Bharat Heavy Electrical Ltd (BHEL) Bangalore

20000MW Project at EDN/ESD

Tender Document (Techno-commercial) for the work of:

"Air conditioning System for New Production Block at ESD Premises."

Opening Date: 20 –09 – 2010.

This Tender document contains 178 pages

Issued to:

Bharat Heavy Electricals Limited
Electronics Division, Mysore Road, Bangalore – 560 026.

Phone: 26998406 / 26989192

NOTICE INVITING TENDERS

01.	Tender Number	:	BHEL/EDN/FS/KCP/AC-01 dtd: 28.08.2010
02.	Name of work	:	Air conditioning System for New Production Block at ESD Premises
03.	Completion Time	:	06 Months
04.	Estimated Cost	:	Rs.240.00 Lakhs (Rupees Two Hundred Forty Lakhs)
05.	Earnest Money Deposit	:	Rs. 2.00 Lakhs (Rupees Two Lakhs)
06.	Last Date & Time for the Receipt of Completed Tender.	:	Before 2:30 PM on 20.09.2010
07.	Date & Time for Tender Opening	:	At 2:45 PM on 20.09.2010
08.	Place of submission of Tender	:	Tender Box marked as "Factory Services" and located at Reception Area of Electronics Division, BHEL Mysore Road, Bangalore-26.

09. Tender Contents: This tender document contains 178 Pages (Part-I) and **10** pages (Part-II) consisting of the following :

i. Technical-cum-Commercial Bid (Part-I) : Comprising the following :-
   a. NIT, Instructions to Tenderers.
   b. Scope of work (Technical Specifications / Standards / Norms including makes of equipments / material).
   c. Details of technical parameters to be furnished by tenderers.
   d. Set of Design Drawings (seven drawings).
   e. Questionnaire
   f. General Conditions of Contract

ii. Schedule of Work / Price Bid (Part-II) : Comprising Bill of Quantities where in the tenderers will submit their Price Bid furnishing the rates and amounts.

10. **Note:**
The tenderer shall read the tender documents carefully and fill all the columns neatly. Incomplete tenders may be rejected. The tenderer shall return the duly filled in tender document after affixing signature on all pages. The Tenderers shall ensure and put "Technical-cum-Commercial bid (Part - I)" & "Instructions to Tenderers" together in one cover and "Schedule of Work / Price bid (Part-II)" in a separate cover. Both these covers shall be separately sealed and then put together in a single cover and sealed. Name of work and due date for opening shall be superscribed on the envelopes and all the sealed covers shall be properly identified with necessary information such as Tender reference, type of document put inside, date of tender opening to enable to open the correct document cover only.

PART-1

TECHNICAL-CUM-COMMERCIAL BIDS

Name of Work : Air conditioning System for New Production Block at ESD Premises.

Tender Ref : BHEL/EDN/FS/KCP/AC-01, dtd: 28.08.2010

Completion Period : 06 Months

A. Information Part :

S.N.	Particulars	To be Filled by Bidder
1.0	Name of the Contractor	
2.0	Address (Office)	
3.0	Telephone Number	
	Office	
	Fax No.	
	Mobile No.	
4.0	E-mail ID	
5.0	Technical Staff Details (Use separate sheet if reqd.)	Furnished / Not Furnished
6.0	Working Staff Details (Use separate sheet if reqd.)	Furnished / Not Furnished
7.0	Plant & Equipment details (Use separate sheet if reqd.)	Furnished / Not Furnished

B. Essential Criteria for Techno-Commercial Acceptance of Bid:

S.N.	Particulars	To be Filled by Bidder
1.0	Experience Certificate for having successfully completed Air-conditioning works during immediate last 7 years as mentioned below : One work not less than 80% of the estimated cost of this NIT or Two works of not less than 50% of the estimated cost of this NIT or Three works of not less than 40% of the estimated cost of this NIT copy of completion certificates from the organization where the work is executed is to be enclosed mentioning the completed value of each single work executed and performance certificate issued by the client. (submission of work order copy is not adequate)	
2.0	Average Turn Over of the last three years (not less than 30% of the estimated cost of the NIT)	
2.1	Turn over – Previous financial year	Rs.
2.2	Turn over – 1 Year before previous financial year	Rs.
2.3	Turn over – 2 Years before previous financial year	Rs.
3.0	Solvency : (Not less than 30% of the estimated cost of the NIT, Certificate from the Bank not older than one year to be furnished)	Furnished / Not Furnished.
4.0	Whether Registered with ESI / PF Authority	Yes / No
4.1	If Yes, indicate PF Registration No. (Copy of last month contribution paid receipt to beenclosed)	Enclosed / Not Enclosed.
4.2	If Yes, indicate ESI Registration No. (Copy of last month contribution paid receipt to be enclosed)	Enclosed / Not Enclosed.
4.3	If No, is the tenderer willing to pay the ESI and PF contribution for the subject work under BHEL Sub code, subject to BHEL Terms and conditions.	Yes / No.

Note: If any of the above-mentioned criteria is not met the bid will be rejected.

C. Other Conditions:

S.N.	Particulars	To be Filled by Bidder
1.0	Form of EMD furnished (Cheque is not acceptable)	DD / Pay Order / Cash(as permissible under the Income Tax Act) Document No. to be mentioned.
2.0	Has the Tenderer read General Conditions of Contract & NIT	Tender Conditions Acceptable / Not Acceptable
3.0	Completion period mentioned in NIT	Acceptable / Not Acceptable
4.0	Payment Terms defined in NIT	Acceptable / Not Acceptable

INSTRUCTIONS TO TENDERERS

1. Sealed Tenders for the above noted work are hereby invited from Contractors experienced in works of similar kind and magnitude.

2. Tenders should be addressed to Sr.Manager (FS), Electronics Division, Bharat Heavy Electricals Limited, Mysore Road, Bangalore – 560 026. The full name and address of the tenderer, name of the work and the date of opening should be indicated on the cover.

2.1 The local address of the Contractor, the name of the person to whom all the correspondence are to be addressed should be indicated with telephone number (both office and residence), FAX /e-mail address, Mobile phone No. etc.

3. All entries in the tender documents should be in the same ink. Erasures and over writing are not permitted. The tenderer concerned with proper indication of the name, designation and address of the person signing should duly sign all cancellations and insertions.

4. Tenderers shall fill in all the required particulars in the blank spaces provided for this purpose in the tender documents and also sign each and every page of the tender document including the drawings (wherever applicable) attached there to before submitting tender.

5. Unit rates should be quoted in figures as well as in words in Indian Currency only i..e. Rupees and Paise with reference to each item and for all the items shown in the attached schedule. The rates shall include all taxes and duties payable on account of Service Tax, Sales Tax etc., and also expenses towards PF and ESI contributions (see clauses 8, 39 and Annexure 'C'). Amount of each item and the total on each sheet as also the grand total amount of the whole contract shall be filled by the tenderers.

6. In case the rate quoted in figures differ from those quoted in words, the lower of the rates will be taken as the tendered rate and shall be binding on the tenderers.

7. In quoting their rates, the tenderers are advised to take into account all factors including any fluctuations in market rates. No claim for enhanced rates will be entertained on this account after acceptance of the tender or during the currency of the contract.

8. The rates to be quoted by the tenderer shall be firm and shall cover and include all statutory levies arising from Acts, passed by Parliament or by State legislature and rules framed there under. The rates shall further be deemed to include statutory levies arising from such Acts, Central or State, which may come into force, subsequent to submission of tenders. The tenderer shall note that no claim for enhancement of rates, on the ground that existing statutory levies have been increased, or that new statutory levies have come into effect after tender, or on any other ground, will be entertained on any account.

9. (a) The rates quoted in the tender shall remain valid for a period of 'THREE MONTHS' from the date of opening of tender.

   (b) Tenderer shall not increase their quoted rates, once the tenderer has submitted his quotation and during execution of the contract in case his tender is accepted.

10. Quantities shown in the attached schedule are only approximate and are liable to variation without entitling the Contractor to any compensation, provided the total value of the contract does not vary by more than 20 % (twenty percent).

11. Before tendering, the tenderers are advised to inspect the site of work and its environments and be well acquainted with the actual working and other prevailing conditions, position of materials and labour. They should be well versed with BHEL General Conditions of Contract, Instructions to tenderers, drawing wherever applicable and specifications and all other documents which form part of the agreement to be entered into subsequent to award of work. The tenderers shall specially note that it is the tenderer's responsibility to provide any item which is not specially mentioned in the specification or drawing, but which is necessary to complete the work.

12. Details and quantities of each item of work shown in the "Bill of Quantities" attached here to are only approximate. They are given as a guide for the purpose of tendering only and are liable to variation and alteration at the discretion of the competent authority. The work under each item as executed shall be measured and priced at the corresponding rates to be quoted by the contractor in the Bill of Quantities attached here to.

13. Should a tenderer find discrepancies or omissions in the drawings wherever applicable / Specifications / Scope of work / Terms & Conditions attached to the tender documents or should be in doubt as to their meaning, he should at once address to the authority inviting the tender for clarifications.

    Every endeavor is made to avoid any error which can materially affect the basis of the tender but the successful tenderer shall take upon himself to provide for the risk of any error which may be subsequently discovered and shall make no subsequent claim on account thereof.

14. In the event of tender being submitted by a firm, the tender must be signed separately and legibly by each partner or member of the firm or in their absence, by the person holding the power of Attorney on behalf of the firm concerned. In the latter case, a copy of the power of attorney duly attested by a Gazetted officer must accompany the tender.

15. In case, the date of tender opening falls on Holiday, the tender will be opened on the next working day.

16. Every tender must be accompanied by deposit receipt for the amount mentioned as Earnest Money Deposit. This earnest money will be refunded to the unsuccessful tenderers after finalisation of the award of work. In the case of successful tenderer, the earnest money will be retained as part of the Security Deposit for satisfactory completion of the work in accordance with Clause – 16 of the BHEL General Conditions of the Contract. Tenders without Earnest Money Deposit receipts are liable to be rejected. No interest will be paid on the earnest money deposits.

17. The Earnest Money Deposit shall be submitted along with Technical bid and may be furnished in any of the following forms :
    (a) Cash
    (b) Pay Order / Demand Draft

18. Unless the Contractor whose tender is accepted signs the contract agreement within fifteen days (15 days) of the date of the order directing him to do so, the amount of Earnest Money already deposited by him may be forfeited and acceptance of his tender withdrawn.

19. If, after opening of tenders, a tenderer revokes his tender or increases his earlier quoted rates or after acceptance of his tender does not commence the work in accordance with the instructions of Engineer-in-charge, the Earnest Money Deposited by him will be forfeited and acceptance of his tender withdrawn. If only a part of the work included in the tender had been awarded to the tenderer, the amount of Earnest Money to be forfeited will be based on the value of the contract so awarded.

20. BHARAT HEAVY ELECTRICALS LIMITED reserves the right to reject any or all the tenders received or accept any tender or part thereof without assigning any reason thereof. In the case of acceptance of a part of tender, the time for completion may also be reduced to the extent considered appropriate by the accepting authority.

21. Conditional and unsigned tenders, tenders containing absurd rates and amounts, tenders which are incomplete or otherwise considered defective, tenders which are not in accordance with the tender conditions laid down by the Accepting Officer and tenders not submitted in the prescribed forms are liable to be rejected.

