injection machines. The outer jacket & the carrier pipe must be held concentric using special chucks. Vent holes must be drilled to ensure expiration of air. The necessary quantity of Polyol & ISO must be mixed at high speed & injected into the void. The quantity of PUF injected for each pipe must be kept as a verifiable record to ensure that the required Density & thickness of insulation is maintained.

8.4 Leak Detection System

1 General

Leak Detection monitor can detect 1500 meter sensing cable. Once if water leaks on the cable alarm will start by flash and sound, and the leakage point will display on the LCD screen and the relays will ON automatically. Combined with MOD BUS RTU protocol & easy to integrate with monitoring system. This can be used as independent alarm, also can be connected to other monitoring system.

2 Performance

The Leak detection system shall locate the point of origin of first liquid or fault within +/- 1% of sensor string length. The system shall identify the type of alarm leak / break /fault of prob as the location. The system shall be able to monitor (detect and locate) up to 1500 meter long string of sensor cable.

The system shall provide Modbus 485 output and dry contact relay for remote indication of the alarm condition.

3 Monitoring Unit (Model no LDS485L1500)

The monitoring unit shall be microprocessor based and capable of monitoring up to 1500 meter of sensing string per device including sensing cable, end cable and leading cable. The monitoring unit shall indicate when any liquid or growing liquid contacts the sensor cable by sounding an alarm, actuating relay and displaying message the states a leak has been detected as shown the location of leak on sensing string.

The monitoring unit power requirement shall be AC/DC 9 to 24, 3 watt and also equipped with RS 485 communication ports and dry relay 125VAC and 24DC NO/NC contacts can be choose.

Basic characteristics	Sensor compatibility	<i>Model no LDS485L1500</i>
	Maximum length of the cable	1500m
	Accuracy	Sensor cable' s length of 0.5%±0.5m
Environmental rating	Storage temperature	-40 °C~60 °C (0 °F~140 °F)
	Working temperature	-20 °C~50 °C (32 °F~122 °F)
	Humidity	5% - 95%(no condensation)
Power supply	Sensor compatibility	AC/DC 9~24V, 3W
Serial interface	Network configuration	RS-485 double wire net work, the baud rate can be set, the factory default value is 9600, choose-able address is from 0 to 255, defaultaddress is 0
	Communication protocol	MODBUS RTU
	Relay contactor	Function
Rating		AC125V, 0.5A, DC24V, 1A

4. Sensor cable Model no LDSSC6000

The conductive-polymer technology and fluoropolymer construction make sensing cable mechanically strong and resistant to corrosion and abrasion. The cable is constructed of two sensing wires, an alarm signal wire, and a continuity wire embedded in a fluoropolymer carrier rod. The alarm module constantly monitors the sensing cable for continuity. The rugged cable construction exposes no metal, and enables the cable to be reused even in corrosive environments.

Cable diameter	0.24 in(6.0mm)nominal
Continuity and signal wires	2*26 AWG with insulation of fluoropolymer
Sensing wires	2*30 AWG with jacket of conductive fluoropolymer
Carrier	Fluoropolymer
Cable weight(50 ft/15m length)	2.3 lb (1kg)
Cable color	High-visibility yellow
Breaking strength	Cable only:160 lb(72KG) .Including connectors:70 lb(32kg)
Cut-through force	>50lb with 0.005(>22kg with with 0.13mm) in blade; crosshead speed 0.2in/min
Abrasion resistance	>65 cycles per UL719
Maximum continuous operating temperature	70degree
Leak size to alarm(tap water)	2 in(50mm)maximum at any piont along sensing cable , up to 5000 ft maximum system length
Drying time	Cable dries and resets within 15 seconds fo removal from standing water
Standard cleaning method	Wipe with clean damp cloth

5 Installation of Sensor Cable

Sensor cable shall be installed in polyurethane foam insulation during puff injection in factory fabricated pipes and each cable must be suitable for to join with adjacent cable with plug and play type connector for easy installation at site.

Sensing cable shall be supplied with factory-installed plastic connectors that plug together. The cable is designed of a range of applications, including data center subfloors, telecommunication rooms HVAC equipment locations, pipes, storage areas, tanks and roofs. The cable is small, lightweight and flexible, allowing easy installation. The smooth design allows for quick drying

Section 9

INSULATION WORK

9.1 SCOPE

This chapter covers the requirements of thermal insulation for chiller, chilled water / hot water piping, pumps and tanks, duct work, and acoustic lining in duct work and weather maker rooms. This does not cover exposed roof insulation and under deck insulation work.

9.2 Material for Chiller Insulation.

Supply and installation of **XLPE-** Chemically Cross Linked Closed Cell Polyethylene foam in **black color with extra flexibility and UV resistive** thermal insulation with nominal density of the material shall be **30 kg/m³ ± 10%**, having thermal conductivity of **0.0329 W/m °k at 23 °C**, mean temperature, as per IS 3346:1980. Material shall be resistant to growth of Fungus as per **ASTM C 1338** and resistant to growth of Bacteria as per **ASTM E 2180 for applying on the chiller. The minimum thickness for chiller insulation shall be 50 mm in multi layers. The top layer shall be with UV painted factory manufactured glass cloth (Preferably grey or as approved by Engineer In Charge).**

Fire characteristics shall confirm to **BS 476 Part 7, Class 1**, for Surface Spread of Flame and meet requirement of Fire Propagation as per **BS 476 Part 6**, having an index **(I) of 5.06** with lamination and **5.17** for plain materials and sub-indices $i_1(2.71)$; $i_2(1.65)$; $i_3(0.70)$. Visibility due to smoke shall confirm to Class A as per Standard UIC 564 – 2 Appendix 15.

Compliance to **BS EN 13501-1:2007 + A1:2009** (Reaction to fire performance) for 25 mm thickness sheet with Alupet + self - adhesive with classification BS1D0 in category of combustible thermal insulation with less fire propagation, low heat emission, zero smoke and zero fire droplets.

Compliance to **UL 94 HF -1 & ASTM E84** with results FSI-15 and SDI-5.

9.3 MATERIAL-TYPES

The insulation material to be used for various applications shall be any of the following, as required:

- 9.3.1 For insulation of water piping, pumps and tanks: -
- 9.3.1.1 Expanded polystyrene (T.F.Quality)
 - 9.3.1.2 Resin bonded glass wool
 - 9.3.1.3 Polyvinyl Nitrile (Closed cell rubber foam)
 - 9.3.1.4 XLPE (Closed cell cross linked polyolefin foam)

Expanded polystyrene (T.F.Quality) shall be used for pipe insulation like inside the A.C. plant room, exposed to outside or burried in ground. In the case of expanded polystyrene (TF quality), Resin bonded glass wool the pipe insulation should be in rigid sections in two halves and preformed to fit snugly on to pipes (upto pipe sizes for which the preformed sections are manufactured by the manufacturer of insulation). For higher pipe sizes insulation slabs shall be used.

Resin bonded glass wool is to be used for piping inside the building due to its fire retardant properties, for considerations of fire safety.

Polyvinyl Nitrile (Closed cell rubber foam) available in tube shapes for sliding on to the small dia. pipes can be used if successfully tested for fire retardant properties.

However, all shall need to be covered with vapour barrier and cladding with aluminium sheet.

9.3.2 For Insulation of duct work: -

- (a) Resin bonded glass wool.
- (b) Polyvinyl Nitrile (Closed cell rubber foam)

9.3.3 For acoustic lining of duct work and AHU rooms: -

- (a) Resin bonded glass wool.
- (b) Resin bonded mineral wool.

9.3.4 For suction line, Chilled water pipe: -

- (a) Expanded Polysterene (T.F.Quality)
- (b) Polyvinyl Nitrile (Closed cell rubber foam)

(v) For double skin AHUs:

- (a) Polyurethane foam (PUF insulation)

9.4 MATERIAL SPECIFICATIONS

The insulation material shall satisfy the following requirements: -

9.4.1 For thermal application on pipes.

Material	Minimum Density (Kg/cu.m)	Maximum Thermal conductivity (K.cal/ hr. degree C/m at 10 Deg C mean temp.)
Resin bonded glass wool	32	0.031
Expanded polystyrene (TF)	20	0.035
Polyvinyl Nitrile foam	55	0.034

9.4.2 For thermal insulation of ducts:

<u>Material</u>	<u>Minimum Density(Kg / cu.m)</u>
Resin bonded glass wool	24
Polyvinyl Nitrile foam	40

Fibre Glass Insulation used for duct insulation shall be factory faced with aluminium foil on one side reinforced with kraft paper & fused to the insulation material.

Polyvinyl Nitrile foam Insulation used for duct insulation shall be factory faced with aluminium foil on one side.

9.4.3 For acoustic lining:

Application	Thickness	Material	Minimum Density (Kg./Cu.M)
Duct	25 mm	Resin bonded glass wool	32
AHU room	50 mm	Resin bonded glass wool/ Mineral wool	32/ 48

9.4.4 The specification for resin bonded glass wool insulation & resin bonded mineral wool insulation shall conform to IS 8183 as amended upto date. The specification for expanded polystyrene shall conform to IS-4671 as amended upto date.

9.4.5 Expansion tank Insulation

Expanded polystyrene insulation of density not less than 20kg per cu.m. shall be used.

9.5 INSULATION THICKNESS

The thickness of insulation shall be as indicated below unless specified otherwise in the tender specifications.

9.5.1 For pipe insulation (for chilled water as well as hot water application

Pipe Size (mm)	Glass fibre /Exp. Polystyrene (mm)
150 & below	50
Above 150	75

ii) <u>For Duct insulation</u>	Fibre glass (mm)
Application	
Thermal for AC area	12.5
Thermal for Non AC area	25
Acoustic	25

iii) For room acoustic lining

Resin bonded glass wool 50 mm
Resin bonded mineral wool 50 mm

iv) For pumps :

Expanded polystyrene TF quality 50 mm

v) Chiller Insulation

Thickness of XLPE insulation used for chiller insulation shall not be less than 50 mm.

vi) Expansion tank

vii) Thickness of XLPE insulation used for chiller insulation shall not be less than 50 mm.

9.6 APPLICATION OF INSULATION ON PIPES (including suction line insulation)

(i) The surface to be insulated shall be first cleaned and a coat of zinc chromate primer shall be given. The insulation shall be fixed tightly to the surface with cold setting adhesive CPRX compound. All joints shall be staggered and sealed. The second layer of insulation wherever required shall be similarly applied over the first layer.

- (ii) *Pipes shall be preferably pre insulated at factory, meeting the requirement or the insulation shall be finished at site as under:*
 - (a) *For pipes laid inside the building, the insulation over the pipe work shall be finished with 0.63 mm thick aluminium sheet cladding over a vapour barrier of 120 gm/ sq.m. polythene sheet with 50 mm overlap and tied down with lacing wire and complete with type 3, grade-I roofing felt strip (as per IS 1322 as amended upto date) at the joints..*
 - (b) *For pipes outside the building laid above ground the finishing over the pipe insulation shall be finished with 0.63 mm G S sheet cladding over a vapour barrier of 120 gm/sq.m polythene sheet with 50mm overlap and tied down with lacing wire and complete with type 3 grade I roofing felt strip applied by means of cold setting CPRX compound..*
 - (c) *For pipes outside the building laid under ground the insulation shall be covered with 500 gauge polythene faced hessian, (the polythene facing outwards), with 50 mm overlap. All joints shall be sealed with bitumen. A layer of 0.50 mm x 20 mm G.I. wire mesh netting shall be provided over it butting all joints and it shall be laced down with GI wire, sand cement plaster (1:4) 20 mm. thick shall be provided in 2 layers of each 10mm and shall be water proofed by applying hot bitumen & fixing tar felt over the plaster. It shall be finally finished with a coat of hot bitumen.) In case of factory pre insulated pipes, buried underground, a water leakage sensing wire shall also be provided, to detect the location of water leakage at later date.*
 - (d) *In case of factory pre insulated pipes, all joints shall be properly insulated at site as per recommendation of manufacturer*
- (iii) *All valves, fittings, strainers etc. shall be insulated to the same thickness and in the same manner as for the respective piping, taking care to allow operation of valves without damaging the insulation.*

9.7 APPLICATION OF INSULATION ON PUMPS

Expanded polystyrene (TF quality) 50mm thickness shall be sandwiched between two aluminium sheets of 0.5mm thickness and properly clamped to pump in two semicircular sections or XLPE insulation as per the requirement.

9.8 APPLICATION OF INSULATION ON EXPANSION TANK

Insulation of expansion tank shall be XLPE/ expanded polysterene (T.F.Quality) of thickness not less than 50mm. It shall be applied as under

- 9.8.1 *Surface shall be thoroughly cleaned with wire brush and rendered free from all dust & grease.*
- 9.8.2 *The two layers of hot bitumen shall be applied.*
- 9.8.3 *The insulation slabs will then be fixed in one layer and joints shall be*

sealed with hot bitumen.