22. The contractors who are not on the approved list of contractors of this organisation must submit the following testimonials simultaneously with their tenders. These testimonials shall be signed by the person (s) issuing the same indicating their name, designation and full address.

    i) A certificate to establish that the tenderer is an independent contractor working on his own.

    ii) At least 2 certificates from responsible officers of Government or firms of repute, regarding the tenderer's capacity to undertake and carryout the work tendered for / similar work satisfactorily.

    iii) A certificate from a Bank of standing or magistrate regarding the tenderer's financial position.

    Note: (a) Copies of testimonials unless attested by a Gazetted Officer will not be accepted.
    (b) Non – submission of the above testimonials simultaneously with the tenders may result in the tenders being rejected.

23. The tenders should be accompanied by a list of contracts already held by the Contractor at the time of submitting the tender and giving the following particulars:

    (a) Name of work, value and address.
    (b) The balance work remaining to be done on the same.

24. Tenders submitted by post should be sent by "Registered Post with Acknowledgement due". These should be posted with due consideration for any delay in postal delivery. Tenders received after the due date of opening of tenders are liable to be rejected.

25. The Contractor's responsibility under this contract shall commence from the date of receipt of the order or acceptance of his tender.

26. If a tenderer expires after the submission of his tender or after the acceptance of his tender, BHEL may, at their discretion, cancel such tender.

    If a partner of the firm expires after the submission of the Tender, after the acceptance of the Tender, BHEL may cancel such Tender at the discretion unless the firm retains its character(s).

27 BHARAT HEAVY ELECTRICALS LIMITED will not be bound by any power of Attorney granted by the tenderer or by changes in the composition of the firm made subsequent to the execution of the contract. They may however, recognise such power of Attorney and changes after obtaining proper legal advice, the cost of which will be chargeable to the contractor concerned.

28. If the tenderer deliberately gives wrong information in his tender, BHEL reserves the right to reject such tender at any stage. Further the tenderer will be liable for any damage caused.

29 Words imparting the singular number shall be deemed to include the plural number and vice-versa where the context so requires.

30 The General and Special Conditions of Contract are complementary to each other and where they are in conflict, the special condition shall prevail.

31 The expenses for completing the stamping the agreement shall be paid by the contractor.

32 Unless and otherwise stated all tendered work includes supply, erection, testing and commissioning of equipment as agreed to in the contract.

33 After completion of the job, the contractor has to furnish actual drawings of work done in
consultation with Engineer-in-charge.

34 Any covering letter and comments of the Contractor should be submitted in duplicate along with the offer.

35 The Contractor shall provide all the materials needed for trial run, testing including chemicals, consumables etc. In quoting their rates, the Contractors are advised to take into account the cost of the above materials.

36 Should a tenderer or a contractor on the list of approved contractors have a relative or in the case of firm or Company of Contractors any of its share holder's relative is employed in a Gazetted Capacity in the Electronics Division of Bharat Heavy Electricals Limited, Bangalore-26, the authority inviting tenders shall be informed of this fact at the time of submission of the tender, failing which tender may be disqualified or if such a fact subsequently come to light, the relevant provisions of the General Conditions of Contract will apply.

37 These 'INSTRUCTIONS TO TENDERERS' & 'GENERAL CONDITIONS OF CONTRACT OF BHEL shall be deemed to form an integral part of the contract agreement for the work to be entered into. In cases of variation between the two in any matter, the conditions in the 'THE INSTRUCTIONS TO TENDERERS' shall prevail. Extracts of some of the important clauses of BHEL GCC are enclosed (Annexure containing extracts of clauses 20, 38 and 58 of BHEL GCC). The contractor has to obtain, at his cost, a copy of the BHEL GCC, scrutinize the same, and when submitting his tender, indicate his acceptance of BHEL GCC in the proforma enclosed at Annexure B.

38 All operations to be carried out by the Contractor during the execution of the contract such as drilling, welding etc., shall be done with proper equipment brought by the tenderer. Suitable power point will be provided and tapping from the power point to equipment shall be done using proper size of cable, equipment and after getting approval of connections from our Engineer-in-charge.

39 The Contractor shall comply with the provision of Employees Provident Fund and Miscellaneous Provisions Act 1952 and rules, regulations and other orders issued there under. He, as an employer, shall be liable to pay employer's contribution/deductions towards PF under the PF Act in respect of all labour employed by him, for the execution of the contract in accordance with the provisions of the Employees Provident Funds and Miscellaneous Provisions Act, 1952 as amended from time to time. For this purpose he shall indicate the code number obtained from the Regional Provident Fund Commissioner or he should obtain a code number if he has not and produce the Photostat copy of the challan / receipt of monthly remittance of the contribution made by him to the PF Commissioner. Final payments due to him will be released only on production of a "No due certificate" from the Regional Provident Fund Commissioner wherever applicable. He shall also furnish such returns as are due, under the Act, to be sent to the appropriate authorities through the Principal Employer".

40 The Contractor should get himself registered with the E.S.I. Authorities as an independent Employer, obtain a separate code number and remit the dues in respect of the labour employed by him for the work and produce the Challans / Receipts of remittance of the ESI contributions due under the E.S.I. Act to the Company authorities. He shall also furnish such returns, as are due, under the Act, to be sent to the appropriate authorities through the Principal Employer.

40.1 If any action is brought in by P.F. Commissioner/ESI authorities on BHEL for the work done by the Contractor for his labourers regarding PF/ESI amount due, short remittances, non remittances etc., the Contractor shall defend the case on behalf of BHEL and/or reimburse BHEL the expenses so incurred.

40.2 If applicable, the Contractor shall apply and obtain license under Contract labour (R&A) Act 1970 and comply with the relevant provisions of this Act in respect of the labour employed by him for executing this contract. The Contractor shall furnish necessary returns to the authority through the Principal Employer.

41 If applicable, the Contractor shall insure all his labourers and materials. Any claim by his employees for the damages shall be settled by the contractor even action is against BHEL or to reimburse the legal expenses incurred by BHEL

42 Any action brought in by anybody on BHEL regarding patent, right etc., used by contractor in execution of work shall be defended by the contractor and / or reimburse to BHEL the cost of the same.

43 Contractor shall produce necessary records, documents, explanation whenever he is called upon to do, by any Government. Agencies like ESI, PF, VIGILANCE etc.

44 TERMS OF PAYMENT :

a) 56.25% of total contract value will be paid against the supply of materials at site and acceptance on prorata basis.

b) 33.75 % of the contract value will be paid on completion of erection on prorata basis.

c) Balance 10 % of the contract value will be paid after;

i) Satisfactory commissioning and handing over the entire system and

ii) On your submitting a Bank Guarantee for a value of 50 % of the Security Deposit towards performance guarantee to the extent required to cover the warrantee period.

iii) For the works which do not involve supply of materials, erection and commissioning, the terms of payment will be as per discretion of Executive in charge of BHEL.

45 SECURITY DEPOSIT

45.1 The successful tenderer shall deposit the Security deposit before start of the work. The rate of Security deposit will be as below.

Upto Rs. 10 Lakhs	10 %
Above Rs. 10 Lakhs upto Rs. 50 Lakhs	Rs. 1 Lakh + 7.5% of the amount exceeding Rs. 10 Lakhs
Above Rs. 50 Lakhs	Rs. 4 Lakhs + 5 % of the amount exceeding Rs. 50 Lakhs

45.2 Security deposit may be furnished in any one of the following forms

i) Cash (as permissible under the Income Tax Act)
ii) Pay Order, Demand Draft in favour of BHEL
iii) Local Cheques of scheduled banks, subject to realization.

iv) Securities available from Post Offices such as National Savings Certificates, Kisan Vikas Patras etc. (Certificates should be held in the name of Contractor furnishing the security and duly pledged in favour of BHEL and discharged on the back)

v) Bank Guarantee from scheduled Banks / Public Financial Institutions as defined in the Companies Act subject to a maximum of 50% of the total security deposit value. The balance 50% has to be remitted either by cash or in the other form of security. The Bank Guarantee format should have the approval of BHEL.

vi) Fixed Deposit Receipt issued by Scheduled Banks / Public Financial Institutions as defined in the Companies Act. The FDR should be in the name of the contractor, A/C. BHEL, duly discharged on the back.

vii) Security Deposit can also be recovered at the rate of 10% from the running bills. However in such cases at least 50% of Security Deposit shall be deposited before start of the work and the balance 50% may be recovered from the running bills.

viii) EMD of the successful tenderer shall be converted and adjusted against the security deposit.

ix) The Security deposit shall not carry any interest.

NOTE: Acceptance of Security Deposit against Sl. No. (iv) and (vi) above will subject to hypothecation or endorsement on the document in favour of BHEL. However, BHEL will not be liable or responsible in any matter for the collection of interest or renewal of the documents or in any other matter connected therewith.

46 RUNNING ACCOUNT PAYMENTS

During execution of work, payments of all works in place will be made on the basis of measurements recorded in measurement sheet / book in respect of items executed but no claim on the account will be entertained, if for any reason payments are not so made.

47 The work shall be carried out as per detailed specifications enclosed with the tender. The items for which there is no mention in the drawings, detailed specifications to relevant IS Specifications (latest edition) shall be followed.

48 CLEANING OF SITE:

After completion of the work, the contractor shall remove all debris, take away left over construction materials, machine, equipment, temporary offices, stores, work shop etc. and make the area neat and clean. The cost of this work shall be included in the quoted rate.

49 COMPLETION OF WORK AND MEASUREMENT

a) On completion of the work, the contractor must submit to the Engineer the following documents for passing of works.

b) A copy of the working drawing showing thereon all addition and alterations in the process of execution and.

c) The authorised Contractor’s representative and a representative of the Employer shall jointly sign a certificate of handing over of any completed work and the date of signature of that certificate will be that the date from which the maintenance period of that unit will be reckoned.

50 MAINTENANCE OF WORKS

The contractor will be responsible for the maintenance of works during the period of execution until the various items are taken over, and for a further period of Six months, from the date of taking over.

51 EXTRA ITEMS :

No extra items of work shall be carried out by the contractor other than those authorised to do so in writing by the Engineer. For any such items of work executed as per instructions of Engineer, The rates will be fixed on the basis indicated under clause 50 of BHEL GCC.

52 SUPPLY OF MATERIALS BY CONTRACTOR :

i) The work is for a completed job including labour and supply of all except those otherwise specified in the bid document.

ii) All materials supplied by the contractor according to the contract conditions shall be subject to inspection and passing by the Engineer or his representatives from time to time, the contractor shall provide all facilities for such inspection free cost. BHEL officers connected with the contract shall have the power at any time to inspect and examine any stores or materials intended to be used in or on the work, whether on the site or at any factory or workshop or other place the same are laying and the contractor shall give necessary facilities for such inspection and examination.

iii) The contractor shall submit necessary Test Certificate / Calibration certificate for the critical items wherever necessary.

53 INTERRUPTION TO WORKS :

i) In quoting the rates / prices the contractor should take in to account the fact that due to the design or other stipulations at site, or the necessity to follow a particular sequence of overall construction operation, or non – supply of particular drawings, or the connected work or other reasons, interruptions are likely to be encountered in a work of this nature and magnitude. No claims for such interruption will be entertained on any account.

ii) Extension of time or penalty / liquidated damages as the case may be will be determined as stipulated in clause 7, 9 and 41 of BHEL General Conditions of Contract.