9.8.4 *The insulation slab then shall be covered with 0.63 mm x 19mm G.I. wire mesh netting which shall be fixed to insulation with brass / G.I. nails.*

9.8.5 *The insulation shall then finally be finished with aluminium cladding of thickness not less than 0.5mm.*

9.9 APPLICATION OF INSULATION (THERMAL) ON DUCT

9.9.1 *The surface of duct on which the external thermal insulation is to be provided shall be thoroughly cleaned with wire brush and rendered free from all dust and grease.*

9.9.2 *Two coats of cold compound adhesive (CPRX compound) shall be applied over the duct. (Any other adhesive recommended by the manufacturers may also be used with the approval of the Engineer-in-charge).*

9.10 APPLICATION OF DUCT LINING (ACOUSTIC INSULATION)

Where specified in the tender specifications, ducts shall be lined internally with acoustic insulation as detailed below:

9.10.1 *The Inside surface of duct on which the acoustic lining is to be provided shall be thoroughly cleaned with wire brush and rendered free from all dust and grease.*

9.10.2 *Then 25 x 25 sq.mm section of minimum 1.25 mm thick G.I. sheet shall be fixed on both ends of the duct piece.*

9.10.3 *The insulation slabs shall then be fixed between these section of ducts using CPRX adhesive compound and stickpins.*

9.10.4 *The insulation shall then be covered with Reinforced plastic/ fibre glass tissue **with proper overlap**, sealing all joints so that no fibre is visible.*

9.10.5 *The insulation shall finally be covered with minimum 0.5 mm thick perforated aluminium sheet having perforations between 20-40%.*

9.11 APPLICATION OF ACOUSTIC LINING IN AHU ROOMS

9.11.1 *The wall/ roof surface should be thoroughly cleaned with wire brush.*

9.11.2 A 610x610 mm frame work of 25mm x50mm x50mm x50mm x25mm shape channel made of 0.6mm thick G.S.S. shall be fixed to walls leaving 610mm from floor by means of raw plugs in walls and dash fasteners in ceiling. Similar frame work shall also be fixed on ceiling by means of dash fasteners.

9.11.3 Resin bonded glass wool/ mineral wool as specified cut to size will be friction fitted in the frame work and covered with tissue paper.

9.11.4 Aluminium perforated sheet having perforation between 20-40% of thickness not less than 0.8mm shall be fixed over the entire surface neatly without causing sag/ depression in between and held with screws. Sheet joints should overlap minimum 10mm.

9.11.5 Aluminum beading of 25mm wide and thickness not less than 1.00 mm shall be fixed on all horizontal/ vertical joints by means of screws.

9.12 MEASUREMENT OF INSULATION

- a) *Pipe insulation shall be measured in units of length along the centre line of the insulated pipe. The linear measurements shall be taken before the application of the insulation. For piping measurements, all valves, orifice plates and strainers shall be considered strictly by linear measurement along the centre line of the pipes, and no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.*
- b) *Duct insulation and acoustic lining shall be measured on the basis of surface area along the outer surface (ref IS14164 of 2008) of insulation thickness. Thus the surface area of externally thermal insulated or acoustically lined duct shall be based on the perimeter at the centre of thickness of insulation, multiplied by the centre-line length of ducting including tapered pieces, bends, tees, branches etc. as measured for bare ducting. In the case of tapering pieces, their average perimeter shall be considered.*

SECTION- 10 Valves, Y-Strainer and associated controls

CONTROLS

10.1 SCOPE

This chapter covers the requirements of equipment safety controls, refrigerant flow controls, system controls, and variable speed drive (VSD). For chilling units all the controls shall be microprocessor based.

10.2 EQUIPMENT SAFETY CONTROLS

10.2.1 Compressor:

10.2.1.1 Compressor shall be provided with the following safety controls: -

i) High discharge pressure (HP) safety (cut out) to stop the compressor automatically, in case discharge pressure exceeds a pre-set safe value. This safety shall operate when discharge head pressure exceeds the set point. Only manual resetting shall be provided for this safety.

ii) Low suction pressure (LP) safety (cut-out) to stop the compressor automatically, in case suction pressure falls below a pre-set value. This safety shall operate when the suction pressure falls below the set point. Automatic resetting shall be provided for this safety, with adjustable cut-in and cut-out pressures. This safety shall be used for pumping down the system for shutting off the refrigeration plant.

iii) Oil pressure (O.P) safety (cut-outs) to stop the compressor, in case lubricating oil pressure falls below a safe set value. A time delay mechanism shall also be provided, so as to permit running of the compressor upto a maximum period of 90 seconds, with the oil pressure differential below the set value and allow it to continue normal operation if the pressure differential builds up to the set value within that time, or otherwise shut-down the compressor. Only manual resetting shall be provided for this safety.

iv) High bearing oil temperature cut-out (for centrifugal compressor only). This shall be provided with a manual reset only.

v) High lubricating oil temperature cut-out (for centrifugal compressor only). This shall be provided with a manual reset only.

vi) Time delay mechanism on the starting gear to limit short cycling regardless of malfunctioning of controls.

The cut-outs (i) to (v) mentioned above shall operate when the respective controlled variable crosses the set point to trip the compressor. Audio visual alarm shall be provided to indicate such operations. A manual reset shall be provided for them.

10.2.1.2 Safeties mentioned above shall operate when the respective controlled variable crosses the set point to trip the compressor.

10.2.1.3 Audio visual alarm shall also be provided to indicate such operations.

10.2.2 Condenser

The safety control for a condenser shall comprise a safety pressure relief valve on the shell. This shall operate to relieve the pressure at the set point without prior leakage. For small condensers, a fusible plug may be provided to melt at a predetermined temperature.

10.2.3 Chiller

i) An antifreeze shall be provided with water chiller, set at a few degrees above the freezing point. This shall operate, when the temperature of water in the chiller falls below the set point to trip the compressor motor. The reset provided for the safety shall be manual.

ii) Flooded type of chiller in addition, shall be provided with safety pressure relief valve.

10.2.4 Refrigeration Plant

i) In addition to the safety controls as above for the individual components of a refrigeration plant, the following safety controls shall also be provided for the plant.

a) Compressor motor over current cut-out. b) Condenser water flow switch. c) Chilled water flow switch. d) Condenser air flow switch in the condenser fan discharge (in case of air-cooled condensers). e) Air flow switch in the evaporator fan discharge in case of direct expansion coils

ii) The above controls, on operation, shall trip the compressor motor, and these shall be provided with manual reset arrangement.

iii) The compressor motor shall also be interlocked electrically with, a) Condenser water pump in case of water cooled condenser, and condenser fan with air cooled condensers, (b) Chilled water pumps in case of chilled water system and evaporator fan in case of direct expansion system, and c) Antifreeze thermostat in case of chillers.

iv) Indicating lamps shall also be provided on the control panel for indicating operation of the safeties and interlocks.

10.3 REFRIGERANT FLOW CONTROLS

A refrigeration plant shall be provided with controls, necessary for starting, stopping and modulating the flow of refrigerant in the plant so as to satisfy the load requirements. These comprise solenoid valve, thermostatic/ Electronic type expansion valve, float valve, compressor capacity controls etc. and other special controls if specified in a particular work.

10.3.1 Solenoid Valve

a) For reciprocating and screw type compressors liquid line solenoid valve shall be provided in the liquid line of the system, ahead of the expansion valve, to allow or to stop the flow of liquid refrigerant to an evaporator, or a section of sectionalized evaporator. This shall be operated by snap-acting thermostat and it shall also be provided with a test switch to enable manual energizing.

b) Discharge gas valves shall be provided in the following applications as required: -

i) Hot gas defrosting: Normally this solenoid valve shall remain closed, but it shall open up to feed the evaporator with hot gas for defrosting when required, especially in cold storage applications.

ii) Compressor capacity control for reciprocating compressor and for cylinder unloading during starting.

c) Solenoid valves shall be direct acting in smaller sizes and pilot operated for larger sizes, as required. The size of the valves shall be determined by the desired flow rate of refrigerant through them and the pressure drop across the same (and not by the size of the refrigerant line).

10.3.2 Thermostatic / Electronic type Expansion Valve

Thermostatic/ Electronic type expansion valve shall be provided in DX type refrigeration plant to modulate the flow rate of liquid refrigerant entering the evaporator in response to the extent of superheat of refrigerant gas leaving the evaporator, so that only a metered flow is ensured matching the load.

The number of expansion valve shall be such that the specified accuracy of temperature control of the system can be achieved and that no valve is expected to operate below 35% of its rated capacity. The sizes shall be selected suitably so as to avoid hunting. Adjustable super heat control and external equalizer port shall be provided for each valve. Each expansion valve shall be easily removable for cleaning and adjusting.

10.3.3 Float Valve

Float valve shall be provided in refrigeration plant with flooded type chiller for maintaining the liquid level in chiller under all conditions of load at a rate commensurate with the rate of vaporisation. This can be provided either on low pressure side or on high pressure side. When provided as low side float valve, this shall be located as a part of the chiller or accumulator.

10.3.4 Compressor Capacity Control

The capacity control arrangement shall be in accordance with section1 for centrifugal type compressor.

10.4 SYSTEM CONTROLS

i)The requirements for maintaining the inside design conditions as specified in the tender specifications for the work shall be met by appropriate system controls and control elements. The system shall satisfy the requirements of both full load and partial load conditions. Details of complete control elements shall be indicated by the tenderer in the tender.

ii)For cooling applications in plants other than package type AC (PTAC) units, control shall be effected by 3 way diverting valve in chilled water coil. For heating using hot water coils, flow control through them shall also be achieved by using 3 way valves.

In the case of PTAC type units, the control of the units is affected through snap acting room thermostat.

iii)The size of 3 way diverting valves shall be selected so as to match the coil wherein the flow is to be regulated. The make and size shall be indicated in the Technical particulars in the tender.

iv)Operation of the modulating motor of 3 way diverting valve shall be controlled by proportional type thermostat.

v) One snap acting humidistat shall be provided for each humidifier.

vi) Where strip heaters are specified, maximum size of each heater bank shall not exceed 9 KW, distributed in three phases of 3 KW per phase.

vii) Every bank of strip heaters shall be controlled by a snap acting thermostat in case of temperature control requirement and by a snap acting humidistat for reheat control to maintain the specified RH condition.

viii) Where more than one bank of heaters is required to be provided for one AHU, thermostat shall be provided in each bank suitable for operation in stages.

ix) A safety thermostat (safety stat) shall be provided as high limit safety for each bank of heaters.

x) The heater banks intended for reheating during monsoon shall form part of heaters required for winter heating (where winter heating is specified). Necessary change-over switch shall be provided as part of the system wiring to change their control by thermostats or humidistat as required.

10.5 OPERATIONAL CONTROLS AND INTERLOCKS

i) The operation of refrigeration plant shall be either manual or automatic, as specified. The plant shall be started by an ON/OFF switch.

Additionally, in the case of an automatic plant, an auto/manual switch shall also be provided.

ii) The automatic operation shall be effected through the monitoring of return chilled water temperature, or the room conditions, as the case may be. In multi unit installations, one unit shall be arranged to be loaded fully before the next unit is switched on automatically. A similar operation system shall be followed in shutting off of the unit. Change over from one operating unit to another shall be possible through the status switch of the plant to be shut down by change to manual position and thus overriding its anti-cycle timer. It should be possible to introduce the changed unit by running it to speed and changing over the status switch to "auto" position.

iii) Pump down shut down shall be provided through low pressure (LP) safety irrespective of the status switch position, auto/manual.

iv) It should be possible to start the compressor motor only after the cooling tower fan motor (where provided), chilled water (where provided) and condenser water pumps are operated.

v) The compressor motor shall be able to be started or run, only after all the safeties as per para 12.2 are satisfied.

vi) The blower motor shall be interlocked with strip heaters (where provided) such that power supply to strip heaters will become ON, only after the blower has been started and run to full (designed) speed.

vii) Where only the blower motor and not heaters is connected to standby generating set in any particular application, a timer shall be provided, such that the heaters may get energised, only after a period of time, after the blower is run.

viii) In the event of signal from high limit safety of heaters the power supply to the blower motor and the heater bank shall automatically and instantly be switched off.

ix) The power supply to AHU shall be cut off on receipt of a signal from the Fire Alarm System.

10.6 REQUIREMENTS OF CONTROL ELEMENTS

The system control elements comprise controlling elements such as thermostats, humidistat, three way valves, heaters, humidifiers, dehumidifier etc as required for individual applications.

5.6.1 Thermostats

Thermostats shall be electric fixed differential type as indicated below, with sensing element located in the return air stream. All thermostats shall be supplied with the standard mounting boxes as recommended by the manufacturer. The profile, mounting arrangement and exact location of the thermostat shall be such as to suit the site.

i)Proportional control thermostats shall be provided for actuating the three way modulating valve at each air handling unit. Thermostat shall provide manual switching (heat-off-cool-in heating-cooling system).

ii)Snap-acting fixed differential type thermostat for actuating the threeway diverting valve at each fan coil unit.