SCOPE OF WORK

1.0 SPECIAL CONDITIONS

1.1 THE BUILDING:

The building **"New Production Block"** is located in **ESD Premises of BHEL Bangalore .** Presently the building is under construction and is coming up fast. Initially the building will have only ground floor but is planned to be expanded vertically in future. However, the scope of Air-conditioning is confined to the present building only covering ground floor. It consists of two sections : one section is the Assembly Area and the other is Testing Area with a partition wall between the two sections. Adjacent to Testing Area is the open space for accommodating the chilling machine. AHU rooms are located on all the four corners of the building, one in each corner.

1.2 THE REQUIREMENT :

It is proposed to install Central Air Conditioning Plant for providing air conditioning to the entire building covering both the sections.

1.3 THE SCHEME AND THE EQUIPMENT

The chilling machine will be located in the open space adjacent to the Testing Area. Pumps, control panel and hot water generator will be placed in the covered area adjacent to AHU room. Chilled water will run in insulated chilled water pipes to all the four AHUs. The AHUs will be double skin construction and will supply conditioned air to the respective section : two AHUs to Assembly Area and two AHUs to Testing Area. The air will be distributed thru GS sheet ducts and supply to the conditioned spaces thru grilles / diffusers. Return air will be taken thru the ceiling spaces provided above the false ceiling. Adequate quantity of fresh air will be added to the AHUs to maintain Indoor Air Quality conforming to specified standards.

1.4 GENERAL

These conditions are intended to amplify the General Conditions of Contract, and shall be read in conjunction with the same along with other relevant sections / portions of NIT. For any discrepancies or conflicts between the Conditions, the specifications, the drawings, the BOQ or any other section of NIT, the more stringent shall prevail and the decision of BHEL will be final and binding in this regard.

1.5 SCOPE OF WORK

The general character and the scope of work to be carried out under this contract are illustrated in Drawings, Specifications and Schedule of Quantities. The Contractor shall carry out and complete the said work under the contract in every respect in conformity with the contract documents and with the directions of and to the satisfaction of the Engineer-in-charge. The Contractor shall furnish all labour, materials and equipments, transportation and incidental necessary for supply, installation, testing and commissioning of the complete Air Conditioning System, comprising Water Chilling Units, ducting, piping, AHUs etc as described in the Specifications/Bill of Quantities and as shown on the Drawings. This also includes any materials, equipment, appliances and incidental work not specifically mentioned herein or noted on the Drawings / Documents as being furnished or installed, but which are necessary and customary to make a complete installation in perfect and satisfactory working condition giving specified design conditions. In general, the work to be performed under this contract shall comprise supply, installation, testing and commissioning of the followings :

a. Water Chilling Units complete with compressor, its motor, chiller, condenser and necessary refrigerant piping, controls, accessories all mounted on a common steel frame including charge of consumables like refrigerant, oil etc. The machine shall

be factory assembled, factory charged with refrigerant and oil etc and factory tested for performance

b. Double skin Air Handling Units with housing, fan, motor, cooling coil, controls, filter section and air filters.

c. Chilled water pumps.

d. Hot Water Generator.

e. Chilled water and drain water piping inclusive of valves and fittings.

f. Sheet metal ducts inclusive of external insulation/ acoustic lining, flexible connections, volume control dampers and fire dampers as required/specified.

g. Supply and return air grilles/diffusers along with supply & fixing of metallic frames for their mounting.

h. Insulation of pipes, pumps, pot strainers, Y-strainer, expansion tank and ducts etc.

j. Ceiling suspended boxing / false ceiling for return air if and as specified in BOQ/Drawings.

k. Main Air-conditioning Control Panel and associated cabling / control wiring / earthing between Panel and various components including provision in Main Control Panel for main incoming Power Cable with earthing from existing source to Main Panel of proposed system.

l. Mini BMS and control wiring for remote operation and monitoring of the system. Mini BMS will be located along with the Control Panel.

m. All associated civil and other works required for completion of work.

n. Vibration isolators for all air conditioning equipment and ducting, as required.

p. Balancing, testing, commissioning and handing over of the entire air conditioning system installation in perfect and satisfactory working condition.

q. Completion documents containing Performance Test reports, list of recommended spares, as installed drawings, operation and maintenance manual for the entire air conditioning system installation including statutory clearances/approvals/license from concerned Local/Govt. Bodies wherever applicable and required.

1.6. ASSICUATED CIVIL WORKS

a. BY AC CONTRACTOR

i. Civil Works :

Civil Works and other related works associated with Air Conditioning installation, like foundations for equipments, digging of ground/floor and making the same good, making opening in the wall/ floor/ ceiling for pipes /ducts / fresh air/cables etc. are included in the scope of this contract. These shall be executed by the AC Contractor in accordance with approved shop Drawings. Prior to making of opening in wall/floor, approval of Engineer-in-Charge is mandatory.

ii. Electrical Works

All associated electrical works are included in the scope of this contract. These shall be carried out / installed by the AC Contractor in accordance with approved shop drawings.

b. BY DEPARTMENT

The following will be provided by BHEL :

i. AHU Room

Construction of AHU rooms with floor drain, water supply with water tap and lighting.

ii. Pump Room

Construction of pump room with floor drain, water supply connection with water tap, lighting and proper ventilation etc.

iii. Chilled Water :

Providing required quantity of chilled water for filling of system along with make-up water and its connection to expansion tank.

iv. Incoming Power Supply to AC Control Panel

Providing / extending incoming power supply to the Main AC Control Panel in the plant room / pump room.

1.7 PERFORMANCE GUARANTEE

The contractor shall guarantee that the Air Conditioning system as installed, shall maintain the inside conditions in various spaces as described under "Basis of Design" in the specifications. The guarantee shall be submitted in the proforma indicated in Appendix-I. It is to be clearly understood that the Drawings, Schedule of Quantities and Air Conditioning system indicated in the specifications are for tenderers guidance only. Each tenderer shall carry out his own comprehensive calculations and shall make all necessary provisions as required to achieve the specified inside conditions in all seasons year round.

1.8 BYE-LAWS AND REGULATIONS

The installation shall be in conformity with the Bye-laws, Regulations and Standards of the local authorities concerned in so far as these become applicable to the installation. But if these Specifications and Drawings call for a higher standard of materials and / or workmanship than those required by any of the above Regulations and Standards, then these Specifications and Drawings shall take precedence over the said Regulations and Standards. However, if the Drawings or Specifications require something, which violates the Bye-Laws and Regulations, then the Bye-Laws and Regulations shall govern the requirement of this installation.

1.9 FEES AND PERMITS

The contractor shall apply and obtain all permits / licenses and pay for any and all fees required for the inspection, approval and commissioning of the installation . However, water/power for running the Plant shall be provided by BHEL.

1.10 DRAWINGS

The HVAC Drawings, which shall be issued with tenders, are diagrammatic only and indicate arrangement of various systems and the extent of work covered in the contract. These Drawings indicate the points of supply and of termination of services and broadly suggest the routes to be followed. Under no circumstances shall dimensions be scaled from these Drawings. The site will be examined by the Contractor before submitting his tender and exact location of equipment, controls, pipe routes, grilles and diffusers etc will be made in accordance with the requirement of site.

The contractor shall follow the tender drawings in preparation of his shop drawings. The installation work will be carried out on the basis of approved shop drawings. The tenderer shall check the drawings / site of other trades to verify spaces in which his work will be installed before tendering.

Maximum headroom and space conditions shall be maintained at all points. Where headroom appears inadequate, the contractor shall notify BHEL before proceeding with the installation.

The contractor shall examine all architectural, structural plumbing and electrical and other services before starting the work. Any changes found essential to coordinate installation of this work with other services and trades shall be made with prior approval of BHEL and without additional cost to BHEL. The data given in the drawings and specifications is as exact as could be procured, but its accuracy is not guaranteed.

1.11 TECHNICAL DATA

Each tenderer must submit along with his tender the technical data, product catalogues of Manufacturer fo r all items being offered by him as listed in 'Schedule of Technical Data' in the indicated format. Failure to furnish technical data with tenders may result in summary rejection of the tender.

1.12 SHOP DRAWINGS

Within two weeks after the award of the contract, the Contractor shall furnish, for the approval of BHEL, three sets of detailed shop drawings of all equipment and materials including Plant Room layout with all equipments, AHU rooms layout, ducting, piping and power/control wiring/earthing layouts, required to complete the project as per specifications and as required. The shop drawings will also show various routes thru vertical risers and horizontal run s of pipes/cables etc. Detailed ducting layout for air distribution to various areas will also be shown along with AHU and other associated accessories. These Drawings shall contain details of construction, size, arrangement, operating clearances, performance characteristics and capacity & make of all items of equipment, also the details of all related items of work by other contractors. Each item of equipment proposed shall be a standard catalogue product of an established manufacturer as per specifications and as listed under 'Approved Makes of Equipment / Material'.

The shop drawings submitted will be reviewed by BHEL. When any amendment is made in the above drawings during review, the Contractor shall supply two fresh sets of drawing s with the amendments duly incorporated, along with the drawings on which corrections were indicated.

a. After the shop drawing is finally approved by BHEL, the Contractor shall submit further four sets of approved shop drawings to the Engineer-in-Charge for the exclusive use by BHEL. No material or equipment may be delivered or installed at the job site until the contractor has in his possession, the approved shop drawings for the particular material or equipment.

b. The shop drawings shall be submitted for approval sufficiently in advance of planned delivery and installation of any materials, to allow BHEL ample time for scrutiny. No claims for extension of time shall be entertained because of any delay in the work due to his failure to produce shop drawings at the right time, in accordance with the approved programme.

c. Samples, manufacturers' drawings, catalogues, pamphlets and other documents submitted for approval shall be in two sets. Each item in each set shall be properly labeled, indicating the specific services for which material or equipment is to be used, giving reference to the governing section and clause number and clearly identifying in ink the items and the operating characteristics. Data of general nature shall not be accepted.

d. Approval of shop drawings shall not be considered as a guarantee of measurements or of building dimensions. Where drawings are approved, said approval does not mean that the drawings supersede the contract requirements, nor does it in any way relieve the contractor of the responsibility or requirement to furnish material or perform work as required by the contract.

e. Where the contractor proposes, and is permitted in writing by BHEL , to use an item of equipment, other than that specified or detailed on the drawings, which requires any re-design of the structure, partitions, mechanical, electrical or architectural layout; all such re-design, and all new drawings and detailing required therefore shall be prepared by the contractor at his own expense and gotten approved by BHEL.

f. Where the work of the contractor has to be installed in close proximity to, or will interfere with work of other trades, he shall assist in working out space conditions to make a satisfactory adjustment. If so directed by BHEL , the contractor shall prepare composite working drawings and sections at a suitable scale not less than 1:50, clearly showing how his work is to be installed in relation to the work of other trades. If the contractor installs his work before coordinating with other trades, or so as to cause any interference with work of other trades, he shall make all the necessary changes without extra cost to BHEL.

1.13 QUIET OPERATION AND VIBRATION ISOLATION

All equipment shall operate under all conditions of load without any sound or Vibration, which is objectionable, and beyond specified limits as per section "Vibration Isolators" and in the opinion of BHEL. In case of rotating machinery sound or vibration noticeable outside the room in which it is installed, or annoyingly noticeable inside its own room, shall be considered objectionable. Such conditions shall be corrected by the Contractor at his own expense.

1.14 ACCESSIBILITY

The contractor shall verify the sufficiency of the size of the shaft openings, clearances in cavity walls and suspended ceilings/boxings for proper installation of his ducting and piping. His failure to communicate insufficiency of any of the above shall constitute his acceptance of sufficiency of the same. The contractor shall locate all equipment, which must be serviced, operated or maintained in fully accessible positions. The exact location and size of all access panels, required for each concealed control damper, valve or other devices requiring attendance, shall be finalized and communicated in sufficient time, to be provided in the normal course of work. Failing this, the Contractor shall make all the necessary repairs and changes at his own expense.

1.15 ELECTRICAL INSTALLATION

The electrical work related to air conditioning services, included under installation of electrical services, shall be carried out in full knowledge of, and with the complete coordination of BHEL. The electrical installation shall be in total conformity with the control wiring drawings prepared by the contractor and approved by BHEL. All air conditioning equipment shall be connected and tested in the presence of authorized representative of BHEL.

The system shall be commissioned only after the contractor has certified in writing that the electrical installation work has been thoroughly checked, tested and found to be totally satisfactory and in full conformity with the contract Drawings, specifications and manufacturers' instructions. It is to be clearly understood that the final responsibility for the sufficiency, adequacy and conformity to the contract requirements, of the electrical installation work for air conditioning services, lies solely with the contractor.

1.16 MATERIALS AND EQUIPMENT

All materials and equipment shall conform to the relevant standards and NIT specifications and shall be of the approved make. Makes shall be strictly in conformity with list of approved manufacturers as per 'Approved Makes of Equipment / Material".

1.17 MANUFACTURERS INSTRUCTIONS

Where manufacturers have furnished specific instructions, relating to the materials and equipment used in this project, covering points not specifically mentioned in these documents, such instructions should be followed in all cases.

1.18 BALANCING, TESTING AND COMMISSIONING

Balancing of systems and all tests as called for in the Specifications shall be carried out by the contractor in accordance with the Specifications and relevant local codes, if any. System performance test shall consist of seven days operation of system for each season with minimum ten hours daily functioning of the system.

The results for summer and monsoon air conditioning in quadruplicate shall be submitted for scrutiny. Four copies of the certified manufacturers performance curves for each piece of equipment shall be submitted along with the test results. The contractor shall also provide four copies of record of all safety and automatic control settings for the entire installation.

The contractor shall pay for and arrange, without any extra cost to BHEL, all necessary balancing and testing equipment, instruments, materials, accessories and the requisite labour. Any defects in materials and / or in workmanship detected in the course of testing shall be rectified by the contractor, entirely at his own cost, to the satisfaction of the BHEL.

The installation shall be tested again after removal of defects and shall be commissioned only after approval by BHEL. All tests shall be carried out in the presence of the representatives of BHEL.

1.19 COMPLETION CERTIFICATES

On completion of the Electrical installation for air-conditioning a certificate shall be furnished by the contractor, counter signed by the licensed qualified supervisor, under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form as required by the local authority.

1.20 COMPLETION DRAWINGS

On completion of the work in all respects, the contractor shall supply four sets each containing complete drawings on approved scale indicating the Work as installed. These drawings shall clearly indicate complete plant room layouts, ducting and piping layouts, location wiring and sequencing of automatic controls, location of all concealed piping, valves, controls, dampers, wiring and other services. Each Portfolio shall also contain consolidated control diagrams and technical literature on all controls.

1.21 OPERATING INSTRUCTIONS & MAINTENANCE MANUAL

The Contractor shall submit to the Consultant a draft copy of comprehensive operating instructions, maintenance schedule and log sheets for all systems and equipment included in this contract. This shall be supplementary to manufacturer's operating and maintenance manuals. Upon approval of the draft, the contractor shall submit four (4) complete bound sets of typewritten operating instructions and maintenance manuals.

1.22 ON SITE TRAINING

Upon completion of all work and tests, the Contractor shall furnish necessary skilled labour and helpers for operating the entire installation for a period of 30 (thirty) working days of ten (10) hours per day, to enable BHEL's staff to get acquainted with the operation of the system. During this period, the contractor shall train BHEL's representatives in the operation, adjustments and maintenance of all equipment installed.

1.23 MAINTENANCE DURING DEFECTS LIABILITY PERIOD

a. COMPLAINTS

The Contractor shall receive calls for any and all problems experienced in the operation of the system under this contract, attend to these within 24 hours of receiving the complaints and shall take steps to immediately correct any deficiencies that may exist.

b. REPAIRS

All equipments that require repairing shall be immediately serviced and repaired.

c. MAJOR FAULT

Whether a particular component / system should be repaired or replaced will be decided by the BHEL in case of any major fault / defects / deficiency noticed during defects liability period calling for repair / replacement of a particular component or system.

1.24 DEFECTS LIABILITY PERIOD

Defects liability period shall be ONE year to be reckoned from the date of satisfactory completion / commissioning and handing over to BHEL the installation in perfect working condition.

1.25 WATER AND POWER REQUIREMENT

The tenderer shall submit with their offer of Technical Bid, the requirement of water and power for normal functioning of the system at full load.

1.26 MAINTENANCE PROVISION

All the installation work including fixing of various components such as valves/controls etc will be done in proper manner providing adequate space/clearance to carry out their inspection/maintenance and removal easily as may be required at site.

1.27 WITNESSING THE TEST AT WORKS/ INSPECTING THE PRODUCT AT WORKS

a. Chilling Machine Performance Test

The contractor shall arrange and conduct performance test of the chilling machine at manufacturers' works under specified conditions of NIT. The representatives of BHEL shall witness the performance test at manufacturers' works and necessary provision for the same shall be made by the Contractor.

b. Other Equipments

Other equipments like AHUs, Hot Water Generator, Control Panels, Fire Dampers etc will be inspected by the representatives of BHEL to check the conformity of these equipments with tender specification, quality of work, thicknesses/sizes etc of various components, general functioning of the assembled equipment to ensure conformity with the performance/rating of the component.

The tenderer shall make necessary provision for the same and shall give adequate notice to enable BHEL to plan their visit for such tests/inspections including witnessing the performance test of chilling machine. Any delay on this account shall not entitle the contractor to get extension of time. The contractor, therefore, shall have to plan and mobilize all associated activities accordingly to ensure completion of work within the stipulated period of time.

1.28 COMPLETION SCHEDULE

Within two weeks after the award of work :

i. a The contractor shall submit to BHEL a detailed list of equipments and materials furnishing exact make of the equipment and material finally selected by him for the proposed system. The list should be complete and exhaustive covering all the equipments and material as specified under the "Approved Makes of Equipment / Material" in the tender. Such a list once furnished will be binding on the contractor and shall be adhered to by him without any change or modification in normal circumstances.

b. If such a list, complete and exhaustive, is not furnished by the contractor within two weeks after the award of work or the list furnished is partial or incomplete, ignoring the partial or incomplete list of the contractor. BHEL will prepare a complete and exhaustive list of the equipment and material of their choice in line with the "Approved Makes of Equipment / Material" given in the tender and the contractor shall adhere to the list prepared by BHEL and the same shall be binding on the contractor.

ii. The contractor shall furnish execution schedule for the work with necessary Bar Chart supported by CPM chart showing the delivery of various components / equipments included in the system. The completion schedule shall also show various stages of work including completion, testing, commissioning and handing over the system to BHEL in perfect working condition and the contractor shall ensure that the work is completed within the stipulated time of completion.

APPENDIX – I

GUARANTEE PROFORMA

GUARANTEE FOR HVAC INSTALLATION

We hereby guarantee the year round satisfactory functioning of the system which we have installed in the complex described below :

Building - **NEW PRODUCTION BLOCK BHEL- ESD**

Location - **ESD PREMISES BANGALORE**

for a period of one year from the date of acceptance of the installation, WE AGREE TO repair or replace to the satisfaction of BHEL, any or all such work that may prove defective in workmanship, equipment or materials within that period, ordinary wear and tear and unusual abuse or neglect excluded, together with any other work which may be damaged or displaced in so doing. In the event of our failure to comply with the above mentioned conditions within a reasonable time, after being notified in writing, we collectively and separately, do hereby authorize BHEL to proceed to have the defects repaired and made good at our expense, and we shall pay the cost and charges thereof immediately upon demand.

WE ALSO HEREBY UNDERTAKE to test the entire installation in first SUMMER AND MONSOON AND WINTER season following the completion of the installation, to check and do everything necessary to ensure that the specified indoor conditions in all seasons are maintained, that all water and air systems are properly balanced, that all controls are calibrated accurately, and that all units and system as a whole are functioning satisfactorily.

SIGNATURE OF CONTRACTOR
for HVAC INSTALLATION

DATE SEAL

2.0 HVAC SYSTEM

2.1 BASIS OF DESIGN

A year round environmental control system has been designed for **New Production Block, ESD Premises, BHEL, Bangalore.** Cooling shall be provided with central water chilling machine and winter heating with Hot Water Generator. Same pumps will circulate chilled water during summer & monsoon and hot water during winter. The system will have provision for bypassing chilling unit while circulating hot water for winter heating.

2.2 THE SYSTEM

The HVAC system will comprise AIR COOLED water chilling machines, water pumpsmain AC control panel, Mini BMS, hot water generators all installed on ground floor, AHUs, pipes & valves and ducting including grilles / diffusers. All floor mounted AHUs will be provided with fire dampers.

2.3 FIRE SAFETY

All AHUs will be provided with smoke sensing electrically actuated fire dampers. If required, indication for various dampers may be displayed on the central fire panel, by extending control / signal cables from fire damper p anel to the central fire panel. In case of fire/smoke, the dampers will close stopping the air supply and simultaneously put off AHU fan.

AHUs will be of double skin construction to contain noise/vibration. AHU rooms, if so specified in BOQ, will also be provided with acoustic treatment.

2.4 DESIGN DATA FOR SITE AMBIENT AND INDOORS

a. **Outdoor** design conditions are as given below :

Seasons	**Temp:DB**		**Temp:WB**	
	˚C	**˚F**	**˚C**	**˚F**
Summer	**35.6**	**96**	**25.6**	**78**
Monsoon	**27.8**	**82**	**25.6**	**78**
Winter	**14.4**	**58**	**12.2**	**54**

b. **Indoor** design conditions shall be as under :

Description	**Temp:DB**		**RH:%**
	˚C	**˚F**	
Summer & Monsoon	**23±2**	**73±4**	**Not to exceed 60%**
Winter	**23±2**	**73±4**	**Not to exceed 40%**

2.5 DESIGN PARAMETERS OR EQUIPMENT SYSTEM

a. CHILLING UNIT

Performance rating of the Chilling Unit shall be based on the following design parameters:

Temperature of chilled water entering chiller	: 12.2 Deg. C (54 Deg. F)
Temperature of chilled water leaving chiller	: 6.7 Deg. C (44 Deg. F)
Fouling factor for chiller: a. FPS Unit	: 0.0005
b. Metric unit	: 0.0001

b. AIR HANDLING UNITS

Design parameters for selection of Air Handling Units and its components shall be :

Maximum face velocity across Pre filters	: 155 M/min.
Fine filters	: 80 M/min.
HEPA filters	: 80 M/min.
ULPA filters	: 27 M/min.
Maximum face velocity across cooling coils	: 155 M/min.
Maximum fan outlet velocity	: 550 M/min.

c. PIPING

Piping shall be sized for the following design parameters :

Maximum flow velocity	: 2.5 M/sec.
Maximum friction	: 5 meter of water per 100 meter run.

d. DUCTING

Design parameters for Duct Design shall be :

Maximum flow velocity	: 450 M/min.
Maximum friction	: 1 cm WG/100 M run
Maximum velocity at supply air outlet	: 155 M/min.