Thermostat shall have temperature adjustments WARM-NORMALCOOL settings and fan switch. Switching off must break fan circuit.

iii)Snap-acting fixed differential heating thermostat for electric winter heating and reheat applications for putting on/off power supply to electric heating or reheat coils in air handling units.

iv)Safety thermostat shall be provided for electric winter heating and reheat application for cutting off power supply to strip heaters in case air flow across strip heater is not established.

vi) Air-stat shall be provided within air handling unit containing electric heating or reheat coils to prevent heaters from energizing unless the air flow is established.

10.6.2 Humidistat

Humidistat shall be provided with air handling unit for areas, which require humidity control. One humidistat shall activate the reheat coils in case the space humidity rises beyond the preset limit. Another humidistat shall energize the humidifier when the humidity falls below the preset limit. These humidistat shall also de-energize these devices when the desired humidity is reached.

Humidistat shall be snap-acting type having humidifier/dehumidifier control from 20-80 percent relative humidity, with differential of 5 percent. Humidistat shall have nylon element with three bobbins, and removable knob to prevent tempering of set point.

10.6.3 Three-way modulating valves (for AHUs)

These shall be provided in chilled/hot water lines as diverting valves at each air-handling unit and shall be actuated by a space thermostat. Space conditions shall be maintained by continuous proportional modulation of the chilled/hot water through the coil. The valve shall revert to fully bypass position when fan is shut off. Maximum pressure drop across valve shall not exceed 0.85 kg/ sq.cm. Where VSD (to control chilled water flow) is provided, the AHUs shall be provided with 2 way diverting valve.

10.6.4 Three-way diverting valves for FCUs

This shall be provided as 2 position diverting valves in chilled/hot water lines at each fan coil unit and shall be actuated by a space thermostat. Space conditions shall be maintained by allowing all of chilled/hot water to either pass through the coil or bypass the coil and mix with the chilled/hot water return. The valves shall revert to fully bypass position when fan is shut off. Pressure drop across the valve shall not exceed 0.14 kg/ sq.cm. Valve shall have the facility to replace motor actuator without removing the valve body.

10.6.5 Spray humidifiers, where specified, shall be as per details given under para 6.2.3.6.1.

10.6.6 Pan humidifiers where provided shall be as per para 6.2.3.6.2.

10.6.7 Strip heaters shall be of finned type construction with a surface temperature not exceeding 45 deg. C. The same shall be suitable for 230 V, AC supply. The heaters shall be adequately insulated electrically from their mountings unit/ casing.

10.6.8 Dehumidifiers, where provided shall use adsorption type desiccants. The desiccant used shall be non-toxic, non-corrosive having a life of about 5 years with constant employment in regeneration cycle.

10.8 VARIABLE SPEED DRIVE (VSD)

10.8.1 Air quantity flow control

The VSD System shall function to supply variable air quantity in the air-conditioned area in response to the load variations including that due to variations in ambient conditions and filter cleanliness conditions, to maintain the inside designed temperature, RH and pressure conditions in conjunction with the humidifier and re-heaters. During the day hours, as per the time interval selected, the VSD System shall regulate the speed of the AHU to maintain the temperature within maximum designed temperature and positive air pressure inside the air-conditioned area. The positive air pressure shall be maintained by keeping a difference of minimum 15% in the airflow between the supply and exhaust air. However, under any circumstances during the day hours, the air flow rate will not fall below the 60% of the rated CFM of the AHU or 15 air changes, whichever is higher. During the rest of the night hours, the Programmable timer shall give a signal to the VSD to run the AHU at a predetermined reduced speed so as to provide only 25% of the normal CFM or the minimum CFM achievable closest to 25% but not below 25% of the normal CFM. Due to the clogging of the air filter if the inside temperature conditions are not achieved even at 100% AHU speed then the VSD will close an N.O. contacts to activate an alarm. The VSD shall have the provision to switch over to the manual mode as and when required. The system shall comprise of dedicated Variable Speed Drives (VSDs) designed for HVAC applications to accept 2 feedback signals (from temperature sensor installed in the AC area and programmable timer controller) and have 2 programmable set points (inside temperature conditions, and 60% of the normal CFM condition as stated above) using HVAC terminology, to regulate the speed of the AHU motors in response to the variations in load and filter cleanliness conditions to maintain temperature and Air flow differential in supply and exhaust conditions. In case, any additional sensor (s) including wiring etc are required to meet the system requirements the cost of that shall be deemed to be included in the cost of the VSD. The VSD control shall have:

a)RFI (Radio frequency interference) Filters for EMC (Electro magnetic compatibility) compliance.

b) Voltage Vector Control technology to generate advanced sinusoidal output voltage, 100% true RMS value of the fundamental voltage at rated speed and nominal torque, cause no motor de-rating and keep motor temperature limits within permissible class B limits.

c) a Numeric Characters for all operating parameters, programming parameters and faults.

d) Built in energy meter.

e) Built in run time counter.

f) Local control panel (key pad)

The system shall also comprise a suitable programmable timer & PLC with required electronic components, to allow 2 feedback signals (Temperature & Minimum CFM) to be passed on to the VSD during the day hours. In the night hours only one signal from the programmable timer shall go to the VSD to run it at pre-determined reduced speed. The room/ space air temperature and air flow shall be sensed by a temperature and air flow transmitters, which shall generate suitable DC signal to provide feedback to the VSD, which in turn shall regulate the speed of the AHU fan to maintain the designed conditions as described above.

VSD shall be designed, with built-in PID controller, control panel (keypads & display), IP 20 enclosure for use on standard centrifugal fans. The VSDs should not cause any de-rating of the connected motors and must ensure that class B temperature levels of the connected motors are never exceeded. The display should be in alpha-numeric characters and programming facility should be in user-friendly HVAC terminology. The VSDs should be able to accept up to 2 feedback signal from temperature & air flow transmitter simultaneously and to program 2 set points in it.

The system shall also have following features incorporated :

a) Heat sink over temperature protection

b) Under voltage protection

c) Over voltage protection

d) Alpha-numeric display facilities

e) ON indication f) Trip indication

g) Selectable display of various parameters line voltage, frequency, speed, power, torque, motor temperature percentage, VSD temperature percentage, KWH.

h) Raise and lower speed push button in local mode.

i) Frequency range variation from 0 to 50 Hz.

j) Remote start and stop facility including indications there of with necessary hardware and terminal blocks, including toggle switch etc. to over ride remote start & stop at the time of maintenance/ repairs. k) Off delay facility through timer or PLC with 30 sec to 120 sec. time delay, to be connected to air flow switch.

l) Safeguard facility against single phasing.

m) Tripping of AHU blower motors in response to the fire alarm signal from AFAS.

n) Inter locking of Exhaust and AHU blowers such that power supply gets fed to exhaust blower only when the supply air flow is there.

10.8.2 Chilled water flow control

Variable Speed Drive (VSDs) for controlling the chilled water flow rate in the secondary circuit may be provided when AHUs operation is for 24 hours and where the secondary chilled water system has been provided. Requirement and Specifications of VSD system shall be as follows:

The VSD System shall function to supply variable chilled water flow in the secondary circuit of air-conditioning system in response to the load variations including that due to variations in ambient conditions to maintain the inside designed temperature conditions. However, under any circumstances, the secondary chilled water pump speed shall not fall below the 30% of the nominal speed or any other suitable minimum speed as per the system requirement. The VSD shall have the provision to switch over to the manual mode as and when required and facility for the manual speed variation from VSD itself. The system shall comprise of dedicated Variable Speed Drives (VSDs) designed for HVAC applications to accept two feedback signals (from differential pressure transmitters installed across the two farthest, most significant AHUs of the zone to select either maximum of the two or average of the two (as selected by the user) feedback signals using HVAC terminology, to regulate the speed of the secondary chilled water pump motors in response to the load variations. In case, any additional sensor (s) including wiring etc. if required to meet the system requirements the cost of that shall be deemed to be included in the cost of the VSD. The VSD shall have:

a) RFI (Radio frequency interference) Filters for EMC (Electro magnetic compatibility) compliance.

b) Voltage Vector Control technology to generate advanced sinusoidal output voltage, 100% true RMS value of the fundamental voltage at rated speed and nominal torque, cause no motor deration, and keep motor temperature limits within permissible class B limits.

c) The VSDs shall have D.C. link reactors/ harmonic filters integrated to minimise power line harmonics. There shall be reactors in both the positive and negative rails.

d) An automatic energy optimisation feature shall be provided as standard in the frequency converter. This feature shall reduce output voltage, further to quadratic V/f characteristics, when the motor is lightly loaded and minimise the motor losses.

e) The VSD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% torque for upto 5 seconds (for high inertic and high friction load).

f) The VSD shall include Automatic Motor Adaptation (AMA) to optimize motor performance, improve start capabilities and compensate for motor cable variances. The AMA shall be carried out at motor stand still with no need for detaching the pump from motor.

g) Unlimited output power circuit switching must be possible without the need for central circuit interlocking and without causing damage to the VSD.

h) Auto-derating of maximum drive current shall be incorporated in VSD to allow continued operation at reduced speed in case of VSD over temperature phase loss or mains imbalance without damaging the VSD.

i) parameters, programming parameters, faults,

j)Built in energy meter. k)in run time counter. l)Local control panel (key pad)

The system shall also comprise a suitable PLC if required, with electronic components.

VSD shall be designed, with built-in PID controller, control panel (keypads & display), IP 20 enclosure for use on standard centrifugal pumps. The VSDs should not cause any de-rating of the connected motors and must ensure that class B temperature levels of the connected motors are never exceeded. The display should be in alphanumeric characters and programming facility should be in user-friendly HVAC terminology. The VSDs shall be able to accept up to two feedback signals from differential Pressure transmitters simultaneously and to program set points in it. The system shall have following features incorporated:- a)Heat sink over temperature protection b)Under voltage protection c)Over voltage protection d)Protections against input transients, loss of A.C. line phase, short circuit, ground fault, frequency converter over temperature. e)Alpha-numeric display facilities f)ON indication g)Trip indication h)Selectable display of various parameters like output line voltage, output frequency, speed, power, motor temperature percentage, heat sink temperature, VSD temperature percentage, KWH, hours run, differential pressure. i)Raise and lower speed push button in local mode. j)Frequency range variation from 0 to 50 Hz. k)Remote start and stop facility including indications thereof with necessary hardware and terminal blocks, including toggle switch etc. for over ride of remote start & stop of at the time of maintenance/ repairs. l)Safeguard facility against single phasing.

10.8.3 Where both building management system and air quantity flow control / chilled water flow control through VFD are provided for same application, control panel for sequencing of VFD shall not be required.

SECTION 11

WATER PLUMBING WORK

SCOPE

This chapter covers the requirements of plumbing work in chilled water, hot water, water in condenser circuit and drains, to be executed as part of heating, ventilating and air conditioning.

11.1 PLUMBING DESIGN

Pipe sizes shown in tender documents are purely for contractor's guidance. The contractor shall be responsible for selection of sizes as per detailed engineering to be done by him. Plumbing design to be done by the Air- conditioning contractor shall conform to the following: -

- i) Water velocity in pipes shall not exceed 2.5 m/sec.*
- ii) Butterfly/ Ball valves shall be provided at
 - a) suction and delivery sides of pumps.*
 - b) inlet and outlet of each condenser, chiller, cooling tower, hot water generator.*
 - c) all drain connections from equipments.*
 - d) Inlet & outlet of every heat exchanger coil, namely for AHU's, FCUs's, convector etc.**
- iii) Non return valve shall be provided at the delivery of each pump. This shall be of swing type.*
- iv) Balancing valve shall be provided at the outlet side of chiller, condenser, heating and cooling coils to regulate the maximum flow rate upto value preset as desired.*
- v) Balancing valves shall be provided, where specified, for AHU's to regulate the maximum flow rate upto a value preset as desired. A mercury manometer shall be supplied with every 10 nos. or part thereof of balancing valves, whether or not specifically indicated in the tender specifications.*
- vi) Air valves shall be provided at all high points in the piping system for venting with a size of 25 mm for pipes upto 100 mm and 40 mm for larger pipes.*
- vii) Plumbing drawings showing the sizes of valves, layout and other details shall be prepared and shall be got approved from the Engineer- in-Charge before the execution of the plumbing work.*

11.2 PIPE MATERIALS

Pipes shall be of the following materials.

- 11.2.1 Mild steel medium class (Black steel) tube conforming to IS: 1239 for sizes upto 150 mm.*
- 11.2.2 Welded black steel pipe, class 2, conforming to IS: 3589, for sizes greater than 150 mm. These pipes shall be factory rolled & fabricated from minimum 6mm thick M.S. Sheet for pipes upto 350mm dia & from minimum 7mm thick M.S. sheet for pipes of 400mm dia & above.*

11.3 PIPE JOINTS

Seismic considerations shall be taken into account while planning joint details. Joints in black steel pipes shall be of any of the following types.

- 11.3.1 Screwed joints and union joints screwed to pipes, upto 25 mm size.*
- 11.3.2 Butt welded joints for pipe sizes above 25mm. Electric welding shall be used for sizes 100mm and above.*
- 11.3.3 Flanges joints with flanges as per IS: 6392 for all sizes. Flanges may be steel*

welded neck type or slip on type welded to pipe, or alternatively screwed type. The item of flanges shall be measured and paid separately.

11.3.4 Flexible coupling V groove joints.

11.3.5 Flexible connections shall be provided at the pumps, and other machine where requires as per following specifications-

11.3.5.1 The Flexible connections shall be flanged type expansion joint. Flanges shall be non-compressible and mechanically strong type and the Neoprene rubber shall be provided in between the flange ends.

11.3.5.2 The connections shall work for a temperature range of minus 10°C to 70°C.

11.3.5.3 The length and working pressure of bellows shall be as follows:

Nominal Bore (mm)	Length (mm)	Pressure (Bar)
20-25	125	15
32-200	150	15
250-350	200	10

11.3.5.4 Connections shall be provided with control rods to control the excessive elongation or compression of piping systems.

11.3.5.5 These shall be capable to withstand torsional movement upto 3° without damage.

11.4 VALVES

i) The material of butter fly valves shall be as under:

Body- Castiron

Disc- Cast Bronze or Stainless Steel Seat-

Either integral or Nitrile rubber O-ring-

Nitrile/Silicon

ii) Balancing valve shall be of cast iron flanged construction with EPDM/ SG iron with epoxy coated disc with built in pressure drop measuring facility (pressure test cocks) to compute flow rate across the valve. The test cocks shall be long enough to protrude out of pipe insulation.

iii) Non return valves shall be of gun metal construction upto 65 mm, the metal conforming to class 2 of IS: 778. For 75 mm and above, the valve shall be of bronze or gun metal, body being of cast iron. While screwed or flanged ends may be provided upto 65 mm, flanged ends shall be provided for larger sizes.

iv) Air valves shall be of gunmetal body.

11.5 STRAINERS

11.5.1 Strainers shall be of 'Y' type or pot type as specified.

11.5.2 'Y' strainers shall be provided on the inlet side of each air-handling unit and pump in chilled water and condenser water circuit.

11.5.3 Pot strainers, where specified, shall be provided in return water headers, for chilled water and condenser water if enough floor area is available in the refrigeration plant room, as an alternate to individual Y type strainers with pumps.

11.5.4 The strainers shall be designed to the test pressure specified for the gate valves.

11.5.5 Filtration area of Y-strainer shall be minimum four times the connecting pipe size.

11.5.6 Strainers shall have a removable bronze/ stainless steel minimum 1mm thick

screen with 3 mm perforations and permanent magnet.

11.5.7 Strainers shall be provided with flanges or threaded sockets as required. They shall be designed so as to enable blowing out accumulated dirt and facilitate removal and replacement of screen without disconnection of the main pipe.

11.5.8 Strainers shall be provided with equal size isolating gate valves on either side so that the strainers may be cleaned without draining the system.

11.5.9 Pot strainer shall be fabricated out of MS sheet and the sizes shall be as under:

Pipe sizes (mm)	Pot dia (mm)	Pot Height (mm)	Basket dia (mm)	Basket Height (mm)
50	300	400	200	240
80	350	450	250	250
100	450	500	300	280
125	500	600	330	340
150	540	700	360	390
200	610	815	400	470
250	800	955	550	510
300	1000	1105	750	580
350	1190	1300	895	678
400	1350	1500	1020	785
450	1518	1700	1060	890
500	1690	1800	1100	900

11.6 INSTRUMENTS

i) Pressure gauge of appropriate range and 150 mm. dial size shall be provided at the following locations.

a) Supply and return of all heat exchange equipments.

b) Suction and discharge of all pump sets.

The pressure gauge shall be duly calibrated before installation and shall be complete with shut off cocks.

ii) Direct reading industrial type thermometer of appropriate range shall be provided at the inlet and outlet of all heat exchange equipments. The thermometers shall be installed in separate wells.

iii) Appropriate number of additional sockets shall be provided for the installation of pressure & temperature transducers for BMS.

11.7 EXPANSION TANKS

i) Expansion tanks for chilled water and hot water shall be of M.S. construction and of adequate capacity, to contain 200% of the maximum expansion likely to take place in the system. The tank shall be insulated and be complete with float valve, gauge glass, drain, overflow and make up connections, with gate valves and vent piping wherever required.

ii) The piping shall be enlarged at the connection to the expansion tank to permit entrained air to separate and to be vented through the tank. The expansion tank should be located at the pump suction side at the highest point of the system.

iii) Valves, strainers and traps must be omitted from the expansion line since these may be accidentally turned off or become plugged.

iv) Pressurized expansion tank with air separator, can be used where the conventional type expansion tank is not feasible to be provided.

11.8 INSTALLATION

- i) *The installation work shall be carried out in accordance with the detailed drawings prepared by the Air-conditioning Contractor and approved by the Engineer-in-charge.*
- ii) *Air-conditioning contractor shall utilize the structural provisions for Air- conditioning services wherever provided by the Department in the building and make his own arrangements for additional changes.*
- iii) *Expansion loops or joints shall be provided to take care of expansion or contraction of pipes due to temperature changes.*
- iv) *Tee-off connections shall be through equal or reducing tees, otherwise ferrules welded to the main pipe shall be used. Drilling and tapping of the walls of the main pipe shall not be resorted to.*
- v) *Wherever reducers are to be made in horizontal runs, eccentric reducers shall be used if the piping is to drain freely, in other locations, concentric reducers may be used.*
- vi) *Open ends of piping shall be blocked as soon as the pipe is installed to avoid entrance of foreign matter.*
- vii) *All pipes using screwed fittings shall be accurately cut to the required size and threaded in accordance with IS: 554 and burs removed before laying.*
- viii) *Piping installation shall be supported on or suspended from structure adequately. The Air-conditioning contractor shall design all brackets, saddles, clamps, hangers etc. and shall be responsible for their structure integrity.*
- ix) *Pipe supports, preferably floor mounted shall be of steel, adjustable for height and prime-coated with zinc chromate paint and finish-coated gray. Spacing of pipe supports shall not be more than that specified below: -*

Nominal Pipe size (mm)	Spacing (Metres)
12 and 15	1.25
20 and 25	2.00
32, 40, 50 and 65	2.50
80, 100 and 125	2.50
150 and above	3.00

Extra supports shall be provided at the bends and at heavy fittings like valves to avoid undue stress on the pipes. Pipe hangers shall be fixed on walls and ceiling by means of metallic or rawl plugs or approved shear fasteners.

- x) *Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation.*
- xi) *Anti vibration pads, springs or liners of resilient and non-deteriorating, material shall be provided at each support, so as to prevent transmission of vibration through the supports.*
- xii) *Pipe sleeves of diameter larger than the pipe by least 50 mm shall be provided wherever pipes pass through walls and the annular spaces shall be filled with felt and finished with retaining rings.*

- xiii) *Vertical risers shall be parallel to walls and column lines and shall be straight and plumb. Risers passing from floor to floor shall be supported at each floor by clamps or collars attached to pipe with a 12 mm thick rubber pad or any other resilient material as approved by the Engineer-in-charge.*
- xiv) *The space in the floor cut outs around the pipe work (after insulation work where applicable) shall be closed using cement concrete (1:2:4 mix) or steel sheet, from the fire safety considerations, taking care to see that a small annular space is left around the pipes to prevent transmission of vibration to the structure.*
- xv) *Riser shall have suitable supports at the lowest point.*
- xvi) *Where pipes are to be buried under ground, the top of the pipes shall be not less than 75 cms. from the ground level. Where this is not practicable, permission of the Engineer-in-charge shall be obtained for burying the pipes at lesser depth. The pipes shall be surrounded on all sides by sand cushion of not less than 15 cms. After the pipes have been laid and top sand cushion provided, the trench shall be refilled with the excavated soil and any extra soil shall be removed from the site of work by the Air conditioning contractors.*
- xvii) *All pipes and their steel supports shall be thoroughly cleaned and given one primer coat of Zinc chromate before being installed.*
- xviii) *After all the water piping has been installed, pressure tested in accordance with clause 10.10, all exposed piping in the plant room shall be given two finish coats of paint, approved by the Engineer-in-
Charge. Similar painting work shall be done over insulated pipe work, valves etc. The direction of flow of fluid in the pipes shall be indicated with identifying arrows.*
- xix) *3 mm gasket shall be used for flanged joints.*
- xx) *Cut-outs in floor slabs shall be sealed with cement concrete or steel plate after the plumbing work is done, from the fire safety point of view.*

11.9 PRESSURE TESTING

11.9.1 *All piping shall be tested to hydrostatic test pressure of at least one and a half times the maximum operating pressure, but not less than 10 kg./sq.cm. for a period not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified to the satisfaction of the Engineer-in-Charge.*

11.9.2 *Piping repaired subsequent to the above pressure test shall be re-tested in the same manner.*

11.9.3 *System may be tested in sections and such sections shall be securely capped.*

11.9.4 *It shall be made sure that proper noiseless circulation is achieved*

through all the coils and other heat exchange equipments in the system. If proper circulation is not achieved due to air-bound connections, the contractor shall rectify the defective connections. He shall bear all the expenses for carrying out the above rectification, including the tearing up and refinishing of floors, walls, etc. as required.

11.9.5 Insulation shall be applied to piping only after the completion of the pressure testing to the satisfaction of the Engineer-in-charge.

11.9.6 Pressure gauges may be capped off during pressure testing of the installation.

11.9.7 The contractor shall provide all materials, tools, equipments, instruments, services and labour required to perform the tests and to remove water resulting from cleaning after testing.

11.10 BALANCING

i) After completion of the installation, all water system shall be adjusted and balanced to first minimize throttling losses; then the pump impeller shall be trimmed or pump speed shall be adjusted to meet design flow conditions.

Exceptions to above:

a) Where Variable frequency Drives are used as starter & capacity control.

b) Impellers need not to be trimmed nor pump speed adjusted for pumps with pump motors of 7.5 kW (10 hp) or less,

c) Impellers need not to be trimmed when throttling results in no greater than 5% of the nameplate horsepower draw, or 2.2 kW (3hp), whichever is greater.

ii) Automatic control valves (Pressure Independent Balancing cum Control Valve) and three way diverting valves shall be set for full flow condition during balancing procedure. Water circuit shall be adjusted by balancing cocks provided for balancing. These shall be permanently

marked after the balancing is completed so that they can be restored to their correct positions, if disturbed.

11.11 MEASUREMENT

Measurements of plumbing work shall be on following basis: -

- a) Piping shall be measured along the centre line of installed pipes including all pipe fittings and accessories but excluding valves and other items for which quantities are specifically indicated in the schedule of work. No separate payment shall be made for fittings and accessories.*
- b) The rates for piping work shall include all wastage allowances, pipe supports, hangers, nuts and check nuts, vibration isolators, suspension where specified or required, and any other item required to complete the piping installation. None of these items will be separately measured nor paid for.*
- c) Piping measurement shall be taken before application of the insulation in the case of insulated pipe work.*

SECTION 12:- ELECTRICAL WORK

SCOPE

This chapter covers the requirements for the electrical works associated with heating, air conditioning, ventilation and cold room applications, namely, switch boards, power cabling, control wiring, earthing, p.f. capacitors and remote control-cum-indicating panels. Electric motors are not covered here, as these are covered as part of the respective equipment specifications.

12.1 GENERAL

i) Unless otherwise specified in the tender specifications, all equipments and materials for electrical works shall be suitable for continuous operations on 415 V / 240 V + 10% (3 phase/single phase), 50 Hz. AC system. Where the use of high voltage equipments is specified in particular works, all the respective equipment's shall be suitable for continuous operation on such specified high voltage.

ii) All electrical works shall be carried out complying with the Indian Electricity Rules, 1956 as amended to date.

iii) All parts of electrical works shall be carried out as per appropriate CPWD General specifications for Electrical works, namely, Part I (Internal) 2013, Part II (External) 1994 work, and Part IV (Sub-station), 2013 all as amended to date.

iv) All materials and components used shall conform to the relevant IS specifications amended to date.

12.2 SWITCH BOARDS

i) The main switch board in the A.C. plant room shall be floor mounted, free standing cubical type and shall be factory built fabricated by one of the reputed switch board manufacturer. It shall be suitable for termination of the incoming cable(s)/ bus trunking from top/ bottom. The switchboards in air handling unit (AHU) rooms shall be wall mounted, or floor mounted as feasible at site and as approved by the Engineer-in-charge, but they shall be cubical design, unless otherwise specified and open able from front.

ii) The capacity of switch gear, starters etc. shall be suitable for the requirements of loads fed/controlled. Starting currents shall be duly considered in case of motor loads.

iii) Switch fuse units shall be used upto and including 63 A and fuse switch units shall be used for 100 A and above. ACB shall be used for 630 A and above ratings.

iv) All switch fuses/fuse switches dis-connector switches shall be of AC 23 duty as per IS: 4064-1978 as amended upto date. They shall be complete with suitable HRC cartridge type fuses.

v) Switch boards controlling motors shall house starters for motors, unless otherwise specified. Independent single phasing preventors for each such starter shall be provided. The starter and SPP shall be located adjacent to the controlling switch gear.

vi) One volt meter with selector switch, a set of indicating lamps and fuses for voltmeter and lamps shall be provided at each switchboard. One ammeter with CTS, and selector switch shall be provided with each motor starter. Instruments shall be flush mounted with the panel and have a glass index not higher than 1.5. The instruments and accessories shall be provided whether or not specifically indicated in the tender specifications.

vii) The fabrication of switchboard shall be taken up only after the drawings for the fabrication of the same are approved by the Engineer-in-charge.