2.6 AIR CONDITIONING LOAD

S.N	Space	Area(SFT)	Ceiling Ht	Load (TR)	Air Qty (CFM)
i	Assembly area	19160	20'-0"	105	29000 x 2 AHUs
ii	Testing Area	16320	20'-0"	90	26000 x 2 AHUs
	Total	35480		195	110000 CFM

Type of Chilling Machine : Air Cooled

Chilling Machine Selection and Configuration :

Normally derating of Air-cooled chilling machines is inevitable particularly during peak load periods. To offset such conditions a provision of 5% safety is made. Accordingly, chilling machines with following capacities and configuration are selected :

For Assembly Area : 220 TR x 1 no. (with twin compressor) Air Cooled
(50% working + 50% standby, two independent circuits)

For Testing Area : 190 TR x 1 no. (with twin compressor) Air Cooled
(50% working + 50% standby, two independent circuits)

3.0 AIR COOLED SCREW PACKAGE CHILLING MACHINE

3.1 SCOPE

The scope of this section comprises design, supply , erection, testing and commissioning of Air Cooled Screw Package Chilling Machines con forming to these specifications and in accordance with the requirement of drawings and Schedule of Quantities.

Supply, installation, testing and commissioning of Air Cooled Screw Water Chilling Machine each complete with following capacities with two and only two circuits of 50% capacity each to work independently, compressor, compressor-motor, air cooled condenser with fan and motor, automatic type soft starter/auto transformer starter/ closed transition star delta starter, air cooled condenser, factory insulated chiller, flow switches at chiller, vibration isolators, integral refrigerant piping with first charge of Refrigerant/lubricant and wiring, accessories as per specifications, automatic and safety controls mounted in a microprocessor based central console / control panel and all mounted on a steel frame. Motors shall be suitable for 415 ± 10% volts, 50 cycles, 3 phase AC supply.

The chilling machine will be with hermatic / semi-hermatic (but not open type) compressor working on R-134a refrigerant. The chilling machine will be factory assembled, factory charged with refrigerant /oil and factory tested for performance and ready for commissioning (use) after placing at foundation and connecting power supply and chilled water piping at site of installation without any addition / alteration or tinkering of the machine.

Starting current of compressor motor shall be as near the full load current as possible but it will not be more than 1.5 times full load current.

a. Chiller

Chilled Water IN 54 °F (12.2 °C)
Chilled Water OUT 44 °F (6.7 °C)
Fouling factor : 0.00025 FPS / 0.00005 MKS

3.2 TYPE

The chilling machine shall be with hermetic/semi hermetic type (and not open type) compressor, consisting of screw compressor, squirrel cage induction motor, starter, air cooled condenser with copper coil and aluminium fins, shell and copper tube chiller, refrigerant piping, microprocessor control, all mounted on a steel frame and control and power wiring / cabling.

3.3 ACTUAL CAPACITY

Actual refrigeration capacity of chilling machine shall be as shown on drawings and in schedule of quantities.

d. Standard / Quality	ARI / Eurovent Certified
e. Performance Test Bed	Works of manufacturer must be equipped with ARI / Eurovent approved full fledged and self-contained' performance test be for chilling machine without which the product (chilling machine) may not be accepted.

3.4 AIR COOLED PACKAGE CHILLER

The packaged air cooled liquid chiller will consist of accessible, hermetic/semi-hermetic, direct driven screw compressor with twin independent circuits, evaporator, condenser, microprocessor based control and a unit-mounted motor starter, refrigerant charged in the factory of manufacturer,

factory run-tested and rated in accordance with ARI 550-90 (updated) and ready for operation after providing power connection and chilled water connection at site of installation.

3.5 SCREW COMPRESSOR

The compressor will be screw (helical rotary) type design for positive displacement for use with ozone friendly refrigerant (R-134 a) conforming to prevailing International Standards.

The compressor will essentially consist of two inter meshing helical grooved rotors, a male rotor (the drive) and a female rotor enclosed in a stationary housing with suction and discharge ports.

During function, it will be pure rotary motion providing uniform gas flow, even torque and positive displacement to ensure vibration-free operation over a wide range of operating conditions. The compressor will generally have only three major moving parts : two rotor assemblies and the capacity controlling valve. Intake and discharge cycles will overlap effectively to produce a smooth and continuous flow of gas.

The rotor tip clearance will be optimized to reduce leakage between high an d low pressure cavities during compression and also to achieve high energy-efficiency to ensure that IKW/TR at part load is always less than IKW/TR at full load.

The capacity controlling device shall be arranged for unloaded start. Power consumption shall proportionately reduce with the stepping down of compressor capacity to as low as 25% of full load in direct response to refrigeration load changes.

3.6 COMPRESSOR MOTOR ASSEMBLY

The screw compressor will have, accessible hermetic direct drive motor with 2950 rpm (or as per manufacturer's design speed), working on 415V ± 10%, 3 phase, 50 Hz power supply, as normally available in India. The motor will be squirrel-cage two-pole induction type and will be suction-gas-cooled. Due consideration will be given while deciding the protection devices to take care of probable voltage fluctuations prevailing at site.

Rolling element bearing groups will be provided at each end of both rotors, separately housed, and pressure lubricated. The system will be provided with oil separator and filtration devices.

3.7 CONDENSER

Condenser coil shall be air cooled with integral sub-cooler constructed of aluminium fins mechanically bonded to seamless copper tubes which shall be then cleaned, dehydrated and sealed.

Condenser fans shall be direct driven propeller/axial type, with totally enclosed air over motor, having class 'F' insulation and IP 55 protection, discharging air vertically upwards and shall be equipped with the following features.

a. Permanently lubricated bearings.
b. Steel wire safety guards duly coated with PVC.
c. Statically and dynamically balanced fan blades.

Air cooled condenser coil shall be leak tested at 150 psig (1034kPa) and pressure tested at 450 psig (3103 kPa).

3.8 CHILLER (COOLER)

Chillers shall be direct-expansion/flooded type comprising mild steel shell, integrally finned copper tubes rolled into tube sheets, cast iron water headers, liquid line connection, suction header, drain plug and purge valves.

Shell and tube type chillers shall have the following components :

a. Shell and Water Boxes

The chiller shell shall be formed of carbon steel, provided with cast iron water boxes having standard flange type connections suitable for 10 KG. per sq. cm (150 psig) working and 21 KG/sq. cm (300 PSIG) test pressure. Necessary test certificate shall be submitted. Water boxes shall be provided with drain connections and shall be easily openable for tube cleaning. Suitable tappings shall be provided in the water boxes/water lines for temperature control bulb and gages.

b. Tube Sheets

A thick steel tube sheet shall be welded to each end of the shell and shall be drilled and reamed to accommodate tubes. Annular grooves in the tube sheets shall prevent leakage at the tube sheet bond. Tube support sheets shall be placed along the length of the shell to avoid relative motion between the tubes.

c. Tubes

12.5 to 19 mm dia. seamless copper tubing, not less than 24G wall thickness, shall be used for evaporator surface. Tubes shall be rolled into the tube sheets and shall pass through intermediate supports so that the refrigerant side of the evaporator shall be leak free and there shall be no relative motion between tubes and tube supports. Each tube shall be individually replaceable.

d. Insulation

The chiller shell shall be factory covered with expanded polystyrene in multiple layer of thermal insulation with vapour barrier as per the section "Insulation" or as per construction details of manufacturer. Suction line of refrigerant circuit piping shall also be provided with thermal insulation with aluminum cladding.

Salient features of the Chiller will be as briefed below :

a. It will be shell-and-tube type with removable heads.

b. Tubes shall be internally enhanced seamless-copper type rolled into tube sheets.

c. It will be equipped with victualic-type fluid connections.

d. Shell shall be insulated with PVC foam (closed-cell) with a maximum K factor of 0.28.

e. Design shall incorporate 2 independent direct expansion refrigerant circuits.

f. Cooler (Chiller) shall be tested and stamped in accordance with ASME Code for a refrigerant working side pressure of 278 psig (1916 kPa). Cooler shall have a maximum fluid-side pressure of 300 psig (2068 kPa).

3.9 REFRIGERANT PIPING AND COMPONENTS

Refrigerant piping and fittings inter connecting compressor, condenser and chiller shall be all copper and valves shall be brass/gun metal construction as explained in section 'PIPING'.

Refrigerant circuit components shall include hot gas muffler, high side pressure switch, liquid line shut off valves, suction and discharge shut off valves, filter drier moisture-indicating sight glass, stepper motor actuated electronic expansion valve or thermostatic expansion valve, and complete operating charge of refrigerant and compressor oil.

3.10 UNIT CABINET

Salient features of the Cabinet will be :

a. Frame shall be of heavy-gage galvanized steel members.

b. Cabinet shall be galvanized steel casing with a pre-painted finish.

c. Cabinet shall be capable of withstanding 500-hour salt spray test in accordance with the ASTM B-117 standard.

d. The assembly shall be installed outdoor and should, therefore, have adequate weather protection/resistance

3.11 CONTROLS

a. Unit Control Module

The unit shall be provided with microprocessor control system for air-cooled Rotary chiller with latest chiller control technology. It shall have control logic with the Clear Language Display which will have various functions that allow the operator to read unit information and adjust set-points. The Clear Language Display panel will have sufficient keys (normally 16 nos.). The read-out screen shall be a two-line, 40 character liquid crystal with a backlight. The backlight shall allow the operator to read the display in low-light conditions.

b. Unit Control Module Features

Equal Compressor Sequencing

The control system shall maximize both compressor and motor life by equalizing the number of starts and the operating hours. The UCM will start the compressor with theleast number of starts and turn off the compressor with the most operating hours, equalizing starts and running hours. This will provide equal compressor wear to various units.

Chiller Flow Protection

The in-built protection will automatically detect a no water flow condition.

c. Chiller System Logging

The UCM will display data required to log the chiller system. The following information will be available as standard feature with the Air-Cooled Rotary Chiller microprocessor.

- Entering and leaving chilled water temperatures.
- Ambient air temperature
- Evaporator and condenser refrigerant temperatures and pressures.
- Compressor suction temperature
- Percent RLA for each compressor
- Percent line voltage
- Compressor starts and running hours
- Active set-points :
  chilled water set-point
  current limit set-point
  low ambient lockout set-point
- Over 90 diagnostic and operating conditions
- Part failure diagnostics :
  Water temperature sensors
  Refrigerant temperature sensor
  Compressor contactors

d. Remote Display Panel

The system shall be provided with a twisted pair connection to an optional remote display panel. With this provision it will be possible to control chiller operation from the remote panel similar to the control interface on the chiller itself, and it will be possible to turn 'On' or 'Off', change the chilled water set-point, and display all operating and diagnostic conditions from this panel. The remote display panel shall be mounted indoors so that it can be accessed without the need to go to the chillers plant room/site.

Remote clear language display will have the ability to control multiple units. In the multiple unit configuration, the Remote Clear Language Display Panel will have the capability to communicate with up to four units. Each unit will require a separate communication link with the Remote Display Panel.

e. Interface To The Building Management System

The system should have provisions and facility for interfacing the chiller with building management systems :

Chiller inputs will include :
- Chiller enable/disable
- Circuit enable/disable
- Chilled water set-point
- Current limit set-point

Chiller outputs will include :
- Compressor running indication
- Alarm indication (for each circuit)
- Maximum capacity

f. Chiller Plant Manager (OPTIONAL)

The Chiller Plant Manager Building Management System will be optional and will provide building automation and energy management functions through stand-alone control. The Chiller Plant Manager should be capable of monitoring and controlling entire chiller plant system. The price for this, however, will be quoted separately.