- viii) Switchboards shall be fabricated as per specifications indicated in subpara above.
- ix) The layout of bus bars and cable alleys shall be designed for convenient connections and inter-connections with the various switchgear. Connections from individual compartments to cable alleys shall be such as not to shut down healthy circuits in the event of maintenance work becoming necessary on a defective circuit.
- x) Care shall be taken to provide adequate clearances between phase bus bars as well as between phase bus bars, neutral and earth.
- xi) Where terminations are done on the bus bars by drilling holes therein, extra cross section shall be provided for the bus bars. Alternatively, terminations may be made by clamping.
- xii) Provision shall be made for proper termination of cables at the switchboards such that there is no strain either on the cables, or on the terminators. Cables connected to the upper tiers shall be duly clamped within the switchboard.
- xiii) Identification labels shall be provided against each switchgear and starter compartment, using plastic engraved labels.
- xiv) Metallic danger board conforming to relevant IS shall be fixed on each electrical switchboard.
- xv) Switchboard housing only isolators near cooling towers shall be housed in weather proof enclosure. The mounting arrangement shall be as approved by the Engineer-in-Charge to suit the site conditions.

12.3 POWER CABLING

- i) Unless otherwise specified, the power cables shall be XLPE insulated, PVC outer sheathed aluminium conductor, armoured cables rated for 1100 V grade. The power cables shall be of 2 core for single phase, 4 core for sizes upto and including 25 sq.mm, 3-1/2 core for sizes higher than 25 sq.mm for 3 phase. Where high voltage equipments are to be fed, the cables shall be rated for continuous operation at the voltages to suit the same.
- ii) Power cables shall be of sizes as indicated in the tender specifications. In all other cases, the sizes shall be as approved by the Engineer-in-Charge, after taking into consideration the load, the length of cabling and the type of load.
- iii) Cables shall be laid in suitable metallic trays suspended from ceiling, or mounted on walls, or laid directly in ground or clamped on structures, as may be required. Cable ducts shall not be provided in plant rooms. Cable trays shall be fabricated from slotted angle/solid angles to make ladder type cable tray, designed with adequate dimensions for proper heat dissipation and also access to the cables. Alternatively, cable trays may be of steel sheet with adequate structural strength and rigidity, with necessary ventilation holes therein. In both the cases, necessary supports and suspenders shall be provided by the Airconditioning Contractor as required.
- iv) Cable laying work shall be carried out in accordance with 13.4 (iii) above. The scope of work for the Air-conditioning Contractor shall include making trenches in ground and refilling as required, but excludes any masonry trenches for the cable work.

12.4 CONTROL WIRING

- i) Control wiring in the plant rooms and AHU rooms shall be done using ISI marked PVC insulated and PVC sheathed, 1.5 sq.mm copper conductor, 250 V grade, cables drawn in ISI marked steel or PVC conduits. Alternatively, armoured multi-core copper conductor cables may also be used for the purpose. The control

cables interconnecting the plant room and the AHU rooms shall be of multi-core armoured type only, and suitable for laying direct in ground.

ii)The number and size of the control cables shall be such as to suit the control system design adopted by the Air-conditioning Contractor.

iii)ISI marked steel conduit pipes, wherever used, shall be of gauge not less than 1.6 mm thick for conduits upto 32 mm dia and not less than 2.0 mm thick for higher sizes. All conduit accessories shall be threaded type with substantial wall thickness.

iv)Control cables shall be of adequate cross section to restrict the voltage drop.

v)In the case of control wires drawn through steel conduits, the wire drawing capacity of conduits as specified under the CPWD General Specifications for Electrical Works (Part I) 1994 shall not be exceeded.

vi)Runs of control wires within the switchboard shall be neatly bunched and suitably supported/clamped. Means shall be provided for easy identification of the control wires.

vii)Control wiring shall correspond to the circuitry/sequence of operations and interlocks approved by Engineer-in-Charge.

viii)In cold storage involving temperatures below zero deg. C, polythene cables shall be used instead of PVC cables.

12.5 EARTHING

i)Provision of earth electrodes and the type of earthing shall be as specified in the tender specifications.

ii) The earth work shall be carried out in conformity with CPWD Specifications for Electrical works (Part-I), Internal 1994.

iii)Metallic body of all medium voltage equipments and switch boards shall be connected by separate and distinct earth conductors to the earth stations of the installations; looping of such body earth conductors is acceptable from one equipment, or switch board to another.

iv)G.I. plate earthing shall be provided for PTAC plants and reciprocating central AC plants upto 100 TR capacity. Above 100 TR reciprocating units and centrifugal/ screw chilling units copper plate earthing shall be provided.

v)The size of earth conductors for body earthing of equipments shall be as under:

Motors upto and including 10 HP rating	2 Nos. 3 mm dia copper wire/ 2 nos. 4mm dia GI wire
12.5 HP to 40 HP	2 Nos. 4 mm diacopper wire/ 2 nos. 6mm dia GI wire
50 HP to 75 HP	2Nos. 6 mm dia copper wire/ 2 nos. 25x3mm GI strip
Above 75 HP	2Nos. 25mm x 3mm copper strip/ 2 nos. 25x6mm GI strip
Switch boards with incoming rating	
Upto 100 A	2 Nos. 3 mm dia copper wire/ 2 nos. 4mm dia GI wire

125 A to 200 A rating

2 Nos. 6mm diacopper wire/ 2 nos. 25x3mm GI strip

Above 200 A rating

2Nos. 25mm x 3mm copper strip/ 2 nos. 25x6 mm GI strip

vi)Armouring of cables shall be connected to the body of the equipments/switch board at both the ends. Compression type glands shall be used for all such terminations in the case of PVC cables.

12.6 POWER FACTOR CAPACITORS

i)PF capacitors shall be provided for all motor loads of 5 HP and above. These capacitors shall come into circuit when the respective motor load is switched on. For this purpose, necessary interconnections between the capacitors and the motors/starters shall be included in the scope of work of the Air-conditioning Contractor.

ii) The power capacitors shall be of such value as to improve the PF to 0.90 lagging when the motor is running at full load. In the case of large size motors, the capacitors may be made in suitable banks so that the required bank(s) of capacitors may be switched under partial load conditions. Such operations of individual banks shall be automatic.

iii) Where the PF capacitors are provided in banks, each bank shall be controlled by suitably rated switch gear with HRC fuses.

iv) The capacitor banks and the controlling switchgear may be fabricated in independent cubical or may form part of the switchboard in the installations. In the latter case, the capacitors are permitted to be mounted on the switchboard, if so desired.

12.7 REMOTE CONTROL CUM INDICATING PANEL

i) The remote control cum indicating panel shall be provided in the plant room. This panel shall have necessary push buttons for on and off controls and status indication of all electric motors except for small motors as of humidifiers of AHUs and FCUs. However , if BMS system is provided , remote control-cum-indicating panel shall not be required.

ii) In view of (i) above, push buttons need not be provided as part of the starters in the switch boards, except of the AHU blower motors. In the case of the AHU blower motors, push buttons shall be provided as part of the starters for local on and off operations.

iii) Back indication to show the status of operation of all the motors (except small motors as in humidifiers of AHUs and FCUs) and also of the electric strip heaters (AHU wise) shall be provided.

iv) Panel shall be fabricated from 1.6 mm thick steel sheet. This shall be of freestanding floor mounting type design. This shall be complete with necessary termination arrangements, multicore cables, tag blocks, control transformer, designation plastic labels, double earth studs etc. as required.

12.8 MOTOR STARTER

i) The motor starter shall conform to IS: 1822 —Motor starters of voltage not exceeding 1000 volts and shall be air insulated and suitable for 415 volts, + 10%, 50 Hz., 3 phase AC supply. Enclosures shall have protection of IP 42 for Indoor applications and IP 55 for outdoor applications.

ii) Starter for the motor shall be direct on line (D.O.L) for motors up to and including 7.5 H.P. rating and automatic star-delta close transition type for motors of higher ratings unless otherwise specified in the tender specifications. Starters shall be rated for intermittent duty. Starting current should not exceed two times the full load current.

iii) Reciprocating chiller shall be fitted with part winding starter and housed in chiller panel.

iv) The starter shall be mounted on the main electrical control panel/ unit mounted/ self mounted as specified.

v) Each starter shall be provided with the following protections: a) Thermal overload on all the three phases with adjustable settings, b) Under voltage protection, and c) Independent single phasing reventor. (current sensing type) vi) Adequate number of extra NO/ NC contacts for interlocks, indicating lamps etc. shall be provided on the starter/ contactor.

18.10 PAINTING All panels shall be supplied with the manufacturer's standard finish painting or as indicated in the Schedule of Work.

12.9 MOTOR EFFICIENCY

1. All permanently wired poly-phase motors of 0.375 kW or more serving the building and expected to operate more than 1500 hours per year and all permanently wired poly phase motors of 50 kW or more serving the building and expected to operate more than 500 hours per year shall have a minimum acceptable nominal full load motor efficiency not less than IE3 class as per IS 12615 for Energy Efficient motors.

2. Motors of horsepower differing from those listed in the table shall have efficiency greater than that of the listed kW motor. See Annexure N.

3. Motor horsepower ratings shall not exceed 20% of the calculated maximum load.

4. Motor nameplates shall list the nominal full load motor efficiencies and the full load power factor.

5. Motor users should insist on proper rewinding practices for rewind motors. If the proper rewinding practices cannot be assured, the damaged motor should be replaced with a new, efficient one rather than suffer the significant efficiency penalty associated with typical rewind practices.

6. Certificates shall be obtained and kept on record indicating the motor efficiency. Whenever a motor is rewind, appropriate measures shall be taken so that the core characteristics of the motor is not lost due to thermal and mechanical stress during removal of damaged parts. After rewinding, a new efficiency test shall be performed and similar records shall be maintained.

7. Motors should be installed with soft start energy savers and Variable Speed drives based on the application required.

INSPECTION, TESTING AND COMMISSIONING GUIDELINES

1.1 SCOPE

This chapter covers initial inspection and testing of Chillers, Pumps, Expansion Tanks, Dirt Separator, Cooling Tower, BMS System and pre insulated pipe, valves 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.

1.2 INITIAL INSPECTION AT MANUFACTURER'S WORKS

- i) Manufacturer's internal test certificate shall be furnished and same shall be checked as per contract requirements
- ii) Pneumatic pressure test at twice the normal pressure for the pre insulated chilled water pipe shall be carried out.
 - vi) Hydraulic test at 10 Kgf/sq.cm. for the Pre insulated chilled water pipe shall be carried out as per the Indian Standard.
 - vii) U value of the pre insulated pipe have to be verified at the manufacturing works as per the Factory Testing:

All instruments and personnel for tests shall be provided by the contractor. Contractor shall inform the client about the pre insulated pipe factory testing schedule min. 10 to 15 days before the pipes are ready for factory testing.

1.3 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 of contract.
- iii) Manufacturer's test certificates for valves for testing of pressure withstand .

1.4 Insulation and acoustic lining

- i) Physical verification for thickness and make should be made as per contract before application of insulation.
- ii) Manufacturer's test certificate for density , thermal conductivity , sound absorption and class of fire retardation wherever applicable should be furnished.

Note: Accuracy of testing instruments shall be as mentioned in the final inspection procedure.

1.5 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 as detailed under para 1.15.
- ii) After the trial run as in para 1.15 above, the AC contractor shall offer the plant for the seasonal test, namely test for summer or monsoon season whichever occurs earlier. The test results as per Appendix G shall be furnished.

iii) The equipment capacity computations as per para `B` under notes of the Annexure `G` shall be carried out.

iv) The Input KW of the unit / TR at full load shall also be checked against contract requirements, if any.

v) Pressure drops across chiller and condenser at specified flow rates shall be checked against the contract requirements.

vi) All instruments for testing shall be provided by the AC contractor . These shall be as per Note `A` of Appendix G. The accuracy of the instruments shall be as follows:

a. Temperature: Liquid in glass thermometer having accuracy + 1 deg. C as per IS: 4825.

b. Wet bulb Temperature : Sling psychrometer conforming to IS:6017.

Scale Error:

For less than 0 deg. C : 0.3 deg C + 0.2 deg. C.

For over 0 deg. C : 0.2 deg. C + 0.1 deg. C.

c. Pressure Gauge: With the accuracy of + 1% for maximum scale value from 10 to 90%, and + 1.9% for maximum scale value for rest of the scale 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.

1.6 TESTING REQUIREMENTS AND PROCEDURES

1.6.1 Balancing of all air and water systems and all tests as called for in the specification shall be carried 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 down loading 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

iv) Electronic rotary vane Anemometer

v) Accubalance flow measuring hood

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

1.6.2 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.