3.12 INSTALLATION

The chilling machine shall be installed over a cement concrete platform on flooring and shall be adequately isolated as per manufacturers recommendations against transmission of vibrations to the building structure. For open type units, special attention shall be paid to the alignment of the drive and driven shafts; final alignment shall be checked at site in presence of the executive-in charge of BHEL/Contractor using a dial indicator.

3.13 PAINTING

The water chilling machine shall be finished with durable enamel paint. Shop coats of paint that have become marred during shipment or erection, shall be cleared off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over adjoining shop painted surface.

3.14 PERFORMANCE RATING

The unit shall be selected for the lowest operating noise level. Capacity ratings, and power consumption with operating points clearly indicated, shall be submitted and verified at the time of testing and commissioning of the installation. Capacity shall be ascertained by measurements of chilled water flow rate and temperature of chilled water IN and OUT of the chilling unit.

Power consumption shall be computed from measurements of incoming voltage and input current to the chilling machine.

Performance test, however, at works will be given by the manufacturer furnishing computer printouts containing full details of technical parameters required to establish actual capacity of the machine and power consumption i.e. IKW/TR at specified conditions of NIT.

A certificate confirming that chilling machine conforms to capacity and IKW/TR values, specified in the tender at conditions mentioned in the tender, will be issued and supplied by the OEM along with the delivery of the machine.

3.15 QUALITY ASSURANCE (AIR COOLED SCREW PACKAGE CHILLERS)

a. Chillers shall be rated in accordance with parameters stipulated in specifications and schedule of quantities. Pressure vessels shall be designed, constructed, tested, stamped and complete with safety devices in accordance with ANSI/ASHRAE 15-1989 Safety Code and ASME Code.

b. The Chiller shall be designed, manufactured and tested in accordance with the applicable portions of the latest revisions of the following recognized Standards and Codes.

ISOs :

ISO 9001:1994, Design manufacture and testing of
EN ISO 9001:1994, Water Chilling Package.
BS EN ISO 9001:1994

ARI 550-98 - Air Conditioning and Refrigeration Institute : Standard for (Latest Update) Water Chilling Packages (General Specifications, Testing and Rating)

ARI 575 - Air Conditioning and Refrigeration Institute : Standard Method of Measuring Machinery Sound Within Equipment Rooms (Basis of all data presented or field testing of equipment, with relation to sound requirements).

ASME CODE - American Society of Mechanical Engineers Code: For Unfired Pressure Vessels - Section VIII (Design, construction, testing and certification of pressure vessels).

ANSI-B9.1 - American National Standards Institute: Safety Code for Mechanical Refrigeration (Overall general safety requirements, relief device sizing etc.)

ANSI-B31.5 - American National Standards Institute: Code for Refrigerant Piping.

TEMA - Tubular Exchanger Manufacturer's Association.

ISO R 281 - Rolling Bearings-Dynamic Load Ratings and Rating Life.

c. Chilling Machine - Chilling machine shall be ARI/Eurovent certified and such a certificate from OEM shall be furnished along with the delivery of machine.

d. Specified IKW/TR - The Specified IKW/TR for the chilling machine at full load at specified site conditions is:

For 190 TR to 220 TR Machine : 1.30 (One point three zero) or less, but not to exceed 1.30. (i.e. Zero upward tolerance)

Whereas, no credit will be given for downward variation of IKW/TR, any upward variation beyond the specified value will be suitably accounted for during evaluation of offer of tenderer and/or at the time of accepting the delivery of machine, on the basis of full load IKW/TR for 2000 hrs of operation per year for

20 years of operation depending upon life span of machine as specified by the Original Equipment Manufacturer (OEM) and at the prevailing tariff for energy consumption in the location of installation of machine.

3.16 CATALOGUE FOR THE MACHINE

The tenderer will submit alongwith his offer technical literature /catalogue of the machine proposed to be offered by him substantiating the capacity and power consumption (IKW/TR) of the machine. These should be the printed catalogue of the OEM. He should also furnish the computer printout from the OEM for selection of the machine and also his (OEM's) confirmation that it (machine) conforms to specifications of the tender.

4.0 PERFORMANCE TESTS

4.1 TESTING OF CHILLING MACHINE AT WORKS

Following tests shall be conducted at works of the OEM at the specified conditions of the tender to demonstrate and establish actual values for chilling machine capacity and power consumption. All instruments/ accessories/ tools /plants /consumables / labour /materials etc required for the tests and necessary provisions to facilitate recording of reading s of various parameters, will be made/provided by the Contractor /OEM without any additional cost to the BHEL.

4.2 CAPACITY TEST

Capacity of the chilling machine will be demonstrated to establish that it is in conformity with the value offered by tenderer/value finally accepted by BHEL during award of work. The Contractor / OEM may evolve methods to conduct th e test. Normally chilled water IN and OUT temperatures, condensing air IN and OUT temperatures and the rate of chilled water & condensing air flow under conditions specified in the tender should give the capacity of the plant. The chilled water and condensing air IN and OUT temperatures will be recorded and GPM of chilled water and condensing air in CFM noted for the ambient conditions specified in the tender and tonnage of the machine worked out accordingly. Five such readings will be taken and recorded.

4.3 POWER CONSUMPTION TEST

The contractor/OEM will demonstrate actual KW or IKW/TR for which the TR will be measured as explained at Sl No 6.3.2 above and power consumption worked out on the basis of amperes and voltage recorded during this TR. Actual power consumed or Input KW divided by total tonnage produced will give the required value of IKW per TR. This will be compared with the value offered by the Contractor/accepted by BHEL, and deviations, if any, suitably accounted for.

4.4 SUMMER, MONSOON AND WINTER TESTS (System performance Tests) AT SITE

The performance of the sy stem will be checked/tested during Summer, Monsoon and Winter immediately following the commissioning of the Plant by running the plant round the clock or normal working hours of the office as may be required by the BHEL for 7 (seven) days for each season. This will include :

a. Observing chilled water/hot water temperature in plant room, at AHU/FCU and indoor conditions (temperature : DB and WB) for various spaces hourly and also recording ambient conditions simultaneously. Making necessary adjustments in water flow and airflow, if required, and balancing the system. The indoor conditions recorded should match with the design conditions specified in the tender.

b. Measuring CFM (air quantity), supply as well as return, for each AHU/FCU and balancing the air distribution if requ ired. Measuring the CFM at each grille/diffuser and comparing the same with design values specified in the tender/shop drawing.

c. Measuring necessary parameters like hot water IN and OUT along with GPM and power consumption for each hot water generator to establish its capacity, which should be in conformity with value specified in the tender/accepted by BHEL. (This will be conducted during winter.)

4.5 PERFORMANCE TEST OF CHILLING MACHINE AT MANUFACTURER'S WORKS

A three point (100, 75 50 & 25 percent capacity) performance test of the chilling machine shall be conducted at works of the manufacturer to establish and confirm that capacity and power consumption are in conformity with the values specified in the tender/contract and a certificate to this effect issued by the manufacturer with counter signatures of representatives of BHEL who shall witness the test at manufacturer's works before shipment of machine.

4.6 WITNESSING THE PERFORMANCE TEST OF CHILLING MACHINE AT WORKS

The contractor shall arrange and conduct performance test of the chilling machines at manufacturer's works under specified conditions of Tender. The representatives of BHEL shall witness the performance test at manufacturer's works and necessary provision for the same shall be made by the Contractor. However witnessing the performance of the chilling machine at works will be at the discretion of BHEL

4.7 OTHER EQUIPMENTS: INSPECTING THE PRODUCT AT WORKS

Other equipments like AHUs, Control Panels, Fire Dampers etc will be inspected by the BHEL's representatives to check the conformity of performance / rating of these equipments with tender specification. Quality of work, thickness/sizes etc of various components, general functioning of the assembled equipment will also be checked to ensure conformity with the performance/rating of the component.

The tenderer shall make necessary provision for the same and shall give adequate notice to enable BHEL to plan their visit for such tests/inspections including witnessing the performance test of chilling machine. Any delay on this account shall not entitle the contractor to get extension of time. The contractor, therefore, shall have to plan and mobilize all associated activities accordingly to ensure completion of work within the stipulated period of time.

4.8 TEST RESULTS

Normally the values of chilling machine capacity (TR) and power consumption (KW or IKW/TR), as established at Manufacturer's Works during the performance test conform to values as specified in the tender / finally accepted offer of the tenderer. However, in event of any deviations following steps will be taken :

i. Capacity of Plant (Chilling Machine)

a. If the capacity of the chilling machine, thus established by the test, is equal (with marginal variation upto not more than ± 3%) to the capacity specified in the tender / contract agreement, the chilling machine capacity will be considered acceptable.

If the capacity of the chilling machine, thus established by the test, is short by more than 3% accepting/rejecting chilling machine will be at the discretion of BHEL

ii. Power Consumption

For technical evaluation of the Machine, both the values, i.e. total power consumption per package of chilling machine and IKW/TR, will be reviewed and considered.

a. If the total power consumption and IKW/TR, thus established by test, are as per the values quoted by the Contractor/finally accepted by BHEL with marginal variation of not more than ±3%, these will be considered to be in conformity with the tender specifications.

a. For any upward deviation in total power consumption and/or IKW/TR more than 3% accepting/rejecting chilling machine will be at the discretion of BHEL

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iii. **System Performance**

Any deficiency noticed during Summer/Monsoon/Winter tests will be rectified by the Contractor and system corrected to give the specified performance, without any additional cost to the BHEL.

5.0 PUMPS

5.1 SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of water pumps conforming to these Specifications and in accordance with requirements of Bill of Quantities and drawings.

Supply, installation, testing & commissioning of Centrifugal split casing pumps factory mounted on a common base with electric motor for re-circulation of water for the central air conditioning system. All pumps shall be aligned.

The pump motor shall be suitable for 415 ± 10%Volts, 50 cycles, 3 phase power supply. The quoted price shall include cost of insulation and plastering for chilled/hot water pump. Pump performance characteristics shall be as follows :

Split casing pump for Chilled/Hot water for central air conditioning systems as per specifications given below :

Water flow rate = 285 USGPM (1079 LPM)
Head = 66 Ft (20 Mtr) of water
Motor HP = 10

Water flow rate = 330 USGPM (1249 LPM)
Head = 66 Ft (20 Mtr) of water
Motor HP = 10

5.2 TYPE

The type and size of all chilled water, hot water and condensate drain pumps for air conditioning applications shall be in accordance with requirement of Drawings and Bill of Quantities.

5.3 CAPACITY

Water flow rates and head of the pumps shall be in accordance with the requirements of Bill of Quantities.

5.4 SPLIT CASING PUMPS

a. Pumps casing shall be close-grained cast iron of heavy section, horizontally split type making possible complete servicing of rotating parts without breaking piping or motor connections. Motor to pump connection shall be of the flexible coupling type. Suction passages shall be volute in form, promoting smooth entry to impeller and increased efficiency. Impeller shall be bronze or gunmetal, double suction, enclosed type, hydraulically balanced and passages smooth finished for minimum friction and maximum efficiency. Shaft shall be steel, protected by gunmetal sleeves extending through mechanical seals. The ends shall be supported in ball/journal bearings, grease lubricated, contained in easily removable housing. Pumps shall be fitted with an air valve; two grease lubricators, drain plug and water seal connections. Mechanical seal shall also be provided for the pumps.

b. Motor shall be totally enclosed fan-cooled, class-F insulation, of approved make as per section *"ELECTRICAL INSTALLATION"* . Motor shall be specially designed for quiet operation and its speed shall not exceed 1440 rpm. The motor rating shall be such as to ensure non-overloading of the motor throughout its capacity range. Motor shall be suitable for 415 ± 10% volts, 3 phase, 50 cycles AC, power supply.

c. Base shall be of a size suitable for the pump, motor and shall be constructed of cast iron or welded

steel. Flexible coupling shall be protected by a guard mounted on the common base.

d. Installation : The pump base shall be mounted on concrete bases with vibration isolator as shown on Approved-for-Construction shop drawings and as described under section *"Vibration Isolation"* .

5.5 MONOBLOCK PUMPS

a. Pump shall be monoblock end-suction design directly or thru coupling connected to motor. The pump casing shall be cast iron & impeller shall be bronze. Shaft sleeve shall be of gunmetal / bronze extending through mechanical seal. Mechanical seal shall be provided to prevent leakage of water.

b. Motor shall be of a size suitable for the pump and shall be TEFC. Motor shall be suitable for 415 ± 6% volts, 3 phase, 50 cycles AC power supply.

c. Installation : The pump shall be mounted on concrete bases with vibration isolators as shown on Approved-for-Construction Shop Drawings and as described under section *'Vibration Isolation'* .

5.6 LUBRICATION

Upon installation of the complete system and before testing, the pump shall be lubricated in strict accordance with the manufacturer's instructions.

5.7 P UMP ALIGNMENT

Split casing pumps, prior to testing shall be aligned with a dial indicator within 0.05mm. Monoblock pumps shall be factory aligned with motor on common base, and need not be realigned at site.

5.8 PAINTING

All pumps, motor and bases shall be supplied with approved finish. Shop coat of paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the adjoining areas.

5.9 PERFORMANCE DATA

Pump performance curves and power consumption with operating points clearly indicated shall be submitted at the time of Technical Bid and verified at the time of testing and commissioning of the installation.

5.10 PUMPS FOR CHILLED/HOT WATER CIRCULATION:

The pumps for chilled water circulation shall also be suitable for hot water circulation during winters for winter heating.

5.11 TESTING

Pump performance shall be computed from the pump curves provided by manufacturer. .

6.0 DOUBLE SKIN AIR HANDLING UNITS (AHUs)

6.1 SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of double skin construction Air Handling Units, conforming to these Specifications and in accordance with requirements of drawings and of the Schedule of Quantities.

Supply, installation, testing and commissioning of double skin draw thru Air handling units for recirculation system. Each AHU shall comprise following sections accessories :

i. Pre-filter section with Pre-filter.

ii. Fan section, housing with blower, motor and drive.

iii. Cooling coil section with 4 row cooling coil

Coil size shall be selected for 150 M/minute velocity. Motor shall be suitable for 415 ± 10% volts, 50 Hz 3 phase AC supply. Vibration isolation shall be as per specifications and as shown on the drawing.

The Air handling unit shall be complete in all respects including above components, except three way motorized valves. Cooling/ heating thermostats, smoke detectors/ sensors whose quantities are indicated separately in this schedule of quantities. The air moving capacities shall be as follows:

	S.Nof AHU	Air Qty CFM	SP(mm)	HP
i.	1	29000	50	20
ii.	2	29000	50	20
iii.	3	26000	50	15
iv.	4	26000	50	15

Pan Humidifier

Supply, installation, testing and commissioning of 22G stainless steel (SS) sheet pan humidifier (18" x12" x 14") with 9 KW electric heater, control / power wiring, humidistat with provision for necessary sensing actuation and control of preset level of Relative Humidity, necessary GI bracket for mounting the humidifier on wall and extending the pipe/duct from humidifier to the supply duct including 25 mm (1") GI pipe connection for make-up water complete with providing and fixing safety / control devices, float valve, isolating valve and thermal insulation etc.

Motorised Valves

Supply, installation, testing and commissioning of Three way motorized valves in chilled water lines at each AHU unit and Three way motorized valve at each Fan Coil Unit complete in all respects including wiring / connections etc. The valves shall be suitable for the following sizes of pipes :

i. 4" (100mm) dia pipes for AHUs
ii. 3" (80 mm) dia pipes for AHUs.

Thermostat

Supply, installation, testing and commissioning of thermostats for various Air Handling Units and Fan Coil Units including wiring and complete in all respects. Proportional cooling / heating thermostat at AHU.

a. Smoke Sensor

Supply, installation, testing & commissioning of smoke detectors / sensors at each AHU complete
with wiring and control / indication panel.

b. Electric Actuator

Electric actuator with necessary linkage to actuate fire dampers complete with required wiring and associated accessories.

6.2 TYPE

The air handling units shall be double skin construction, draw-thru type comprising various sections such as filter sections, Chilled / Hot water coil sections, humidification section, fan section with motor inside the AHU casing, fine filter plenum fabricated (wherever required), as per details given in drawings and Schedule of Quantities.

6.3 CAPACITY

The air handling capacities, maximum motor horse power and static pressure shall be as shown on Drawings and in Schedule of Quantities.

6.4 HOUSING/CASING

The housing/casing of the Air Handling Units shall be double skin construction. The frame work shall be of Extruded Aluminium hollow sections. All the frames shall be assembled using pressure die cast Aluminum/Nylon joints to make a sturdy, strong and self-supporting framework for various sections.

25 mm thick Double Skin Panels shall be made of 0.6 mm Pre-painted GSS / Pre-plastified / 0.5mm Alu zinc sheet on outside and 0.6 mm Galvanized sheet/ 0.5mm Alu Zinc sheet inside with CFC free PUF insulation injected in between having 38 kg per cubic metre density. These panels shall be screwed on to the framework with soft rubber gasket fixed in built-in groove of aluminum frame in between to make the joints airtight. The inner casing of cooling coil, however, shall be of Stainless Steel grade SS-304 not less than 18G. Water headers shall be of copper to connect all the tubes with MS adopter brazed with 42% silver brazing rods.

Framework for each section shall be jointed together with soft rubber gasket in between, to make the joints airtight. Suitable airtight access doors/panels with Nylon hinges and locks shall be provided for access to various sections for maintenance. The entire housing shall be mounted on Rolled Formed GSS / Extruded Aluminium channel framework having pressure die Cast Aluminum jointers. For TFA units with mixing box, the casing shall be in thermal break construction.

Condensate drain pan shall be fabricated from 18-gauge stainless steel sheet with all corners welded. It shall be provided with proper slope and insulated with 12mm thick closed cell polyethylene insulation.

All hardware used shall be of high quality galvanized steel.

6.5 MOTOR AND DRIVE

Fan motors shall be 415 ± 10% volts, 50 cycles, three phase, totally enclosed fan-cooled with IP-55 protection. Motors shall be especially designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fan shall be provided through belt-drive arrangement. Belts shall be of the oil-resistant type. Motor shall be mounted within AHU fan section and assembly provided with suitable vibration isolation.

6.6 FAN

The fan shall be forward / backward curved (as specified in BOQ), double inlet double width type. The wheel and housing shall be fabricated from heavy gauge galvanized steel. The fan impeller shall be mounted on a solid shaft supported to housing with Hot Dip Galvanized angle iron frame and heavy duty ball bearings. The fan shall be selected for a noise level less than 85 db (A). The impeller and fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 550 M/min. Fan housing with motor shall be mounted on a common extruded aluminum base mounted in side the air handling housing on anti-vibration mounts. The fan outlet shall be connected to casing with the help of fire retardant fabric as a flexible connection for anti-vibration.

6.7 COOLING/HEATING COILS

Chilled/hot water coils shall have 12.5mm to 15 mm dia tubes of minimum 0.4 / 0.5 mm thick wall with aluminium fins firmly bonded to copper tubes assembled in zinc coated steel frame. Face and surface areas shall be such as to ensure rated capacity from each unit and such that air velocity across each coil shall not exceed 150 meters per minute. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory-tested at 21 kg per sqm. air pressure under water. Tube shall be mechanically expanded for maximum thermal contact resistance with fins. Fin spacing shall be 11 to 13 fins per inch (4-5 fins per cm). Coils shall be provided with copper header.

6.8 FILTERS :

These specifications provide general description of filters covering pre-filter, fine filter and HEPA filters. Actual provision of filters shall be made on the basis of shop drawings and BOQ which furnish the exact requirement associated with the work. Each unit shall be provided with a factory assembled filter sections e.g. pre-filter, fine filter & HEPA filter as per drawings and BOQ. Each section shall be equipped with airtight access door. Whenever Fine / HEPA filters are required to be installed, unit shall be provided with factory fabricated plenum chamber in double skin construction as described above for casing specification.

i. PRE FILTERS

Pre filters shall be 50mm thick washable synthetic type multi-pleat air filters having 35-37 pleats per meter mesh on one side and aluminum mesh on other side, expanded aluminium mesh in aluminium frame. Filters face velocity shall not exceed 150 meters per minute. Filter shall fit so as to prevent by pass. Holding frames shall be provided for installing a number of filter cells in banks. These cells shall be held within the frames by sliding the cells between guiding channels. All the frame work for mounting filters shall be of galvanized steel sheet construction with necessary sealing arrangement.

ii. STAGES OF FILTRATION AND FILTER EFFICIENCY

There are three stages of filtering the supply air :

Stage-I : Will have Pre-filters having 95% efficiency down to 10 microns.
Stage-II : Will have intermediate filter or Fine filters having 99% efficiency down to 5 microns.
Stage-III : Will have HEPA filters having 99.97 efficiency down to 0.3 microns.

For all clean room applications, supply air will be filtered in three stages.
For normal comfort application, only Stage-I filtration will be required.

6.9 ACCESSORIES

Each Air Handling Unit shall be provided with auto air vent at high point in the cooling coil/chilled water pipe and drain plug in the bottom of the coil. In addition, the following accessories may be required at Air Handling Units, their detailed specifications are given in individual sections, & quantities separately identified in Bill of Quantities.

a. Motorized three way mixing valves located in chilled/hot water lines connecting to the coil. This valve shall be operated by the sensors and shall control the flow of chilled / hot water. See the section "Automatic Controls and Instruments" for detailed Specifications.

b. Temperature / RH sensor / cooling thermostats as per section "Automatic Controls and Instruments" shall be located in supply / return air stream as per requirement of BOQ and drawings.

c. Insulated butterfly valves, balancing valves, 'Y' strainer, union & condensate drain piping upto sump or floor drain in Air Handling Unit room, as described in section "Piping" .

d. Thermometers in brass thermo wells and pressure gauge (with Ball/ Gate valve) within gauge ports in chilled/hot water supply and return lines as per the section "Automatic Controls and Instruments" .

6.10 VIBRATION ISOLATORS

Vibration isolators shall be provided with all air handling units. Vibration isolators shall be as described under section *"Vibration Isolations"* .

6.11 FRESH AIR INTAKES

Extruded Aluminium construction duly anodized (20 microns and above) fresh air louver with bird screen and extruded construction dampers shall be provided in the clear openings in masonry walls of the Air Handling Unit rooms having at least one external wall. Louvers, damper, pre-filters, ducts and fresh air fan with speed regulator shall be provided as shown on drawings and in Schedule of Quantities. Fresh air dampers shall be of the interlocking, opposed blade louver type. Blades shall be made of Extruded Aluminium construction and shall be rattle-free. Dampers shall be similar to those specified in *"*Air Distribution*"* . Fresh air fans and fresh air intakes shall be as per the requirements of Schedule of Quantities.