- i) Test all fan systems to provide proper cfm/ cmh.
- ii) Adjust fresh air, return air and exhaust dampers to provide proper air quantities in all modes of control.
- iii) 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.
- iv) 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.
- v) 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.
- vi) Test and record static pressure drop across all filters and major coils.
- vii) High velocity duct systems shall be tested for leakage. 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.

1.6.3 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 air. Verify that the system has been properly cleaned, flushed and treated before testing. Basically, the following tests and adjustments are required.

- i) Test and adjust all pumps to deliver the proper gpm. Record rpm, motor amperage, discharge and suction pressure. Pumps shall operate without objectionable noise or cavitation. Plot actual pump and system performance points on manufacturer's pump curves.
- ii) Check all expansion tanks for proper filling pressurization. Verify operation of automatic fill and relief valves.
- iii) Check the operation of all automatic valves.
- iv) 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.
- v) Check capacity output of chillers and set water flow rate for proper data.
- vi) Check and adjust each coil to provide proper gpm. Record water and air temperature changes and water pressure drop.
- vii) Set pressure drops across coil by-pass to match coil full-flow pressure drop.

1.6.4 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, atleast the discharge head and BHP (on the input side) shall be field tested.

1.6.5 Balancing Tolerance:

Systems shall be balanced within the following tolerances ;

i) Duct leakage Rates (at operating pressures) :

Low pressure ducts	5% of full flow
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(0 to 0.5 kPa)

Medium Pressure Ducts	1% of full flow
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(0.5 to 3 kPa)

High Pressure Ducts	1% of full flow
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(Greater than 3 kPa)

ii) Air flow rates :

Under 70 L/S	10% of flow
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Over/ at 70 L/S	5% of flow
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iii) Water flow rates :

Chilled Water	2% of flow
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Other	5% of flow
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iv) Heat flow rates :

Heat exchangers	5% of design capacity
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Procedure:

Review all pertinent plans, specifications, shop drawings and other documentation to become fully familiar with the systems and their specified and intended performance.

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 Department's representative.

Test relative barometric pressures in various building area, as deemed necessary by the Department's representative and at least in all areas served by different systems.

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.

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 authorised person.

1.6.6 Reports

Provide 3 copies 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 as per para 1.14.3.

1.6.7 Final documentation

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. 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 design/ performance criteria.

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 as mentioned above.

- i) Comprehensive operation and maintenance manual
- ii) Test certificates, consolidated control diagram and technical literature on all controls.
- iii) Equipment warranties from manufacturers.
- iv) Commissioning and testing reports
- v) Rating charts for all equipment
- vi) Log books as per equipment manufacturers standard format
- vii) List of recommended spares and consumables
- viii) Any special tools required for the operation or the maintenance of the plant shall be supplied free with the plant.

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.

i) Any defective material or equipment supplied by the contractor ii) 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.

1.7. **Miscellaneous**

1.7.1 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.

1.7.2 Any damage resulting from the tests shall be repaired and/or damaged material replaced, to the satisfaction of the Engineer In Charge without any extra cost.

- 1.7.3 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.
- 1.7.4 The contractor must inform the Engineer In Charge when such tests are to be made, giving sufficient notice, in order that the architect or his nominated representative may be present.
- 1.7.5 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 Engineer In Charge, sufficient and suitable indication of the effect and performance of the installation as a whole or of any part, as required.

IDENTIFICATION OF SERVICES

1.1 **SCOPE**

The scope of this section comprises of identification of services for each piece of equipment

1.2 **VALVE LABELS AND CHARTS**

Each valve shall be provided with a label indicating the service being controlled, together with a reference number corresponding with that shown on the Valve Charts and “ as fitted” drawings. The labels shall be made from 3 ply (black / white/ black) Traffolyte material showing white letters and figures on a black background. Labels to be tied to each valve with chromium plated linked chain.

A wall mounted, glass covered plan to the approval of the Architect / Engineer shall be provided and displayed in each plant room showing the plant layout with pipe work, valve diagram and valve schedule indicating size, service, duty, etc.

1.3 **IDENTIFICATION OF SERVICES**

Pipe work and duct work shall be identified by colour bands 150 mm. wide or colour triangles of at least 150 mm. / side. The bands of triangles shall be applied at termination points, junctions, entries and exits of plant rooms, walls and ducts, and control points to readily identify the service, but spacing shall not exceed 4.0 metres.

1.3.1. **Pipe work Services :-**

For pipe work services and its insulation the colours of the bands shall comply with BS. 1710: 1971.

Basic colours for pipe line identification :

<u>Pipe Line Contents</u>	<u>BS. 4800 Colour Reference</u>	<u>Colour.</u>
Water	12 D 45	Green
Steam	10 A 03	Grey
Oils	06 C 39	Brown
Gas	08 C 35	Yellow / Brown
Air	20 E 51	Blue
Drainage	00 E 53	Black
Electrical	06 E 51	Orange

Colour code indicator bands shall be applied as colour bands over the basic identification colour in the various combinations as listed below :-

Pipe Line Contents	Colour Bands to BS. 4800
Water Services :	
Cooling	00 E 55

Fresh / drinking	18 E 53
Boiler feed	04 D 45/00 E 55 / 04 D 45
Condensate	04 D 45/14 E 53 / 04 D 45
Chilled	00 D 55/14 E 53 / 00 D 45
Central Heating Services :	
Below 100° C	18 E 55/04 D 45/18 E 53
Above 100° C	04 D 45/18 E 53 /04 D 45
Cold Water Storage	
Tanks:	00 E 55/18 E 53/00 E 55
Hot Water Supply	00 E 55/04 D 45/00 E 55
Hydraulic Power	04 C 33
Sea / River Untreated	Basic Colour only
Fire Extinguishing	04 E 53
Steam Services:	Basic Colour only
Air : Compressed	Basic Colour only
Vacuum	White.
Town Gas : Manufactured	14 E 53
Natural	10 E 53
Oils:	
Diesel	00 E 55
Lubricating	14 E 53
Hydraulic Power	04 C 53
Transformer	04 D 45
Drainage and other fluids :	Basic Colour only
Electrical Services :	Basic Colour only

In addition to the colour bands specified above all pipe work shall be legibly marked with black or white letters to indicate the type of service and the direction of flow, identified as follows :-

High Temperature Hot Water	HTHW
Medium Temperature Hot Water	MTHW
Low Temperature Hot Water	LTHW
Chilled Water	CHW
Condenser Water	CONDW
Steam	ST
Condensate	CN

Pipe shall have the letters F and R added to indicate flow and return respectively as well as directional arrows.

1.3.2 Duct Work Services

For Duct work services and its insulation the colours of the triangles shall comply with BS.1710 : 1971. The size of the symbol will depend on the size of the duct and the viewing distance but the minimum size should not be less than 150 mm. length per side. One apex of the triangle shall point in the direction of airflow.

Services	<u>Colour</u>	<u>BS.4800 Colour Reference</u>
Conditioned Air	Red and Blue	04 E 53 / 18 E 53
Ward Air	Yellow	10 E 53
Fresh Air	Green	14 E 53
Exhaust / Extract / Recirculated Air	Grey	AA 0 09
Foul Air	Brown	06 C 39
Dual Duct System Hot Supply Air	Red	04 E 53
Cold Supply Air	Blue	18 E 53

In addition to the colour triangles specified above all duct work shall be legibly marked with black or white letters to indicate the type of service, identified as follows:-

Supply Air	S
Return Air	R
Fresh Air	F
Exhaust Air	E

The colour banding and triangles shall be manufactured from self adhesive cellulose tape, laminated with a layer of transparent ethyl cellulose tape.

SPECIAL CONDITION FOR SAFETY AT THE WORK SITE

The contractor will identify one of the supervisors for taking care of implementation of Safety systems.

The Contractor should follow the following General Guidelines governing the safety rules as laid down under:

1. Smoking is strictly prohibited at workplace.
2. Nobody is allowed to work without wearing safety helmet. Chinstrap of safety helmet shall be always on. Drivers, helpers and operators are no exception.
3. 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.
4. No one is allowed to work without adequate foot protection.
5. 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.
6. All safety appliances like Safety shoes, Safety gloves, Safety helmet, Safety belt, Safety goggles etc. shall be arranged before starting the job.
7. All excavated pits shall be barricaded & barricading to be maintained till the backfilling is done. Safe approach to be ensured into every excavation.
8. Adequate illumination at workplace shall be ensured before starting the job at night.
9. All the dangerous moving parts of the portable / fixed machinery being used shall be adequately guarded.
10. Ladders being used at site shall be adequately secured at bottom and top. Ladders shall not be used as work platforms.
11. 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 tre-passers from entering the area.
12. Other than electricians no one is allowed to carry out electrical connections, repairs on electrical equipment or other jobs related thereto.
13. All electrical connections shall be made using 3 or 5 core cables, having a earth wire.
14. Inserting of bare wires for tapping the power from electrical sockets is completely prohibited.
15. A tools and tackles inspection register must be maintained and updated regularly.
16. Debris, scrap and other materials to be cleared from time to time from the workplace and at the time of closing of work everyday.

17. All the unsafe conditions, unsafe acts identified by contractors, reported by site supervisors and / or safety personnel to be corrected on priority basis.
18. No children shall be allowed to enter the workplace.
19. All the lifting tools and tackles shall be stored properly when not in use.
20. Clamps shall be used on Return cables to ensure proper earthing for welding works.
21. Return cables shall be used for earthing.
22. All the pressure gauges used in gas cutting apparatus shall be in good working condition.
23. Proper eye washing facilities shall be made in areas where chemicals are handled.
24. Connectors and hose clamps are used for making welding hose connections.
25. All underground cables for supplying construction power shall be routed using conduit pipes.
26. Spill trays shall be used to contain the oil spills while transferring / storing them.
27. Tapping of power by cutting electric cables in between must be avoided. Proper junction boxes must be used.

Superintending Engineer

Technical Submittals

The successful tenderer after award of work shall furnish technical submittals for various items incorporating complete technical details prior to procurement of equipment/materials, for the approval of the Engineer-in-charge. The submittals for items mentioned in the tender document but not restricted to the following:

a.	CHILLER WITH CHILLER PLANT MANAGER
b.	CHILLED WATER PRIMARY PUMPS
c.	CHILLED WATER SECONDARY PUMPS
d.	CONDENSER WATER PUMP
e.	CHILLED WATER TERTIARY PUMPING
f.	EXPANSION TANK CUM DEGASSER
g.	COOLING TOWER
h.	DIRT SEPARATOR
i.	BMS
j.	WATER SOFTENER SYSTEM
k.	ELECTRICAL PANELS & COMPONENTS.
L	VALVES, PIPES AND ASSOCIATED CONTROL
m	CHILLER INSULATION MATERIAL

Test certificates for various items shall also be submitted by the contractor.

APPENDIX- I

**GUARANTEE PROFORMA FOR HVAC INSTALLATION (SITC of 3200 TR CAPACITY
CENTRAL AC PLANT)**

Owner : **IIT KANPUR**

Location : **IITK Campus**

1. The Contractor shall furnish the following guarantee:

“We warrant that everything supplied by us including all components fitted into the equipment manufactured by others also, shall be in all respects free from all defects and faults in material, workmanship and manufacture and shall be of the highest grade and quality to acceptable standards for all materials of the type ordered and shall be in full conformity with all the specifications, drawings or samples if any and we shall be fully responsible for its efficient performance. This guarantee shall survive inspection for acceptance and payment for the equipment and installation, but shall expire (except in respect of the complaints notified to us) 24 months from the date of issue of completion certificate by the Engineer In Charge. The complaints, workmanship, manufacturer, or performance of any of the equipment or part/parts thereof shall be notified by fax within 24 months from the date of issue of such completion certificate.”

2. The Contractor shall replace such of these parts which require replacement under these conditions free of cost, charge and expenses to the purchaser. In addition, the Contractor shall be responsible for a period of 24 months from the date of issue of completion certificate for any defect that may develop or appear under the conditions provided by the Contractor or use thereof arising from faulty material design or workmanship in the equivalent or any part thereof or faulty installation of the equipment by the Contractor but not otherwise and shall correct such defects within one week from the date of notification at his own cost when called upon to do so by the purchaser who shall state in writing in what respect the portion is faulty.
3. Any faulty component replaced or renewed under the clause shall also be guaranteed for a period of six months from the date of such replacement or removal of until the end of the above mentioned period whichever is later.
4. If defects are not rectified within a reasonable time as mentioned in the written notice, the Engineer In-Charge shall proceed to do so at the Contractor’s risk and cost without prejudice to any other right thereof.

SIGNATURE AND STAMP OF THE CONTRACTOR

DATE :

APPENDIX-II

HVAC TENDER DRAWINGS (Attached in tender separately)

Drg. No.	Title
01	3200 TR AC PLANT SCHEMATIC
02	AC PLANT ROOM LAYOUT
03	TERRACE LAYOUT PLAN
04	SKID PUMP SCHEMATIC
05	PRESSURIZATION UNIT SCHEMATIC

APPENDIX-III

INTERNATIONAL CODES AND STANDARDS

Apart from the specific equipment standards and specifications, the following broad certifying agency / standards will be considered while designing the system :

- 1.1 ASHRAE – American Society for Heating, Refrigerating and Air-conditioning Engineers .
- 1.2 ISHRAE- Indian Society for Heating, Refrigerating and Air-conditioning Engineers
- 1.3 SMACNA – Sheet Metal and Air Conditioning Contractors National Association or Indian Standards –1982 Edition or IS277/655 Standards.

- 1.4 UL - Underwriter’s Laboratory , USA.

- 1.5 AMCA - Air Movement & Control Association, International

- 1.6 AHRI - American Heating & Refrigeration Institute

- 1.7 ANSI - American National Standards Institute
- 1.8 CSA - Canadian Standards Association
- 1.9 ISO - International Standards Organization
- 2.0 IEC - International Electrochemical Commission
- 2.1 EUROVENT - European Certification Program

APPENDIX-IV

A. LIST OF BUREAU OF INDIAN STANDARDS CODES

IS : 277 - 1992	Galvanized steel sheet (Plain & corrugated) wire for fencing.
IS : 554 - 1985 (Reaffirmed 1996)	Dimensions for pipe threads where pressure tight joints are required on the threads.
IS : 655 - 1963 (Reaffirmed 1991)	Metal air ducts.
IS : 694 - 1990 (Reaffirmed 1994)	PVC insulated (HD) electric cables for working voltage upto and including 1100 volts.
IS : 732 - 1989	Code of practice for electrical wiring.
IS : 780 - 1984	Sluice valves for water works purposes.
IS : 822-1970 (Reaffirmed 1991)	Code of procedure for inspection of welds.
IS : 1239 (Part - I) - 1990	Mild steel tube
IS : 1239 (Part - II) - 1992	Mild steel Tubular and other wrought steel pipe fittings.
IS : 1255 – 1983	Code of Practice for installation and maintenance of Power Cables upto and including 33 KV rating (Second Revision)
IS : 1554 - 1988 (Part – I)	PVC insulated (Heavy Duty) electric cables for working voltages upto and including 1100 volts.
IS : 1897 - 1983(Reaffirmed 1991)	Copper bus bar / strip for electrical Purposes
IS : 2379 - 1990	Color code for the identification of pipelines.
IS : 2551 - 1982	Danger notice plate
IS : 3043 – 1987	Code of practice for earthing.
IS : 3103 – 1975 (Reaffirmed 1999)	Code of practice for Industrial Ventilation
IS : 3837 – 1976 (Reaffirmed 1990)	Accessories for rigid steel conduit for electrical wiring.
IS : 4736 – 1986 (Reaffirmed 1998)	Hot-dip zinc coatings on steel tubes.
IS : 4894 - 1987	Centrifugal Fan.

IS : 5133 -1969 (Part-I) (Reaffirmed 1990)	Boxes for the enclosure of electrical accessories.
IS : 5312 (Part-I) -1984 (Reaffirmed 1990)	Swing - check type reflux Non return valves for water works
IS : 5424 – 1989 (Reaffirmed 1994)	Rubber mats for electrical purposes.
IS : 5578 & 11353-1985	Marking and identification of conductors
IS : 6392 - 1971(Reaffirmed 1988)	Steel pipe flanges.
IS : 8623 – 1993	Low voltage switchgear and control gear Assemblies (Requirement for type / partly type tested assemblies)
IS : 8623 - 1993	Bus Bar trunking system(Part - II)
IS : 8828 - 1996	Circuit Breakers for over current Protection For house hold and similar installation.
IS : 9537 - 1981(Part II)	Rigid Steel Conduits for electrical wiring
IS : 10810 - 1988	Methods of test for cables.
IS : 13947-1993 (Part-I)	General rules for low voltage switch gears and control gears.
IS : 13947-1993 (Part-II) IEC 947 – 2	Circuit Breakers
IS : 13947 - 1993 (Part-III)	Switches, dis connectors and fuse for low volta switch gear and control gear.
IS : 13947 - 1993 (Part-IV)	Low voltage switch gear and control Gear for contactors and motor starters
IS : 13947 – 1993 (Part-V) IEC NBC	Control Circuit Devices. Relevant Sections. National Building Code
ISHRAE	Indian Society for Heating, Refrigerating and Air-conditioning Engineers – ISHRAE 2005 Edition .

B. I.S. SAFETY CODES

IS : 659 – 1964 (Reaffirmed 1991)	Safety Code for Air Conditioning.
IS : 660 – 1963 (Reaffirmed 1991)	Safety code for Mechanical Refrigeration.
IS : 3016	Code of Practice for Fire Precautions

in Welding and Cutting operations.

IS : 818

Code of practice for Safety and Health Requirements in Electrical & Gas Welding and cutting operations.

IS : 5216–1982 (Part-I) (Reaffirmed 1990)

Guide for safety procedure and Practices in electrical work.

IS : 3696

Safety Code for Scaffolds and Ladders.

APPENDIX V

LIST OF APPROVED MAKES

S. No.	Details of Equipment's and materials	Manufacturers Name
1.	Pre-Insulated Chilled Water Pipe	Zeco/Perma-Pipe/KCPolymer's/AGS Engineering
2	Water Leak Detection Monitoring Unit	Siemens/Honeywell/JCI/Zeco/Perma Pipe
3.	GI Sheets	Bhushan / TATA/ Jindal/SAIL
4.	Duct (factory fabricated)	Rola Star / Techno Fabriduct/Zeco/Ductofab
5.	Pipes (MS & GI)	Tata /Jindal (Hissar)/QST/Jindal(Star)
6.	Gate Valve/ SS Ball Valve	Leader /CIM/ Zoloto / Sant/Honeywell
7.	Butterfly valve	Audco / Advance / Honeywell/Kirlosker
8	Check Valve (Non return valve)	Audco/SKS/Advance/ Zoloto/ Honeywell
9.	Balancing valve	Advance /Audco/ Honeywell/Danfoss
10.	Water strainers (Y-strainer/pot strainer)	Emerald/Sant/D.S. Engineering / Maharaja Casting
11.	Proportional thermostat	Siemens /Honeywell/Johnson
12.	3 Way Motorized/ Mixing / Diverting valves	Siemens /Honeywell/Johnson/Anergy/ Rapid Control/Danfoss
13.	Pressure gauges for water line/Refrigerant	Emerald / Fiebeg/ H. Guru
14.	Thermometers	Emerald/ Japsin
15.	V-Belts	Fenner India/ Dunlop
16.	Fibre glass wool	UP Twiga /Owens Corning
17.	Nitrile Rubber / closed cells expanded /XLPE	Thermafex/Armafex/Eurobatex/Paramount polyethylene foam/Aerolam
18.	Fire retardant flexible duct connection	Air flow / Twiga/ATCO/GP spira/caryaire
19.	Gasket for ducts	Prima Kool / Nuprine
20.	Anchor Fasteners	Hilti / Fischer
21.	Extruded Aluminum grilles & diffusers Fresh air louvers/Dampers	Caryaire/ Ravi Star/ Air Flow/Air master/Titus/System air
22.	Fire damper	Ravi Star/Air Flow/ Mapro/System air/Ruskin Titus/Greenheck
23.	Duct attenuator	AirFlow/Ravi Star/ Continental/Mahajan
24.	Vibration isolators	Resistolex /Gerb / Base/ Dunlop
25.	Motors	Siemens/Crompton/ABB/Bharat Bijlee
26.	Fuse switch unit/switch fuse unit/HRC fuse	Larsen Toubro / Siemens / Schneider (MG)/Havells
27.	Contactors, Timers, O/L relays/Motor starters	Larsen Toubro/ Siemens / Schneider
28.	Control cables	CCI/ Fort Gloster/ Universal/ Incab/ Havells/KEI
29.	Cable glands	Dowells/ Comet/ Peeco
30.	Electrical Panel	Milestone Switchgear Pvt. Ltd/Neptune Systems Pvt. Ltd. / Tricolite Elect. Industries/ESSAAR/Modern Switchgears/Adlec
31.	Indication lamps and Push Buttons	L&T/ BCH/ Siemens

32.	Ammeters and voltmeters	AEI/L&T/ Rishab / IMP
33.	CTs	AEI/L&T/ Rishab / IMP
34.	MCB	Legrand (MDS)/L & T/ Schnieder
35.	MCCB	L & T/Siemens / Schneider / Legrand (MDS)
36.	XLPE / PVC power cables	CCI/Gloster/Universal/ Havells
37.	Digital LCD energy meter	Enercon / Havells / IMP
38.	Water leak Detection Cable	CCI/ Fort Gloster/ Universal/ Zeco/ Havells/KEI/Permapipe
39.	Cable Trays	Steel Ways/Slotco
40.	Stick Pins	Primaseal/Airflow
41.	Humidistat	Honeywell/Danfoss/Penn
42.	Centrifugal Chiller	Trane/Carrier/York/Daikin
43.	Fan Coil Units	Cruise/Zeco/Edgetech/Kubic Midea/Trane
44.	Thermocole	Pioneer/Styrin
45.	Chemical Reagent	Antiscalant/ Descalant / Antifungal Hibird / amacid/ Maic
46.	Skid mounted Vertical Inline Centrifugal pump / Monobloc Pump	Grundfos/Armstrong/Willo/Xylem
47.	Water Softening Plant	Ion Exchange Ltd. / Milton Royal
48.	Pressure switch	Indfoss / Honeywell /Danfoss/Siemens
49.	Bronze ball valve	Emerald/ Zolto / Leader/ Sant
50.	Bronze ball valve with Y strainer	Emerald / Rapid control/ BAP
51.	VFD with sensors	ABB/DANFOSS/ Siemens/CHILLER OEM
52.	Cooling Tower	Paharpur/Mihir/ Flow tech /Advance
53.	Cooling Tower PVC Fills	Paharpur/Mihir/Flowtech/Advance
54.	Aluminum cable lugs	Alcon (Heavy gauge) / Jainson
55.	Suction guide	Anergy instrument Pvt.Ltd./Johnson
56.	Water cooled screw chilling unit	Trane/Carrier/York/Daikin
57.	Window/Split Air-conditioner/Hi-wall split AC	Voltas/Hitachi / Carrier/Panasonic/Blue star/ Toshiba/Daikin
58.	Dosing pump	M/s Ion Exchange (I) Ltd/ Milton Royal
59.	Chemical reagent	Eco friendly bio clean pond clarifier/ Volga
60.	Sand filter	M/s Ion Exchange (I) Ltd / Pentair.
61.	Compressor	Emerson/Tecumsseh/Bohn/Danfoss
62.	Cold room/Deep freezer	Danfoss/Blue Star/Bohn
63.	Air-cooled ductable split/ceiling mounted Cassette type air-conditioning unit	Voltas/Hitachi / Carrier/Panasonic/Blue star/ Toshiba/Daikin
64.	PVC water tank	Syntex/ Polycon
65.	Water Cooler	Blue Star/Usha/Sidwal/Voltas
66.	Tower AC units	Voltas/Hitachi / Carrier/Panasonic/Blue star/ Toshiba/Daikin
67.	Inverter VRF system	Voltas/Hitachi / Carrier/Panasonic/Blue star/ Toshiba/Daikin/Mitsubishi Electric
68.	Hi wall type chilled water FCU	Cruise/Zeco/Edgetech/Kubic Midea/Trane
69.	Wet scrubber	Zeco/Edgetech/ZAIR
70.	Air washer (Evaporative cooling unit)	Carryaire/Zeco/Zair/Edgetech/Airflow
71.	VAV Boxes	Ruskin Titus/Honeywell/Trox/Trane/Johnson Controls/Tristar
72.	Axial Fans	Krugar/Nicotra/Comefri/Green Deck/Airflow
73.	Spiral Flat Oval Duct (with GSS sheets of approved make)	Dustech/GP spira/Spiral Tubes/Western air ducts/ Ductofab /Seven star
74.	Silicone flexible duct connector	Easyflex/Airflow//Resistoflex/Dustech

75.	Motorized butterfly valve/ Modulating Valve/Solenoid valve	Advance/Danfoss/Belimo/Johnson Control/Zoloto/Tyco/Victaulic/Honeywell
76	Expansion Bellow	Easyflex/Resistoflex/Cori
77	Fire rated vane Axial/Fire rated tube Axial/Vane Axial/Tube Axial Fan	Nicotra/Comferi/Kruger/Greenheck/Airflow/system air/Zair
78	Inline Fan	Nicotra/ Kruger/Greenheck/Airflow/system air
79	Propeller fan	Nicotra/ Kruger/Caryaire/Crompton/GE
80	Paint/Anti Corrosive coating	Nerolac/Asian/Berger
81	Inline Electromagnetic Flow Meter	Belimo/Siemens/Danfoss/Honeywell
82	Automatic Pressurization Cum Expansion Tank	Flamco/Reflex/IMI Hydronics/Spirotech
83	Dirt Separator	Flamco/Reflex/IMI Hydronics/Spirotech
84	BMS Operator Workstation PC	Dell /HP/ IBM
85	Main BMS Software	Honeywell / Johnson Controls /Siemens
86	Web based Energy Management software	<i>Honeywell / Johnson Controls /Siemens</i>
87	DDC Controller with necessary Housing Panels	Honeywell / Johnson Controls /Siemens
88	Room Type Temperature + RH Sensor	Honeywell / Greystone / Johnson Controls / Siemens
89	DP Switch (For Run Status)	Honeywell / Greystone / Johnson Controls
90	Sensors/Transducers	Honeywell / Johnson Controls /Siemens/Trane

Note: Any other material not listed shall be approved by Engineer In Charge.

APPENDIX VI

(Refer Para 5.20 (2) of CPWD Works Manual 2019)

FORM OF SUPPLEMENTARY AGREEMENT

This Agreement made this day the 20..... between hereinafter called the First Party which expression shall include his heirs, executors and administrators/their successors and assigns and the Director, IIT Kanpur, hereinafter called the Second Party, which expression shall include his successors and assigns, shown as under :

- 1. That this Agreement shall be called as Supplementary Agreement to the Agreement No. relating to the Name of work entered into by the parties to this Agreement.*
- 2. That WHEREAS the First Party has substantially completed the execution of the work described in and covered by the Agreement No... except the items mentioned in the Schedule annexed to this Agreement and whereas the items of the work mentioned in the Schedule annexed to this agreement cannot now be executed on account of non completion of the sanitary work, electric installation and some other work; and whereas both the parties are desirous that the items mentioned in the Schedule annexed to this Agreement should be executed by the First Party after the completion of the sanitary work, electric installation and some other work, it is hereby further agreed as under :*
 - (a) That First Party shall and will execute the work covered by the items mentioned in the Schedule annexed to this Agreement at the rates and as per the terms and conditions of the original Agreement No. whatsoever called upon to do so by the Engineer-in-Charge, within a period of one year from the date hereof.*
 - (b) That the First Party shall have absolutely no claim of whatsoever nature against the Second Party for doing the work mentioned in the Schedule annexed to this Agreement as required under clause (a) above, except that which he would be entitled to under the original Agreement No.*
 - (c) That the First Party shall have to execute all the items which the Engineer-in-charge consider necessary.*
 - (d) That the First Party shall start with the work of the remaining items mentioned in the Schedule annexed to this Agreement within days from ..on the receipt of a letter to the effect from the Engineer-in-Charge or from any date fixed in the said letter and shall complete the said work within the time fixed by the Engineer-in-Charge or as extended by him from time to time.*
 - (e) That on the due execution and completion of this Agreement by the parties, the bill of the First Party in relation to the work already done by him under the Original Agreement No. shall be provisionally finalized by the Second Party and payment on account, if any amount due, shall be made to the First Party provided that the Second Party shall have a right to retain such amount as is considered reasonable by him as a security for the execution of the work mentioned in the Schedule annexed to this Agreement and the Second Party shall have right to deal with the said amount of security as he thinks proper under the terms and conditions of the Original Agreement. Further, on the due execution and original completion of this Agreement, the First Party shall be entitled to claim back his*

security deposit relating to the work in question, subject to the right of the Second Party to retain such amount as he thinks reasonable as mentioned above soon after the maintenance period of three months or six months, as the case may be mentioned in clause of the Original Agreement, is over.

- (f) *That the final bill relating to the entire work under the two agreements shall be prepared after the completion of the entire work covered by Agreement No. and this Agreement. (3) Except as modified by this Agreement the said Agreement No. shall remain in full force and effect.*

IN WITNESS WHEREOF THE ABOVE MENTIONED PARTIES HAVE PUT THEIR SIGNATURE ON THIS DAY THE.....

APPENDIX VII

Undertaking from major equipment OEM's (Original Equipment Manufacturer)

The lowest tenderer shall submit alongwith the performance guarantee after the acceptance of tender, an undertaking from OEM regarding:

- The Authorization Certificate from Chiller Manufacturer.
- In Annexure 8 for the 2 years defect liability period & 2 years comprehensive warranty of the chiller in favor of IIT Kanpur. The OEM shall un conditionally support the lowest tenderer technically throughout the execution of the contract as well during DLP , comprehensive warranty & non comprehensive maintenance contract period for the useful life of the equipment.
- In Annexure 9 . The OEM shall provide all the spares/refrigerant required for healthy functioning of the chiller till the useful life of the equipment.

ANNEXURE – 1

Original Equipment Manufacturers (OEM) undertaking for providing 2 years of Defect Liability Period & additional 2 years of comprehensive warranty after DLP of the chiller to the lowest tenderer for 800 TR Centrifugal Chiller proposed to be supplied to IIT Kanpur under the above tender No..... by M/s.....

1. We, OEM for 800 TR Centrifugal Chiller do hereby give undertaking to IIT Kanpur for the 2 years of Defect liability period & 2 years of comprehensive warranty support through M/s....., lowest tenderer for the work, ***“Supply, installation, testing & commissioning of Water Cooled Central AC plant of capacity 3200 TR (4nos. centrifugal Chillers each of capacity 800 TR) in IIT Kanpur”***.

1. We also give undertaking to provide maintenance support and all the spares to IIT Kanpur throughout the useful life of the equipment for the hardware, software and any other accessories for running the equipment.

M/s.....

Authorized signatory with stamp.

ANNEXURE – 2

Original Equipment Manufacturer (OEM) undertaking for ensuring availability of the refrigerant throughout the useful life of 800 TR Centrifugal Chiller proposed to be supplied to IIT Kanpur under the above tender No..... by M/s.....

1. We, OEM for 800 TR Centrifugal Chiller do hereby give undertaking to IIT Kanpur for the providing refrigerant throughout the life of the chiller through M/s....., lowest tenderer for the work, ***“Supply, installation, testing & commissioning of Water Cooled Central AC plant of capacity 3200 TR (4nos. centrifugal Chillers each of capacity 800 TR) in IIT Kanpur”***.

2. We also give undertaking to provide **un conditional support to the lowest tenderer technically throughout the execution of the contract as well during DLP , comprehensive warranty & non comprehensive maintenance contract period for the useful life of the equipment.**

M/s.....

Authorized signatory with stamp.

ANNEXURE – 3

Original Equipment Manufacturers (OEM) undertaking for providing **2 years of Defect Liability Period & additional 2 years of comprehensive warranty after DLP of the Pumping system to the lowest tenderer for skid mounted primary, secondary & tertiary pumping proposed to be supplied to IIT Kanpur under the above tender No..... by M/s.....**

1. We, OEM for pumps do hereby give undertaking to IIT Kanpur for the 2 years of Defect liability period & additional 2 years of comprehensive warranty support through M/s....., lowest tenderer for the work, **“Supply, installation, testing & commissioning of Water Cooled Central AC plant of capacity 3200 TR (4nos. centrifugal Chillers each of capacity 800 TR) in IIT Kanpur”.**

3. We also give undertaking to provide maintenance support and all the spares to IIT Kanpur throughout the useful life of the equipment for the hardware, software and any other accessories for running the equipment.

M/s.....

Authorized signatory with stamp.

ANNEXURE – 4

Original Equipment Manufacturers (OEM) undertaking for providing 2 years of Defect Liability Period & additional 2 years of comprehensive warranty after DLP to the lowest tenderer for Automatic Pressurization system with twin pump expansion tank & Dirt Separator system proposed to be supplied to IIT Kanpur under the above tender No..... by M/s.....

1. We, OEM for Expansion Tank & Dirt Separator do hereby give undertaking to IIT Kanpur for the 2 years of Defect liability period & additional 2 years of comprehensive warranty support through M/s....., lowest tenderer for the work, ***“Supply, installation, testing & commissioning of Water Cooled Central AC plant of capacity 3200 TR (4nos. centrifugal Chillers each of capacity 800 TR) in IIT Kanpur”***.

1. We also give undertaking to provide maintenance support and all the spares to IIT Kanpur throughout the useful life of the equipment for the hardware, software and any other accessories for running the equipment.

M/s.....

Authorized signatory with stamp.

ANNEXURE – 5

Original Equipment Manufacturers (OEM) undertaking for providing **2 years of Defect Liability Period & additional 2 years of comprehensive warranty after DLP to the lowest tenderer for Cooling Tower system proposed to be supplied to IIT Kanpur under the above tender No..... by M/s.....**

1. We, OEM for Cooling Tower do hereby give undertaking to IIT Kanpur for the 2 years of Defect liability period & additional 2 years of comprehensive warranty support through M/s....., lowest tenderer for the work, ***“Supply, installation, testing & commissioning of Water Cooled Central AC plant of capacity 3200 TR (4nos. centrifugal Chillers each of capacity 800 TR) in IIT Kanpur”***.

1. We also give undertaking to provide maintenance support and all the spares to IIT Kanpur throughout the useful life of the equipment for the hardware, software and any other accessories for running the equipment.

M/s.....

Authorized signatory with stamp.

ANNEXURE – 6

Original Equipment Manufacturers (OEM) undertaking for providing **2 years of Defect Liability Period & additional 2 years of comprehensive warranty after DLP to the lowest tenderer for BMS system** system proposed to be supplied to IIT Kanpur under the above tender No..... by
M/s.....

1. We, OEM for BMS System do hereby give undertaking to IIT Kanpur for the 2 years of Defect liability period & additional 2 years of comprehensive warranty support through M/s....., lowest tenderer for the work, ***“Supply, installation, testing & commissioning of Water Cooled Central AC plant of capacity 3200 TR (4nos. centrifugal Chillers each of capacity 800 TR) in IIT Kanpur”***.

1. We also give undertaking to provide maintenance support and all the spares to IIT Kanpur throughout the useful life of the equipment for the hardware, software and any other accessories for running the equipment.

M/s.....

Authorized signatory with stamp.

APPENDIX VIII

CONTRACT AGREEMENT FORMAT

AGREEMENT made this day of , between the Indian Institute of Technology, Kanpur incorporated as a body corporate under the Institute of technology Act 1961 (No.59 of 1961) through its Director Kanpur (hereinafter referred to as 'The Institute' "M/s....." (hereinafter referred to as 'the contractor') which expression shall include his/their respective heirs, executors, administrators and assigns of the other part.

WHEREAS the Institute is desirous for "....." at Institute Campus and has caused drawings and specifications describing the work to be done and WHEREAS the said drawings as per list attached, the specifications, the Priced Schedule of Quantities, the conditions of Tender and the conditions of contract have been signed by or on behalf of the parties hereto AND WHEREAS the contractor has agreed to execute upon and subject to the conditions set fourth herein (hereinafter referred to as 'the said conditions') the work shown upon 'the said drawings' and described in 'the said specification' and 'the said Priced Schedule of Quantities at the respective rates mentioned in the Priced Schedule of Quantities.

AND WHEREAS the contractor has deposited by FDR/BG a sum of Rs./- (Rupees Only) with the Institute for the due performance of this agreement.

NOW IT IS HEREBY AGREED AS FOLLOWS

1. In consideration of the payments to be made to the contractor as hereinafter provided the contractor shall upon and subject to the said conditions execute and complete the works shown upon the said drawings and such further detailed drawings as may be furnished to him by the said Institute and described in the said specification, and the said Priced Schedule of Quantities.

2. The Institute shall pay the contractor such sums as shall become payable hereunder at the times and in the manner specified in the said conditions.
3. Time is the essence of the agreement. In the event of the contractor failing to comply with this conditions he shall be liable to pay compensation as per clause 9 of the conditions of the contract as decided by the Director of the Institute in writing which shall be final and binding on the contractor.
4. The drawings, specifications and Priced Schedule of Quantities above mentioned shall form the basis of this contract and the decision of the Director or Arbitrator or Umpire as mentioned in the conditions of contract in reference to all matters of dispute as to material, workmanship or account and as to the intended interpretation of the clause of this agreement or any other document attached here to shall be final and binding on both parties and may be made a Rule of Court.
5. The said contract comprises the work above-mentioned and all the subsidiary works connected therewith within the same site all may be ordered to be done from time to time by the said Institute even though such works may not be shown on the drawings or described in the said specifications or the Priced Schedule of Quantities.
6. The Institute reserves the right of altering the drawings and nature of the work and of adding to or omitting any items of work or of having portions of the same carried-out departmentally or otherwise and such alterations or variation's shall not vitiate this contract.
7. The said conditions and Appendix thereto shall be read and construed as forming part of this Agreement and the parties hereto will respectively abide by and submit themselves to the conditions and stipulations and perform the Agreement on their parts respectively in such conditions contained.
8. All other disputes and differences except as excluded by clause 10 shall be referred to Arbitrations as per clause 55 of the said conditions of contract. The provision of the Arbitrations Act 1940 or any statutory modifications or reenactment thereof and of the rules made there under for the time being enforce shall apply to Arbitration proceedings under this clause.
9. All disputes arising out of or in any way connected with this Agreement shall be deemed to have arisen in Kanpur and only courts in Kanpur shall have jurisdiction to determine the same.
10. The several parts of this contract have been read to us and fully understood by us. IN WITNESS WHEREOF the parties hereto have set their respective hands the day and the year herein above written.

In the presence of

1.

DIRECTOR

2.

CONTRACTOR.