6.12 HUMIDIFIER

Mounted on room wall or AHU wall, each unit will be equipped with Pan Type Humidifier (as specified in BOQ) located along the unit. The Pan Humidifier is an independent element as included in the BOQ but will be complementary to the performance of the AHU. The Pan type humidifier shall consist of water tank made of Galvanized Sheet Steel with stainless steel perforated cover. Electronic water level sensor will be interlocked with water heating element. The heating element shall work automatically with a humidistat. Spray type humidifier, if specified in BOQ will consists of spray header, nozzles, mounted inside the unit, with water tank and pump outside the unit in AHU room. The water spray pump shall work automatically with a humidistat. The water pump shall be made of non-corrosive material with water strainer before pump. Two-Bend PVC eliminator shall be provided after the spray to prevent water carry over to Fan Section.

6.13 SAFETY FEATURES

Each Air Handling Unit must have safety features as under:

a. The fan access door shall be equipped with micro-switch inter-locked with fan motor to enable switching of the fan motor automatically in the event of door opening.

b. The access door shall further have wire mesh screen as an added safety feature bolted on to the unit frame.

c. Fan and motor base shall be properly earthed from the factory.

d. All screws used for panel fixing and projecting inside the unit shall be covered with PVC caps to avoid human injury.

6.14 PAINTING

Shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with paint to match the finish over the adjoining shop painted surface.

6.15 PERFORMANCE DATA

Air handling unit shall be selected for the lowest operating noise level of the equipment. Fan performance rating and power consumption data, with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of the installation.

6.16 TESTING

Cooling / heating capacity of various Air Handling Unit models be computed from the measurements of air flow and dry and wet bulb temperatures of air entering and leaving the coil. Flow measurements shall be by an anemometer and temperature measurements by accurately calibrated mercury-in-glass thermometers. Computed results shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

6.17 CEILING SUSPENDED AHUs (CS-AHUs)

Ceiling suspended AHUs shall conform to same specification as described for double skin AHUs but these (Ceiling Suspended AHUs) will be smaller in size and dimension and will have coil section with coil, fan section with fan, filter section with pre-filter and other associated accessories required for satisfactory functioning of the Ceiling Suspended AHUs. These units will be ductable and the air handling capacities will be as shown in drawings / BOQ. Performance data and testing etc will be same as applicable to AHUs.

7.0 FANS

7.1 SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of centrifugal, in-line and propeller type fans and roof-mounted units conforming to these Specifications and in accordance with the requirement of Drawings and Bill of Quantities.

7.2 TYPE

Centrifugal, in line propeller fans and roof mounted units shall be of the type as indicated on Drawings and identified in Bill of Quantities.

7.3 CAPACITY

The air-moving capacity of fans shall be as shown on Drawings and in Bill of Quantities.

7.4 CENTRIFUGAL FANS

Centrifugal fans shall be DWDI construction, complete with access door, squirrel - cage induction motor, V-belt drive, belt guard and vibration isolators. Type, direction of discharge/ rotation, and motor position shall be as per the Approved-for-Construction shop drawings.

a. **Housing** shall be constructed of 14 gage sheet steel welded construction. It shall be rigidly reinforced and supported by structural angles. Split casing shall be provided on larger sizes of fans, however neoprene / packing should be provided throughout split joints to make it airtight. Entire fan casing & impellers shall be epoxy painted.

18 gauge galvanized wire mesh inlet guards of 5 cm sieves shall be provided on both inlets. Housing shall be provided with standard cleanout door with handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.

b. **Fan wheel** shall be backward-curved non-over loading type. Fan wheel and housing shall be statically and dynamically balanced. Fan outlet velocity shall not exceed 550 meters per minute and maximum fan speed shall be 1000 rpm.

c. **Shaft** shall be constructed of steel, turned, ground and polished.

d. **Bearings** shall be of the sleeve/ball-bearing type mounted directly on the fan housing. Bearings shall be designed especially for quiet operation and shall be of the self-aligning, oil/ grease pack pillow block type.

e. **Motor** shall be suitable for 415 ± 10% volts, 50 cycles, 3 phase AC power supply, squirrel-cage, totally enclosed, fan-cooled, provided with class B insulation, and of approved make, Motor shall be designed for quiet operation and motor speed shall not exceed 1440 rpm.

f. **Drive** to fan shall be provided through belt with adjustable motor leave and a standard belt guard. Belts shall be of the oil-resistant type.

g. **Vibration Isolation :** MS base shall be provided for both fan and motor, built as an integral part, and shall be mounted on a concrete foundation through vibration isolators - as described under section "Vibration Isolation" . The concrete foundation shall be at least 15 cm above the finished floor level, or as shown in approved-for-construction shop drawings.

7.5 PROPELLER FANS

Propeller fan shall be direct-driven, three or four blade type, mounted on a steel mounting plate with orifice ring.

a. **Mounting Plate** shall be of steel construction, square with streamlined venture inlet (reversed for supply applications) coated with baked enamel paint. Mounting plate shall be of standard size, constructed of 12 to 16 gauge sheet steel depending upon the fan size.

Orifice ring shall be correctly formed by shinning or stamping to provide easy passage of air without turbulence and to direct the air stream.

b. **Fan Blades** shall be constructed of aluminium or steel. Fan hub shall be of heavy welded steel construction with blades bolted to the hub. Fan blades and hub assembly shall be statically and dynamically balanced at the manufacturer's works.

c. **Shaft** shall be of steel, accurately ground and shall be of ample size for the load transmitted and shall not pass through first critical speed thru the full range of specified fan speeds.

d. **Motor** shall be standard easily replaceable) permanent split capacitor or shaded pole for small sizes, totally enclosed with pre-lubricated sleeve or ball bearings, designed for quiet operation with a maximum speed of 1000 rpm for fans 38 cm dia or larger and 1440 rpm for fans 31 cm dia and smaller. Motor for larger fans shall be suitable for 415 ± 6% volts, 50 cycles 3 phase power supply and for smaller fans shall be suitable for 220 ± 6% volts, 50 cycles single phase power supply. Motors shall be suitable for either horizontal or vertical services as indicated on Drawings and in Schedule of Quantities.

e. **Accessories :** The following accessories may be required and provided with propeller fans, as indicated in Schedule of Quantities.

i. Wire guard on inlet side and birdscreen at the outlet.
ii. Fixed louvers built into a steel frame.
iii. Regulators for controlling fan speed for single phase fan motors.

7.6 AXIAL FLOW FANS

Fans shall be complete with motor, motor mount, belt driven (or direct driven) and vibration isolation type, suspension arrangement as per approved shop drawings.

a. Casing : Casing shall be constructed of heavy gauge sheet steel. Fan casing, motor mount and straightening vane shall be of welded wheel construction. Motor mounting plate shall be minimum 20 mm thick and machined to receive motor flange.

An inspection door with handle and neoprene gasket shall be provided. Casing shall have flanged connection on both ends for ducted applications. Support brackets for ceiling suspension shall be welded to the casing for connection to hanger bolts. Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. Casing shall be bonderized, primed and finish coated with enamel paint.

b. Rotor : hub and blades shall be cast aluminium or cast steel construction, blades shall be die-formed aerofoil shaped for maximum efficiency and shall vary in twist and width from hub to tip to effect equal air distribution along the blade length. Fan blades mounting on the hub shall be statically and dynamically balanced. Extended grease leads for external lubrication shall be provided. The fan pitch control may be manually readjusted at site upon installation, for obtaining actual airflow values, as specified and quoted.

c. Motor : Motor shall be of approved make, squirrel-cage, totally-enclosed, fan cooled standard round frame, constant speed, continuous duty, single winding, suitable for 415 ± 10% volts, 50 cycles, 3 phase AC power supply, provided with class 'B' insulation. Motor name plate horsepower shall be exceed brake horse-power by a minimum of 10%. Motor shall be specially designed for quiet operation.

The speed of fans shall not exceed 1000 RPM for fans with impeller diameter above 450mm, and 1440 RPM for fans with impeller diameter 450mm and less. For lowest sound level, fan shall be selected for maximum efficiency or minimum horse-power. Motor conduit box shall be mounted on exterior of fan casing, and lead protected from the motor to the conduit box shall be protected from the air stream by enclosing in a flexible metal conduit.

d. Drive : to fan shall be provided through belt drive with adjustable motor sheave and standard sheet steel belt guard with vented front for heat dissipation. Belts shall be of oil-resistant type.

e. Vibration Isolation : The assembly of fan and motor shall be suspended from the ceiling by vibration isolation suspensions of rubber-in-shear type.

f. Accessories : The following accessories shall be provided with all fans :

i. Outlet cone for static pressure regain.

ii. Inlet Cone

Fan silencers may be provided where specifically called for in Schedule of Quantities.

Fans shall be factory assembled and shipped with all accessories.

7.7 ROOF MOUNTED FANS

Roof mounted fans shall be propeller type or centrifugal fans, direct driven or belt driven, complete with motor drive, and housing with weather-proof cowl.

a. Housing : shall be constructed of 16 gauge steel sheet. The housing shall have an adjustable flange to facilitate installation and shall be especially adapted to receive fan, motor, and drive. The housing shall have a low silhousette. For belt driven units, motor shall be installed in ventilated waterproof housing outside the air stream. The discharge cowl shall be hinged along one edge for easy access to motor and drive, for inspection and maintenance. The entire assembly shall be weatherproof and raised from the roof terrace sufficiently to prevent down flow of rainwater accumulated on the terrace. 18 gauge galvanized steel mesh bird screen of 6mm sleeves shall be provided on all discharge cowls around the outlet areas.

b. Fans : shall be backwardly inclined centrifugal wheel or propeller type as required, designed for maximum efficiency, minimum turbulence and quiet operation. Fan shall be statically and dynamically balanced.

c. Motor : shall be shaded pole, of split capacitor type with lubricated sleeve or ball bearings, designed for quiet operation. Bearings shall be designed for vertical mountings. Motor name-plate horse-power shall be such that the motor shall not be overloaded in the entire range of rated speed. Motor and fan assembly shall be easily removable. Motor power supply characteristic and maximum speed shall be as specified for propeller fans and as indicated in the Schedule of Quantities.

d. Fan bearings : shall be heavy duty, self aligning sleeve/ball bearings designed for thrust load and sealed for grease retention.

e. Backdraft Damper : Where called for in the Schedule of Quantities, roof-mounted fan shall be equipped with a rattle-free back draft damper to prevent air from re-entering the fan when fan is not in operation, thus sealing completely in closed position. Damper shall be chatter proof under all conditions.

f. Vibration Isolation : The motor and fan assembly shall be isolated from the base with Dunlop / Emerald vibration isolators.

7.8 PERFORMANCE DATA

All fans shall be selected for the lowest operating noise level. Capacity ratings, power consumption with operating points clearly indicated, shall be submitted with Technical Bid and verified at the time of testing and commissioning of the installation.

7.9 TESTING

Capacity of all fans shall be measured by an anemometer. Measured air flow capacities shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

8.0 PIPING

8.1 SCOPE

The scope of this section comprises the supply and laying of pipes, pipe fittings and valves, testing and balancing of all water and refrigerant piping required for the complete installation as shown on the Drawings. All piping inclusive of fittings and valves shall follow the applicable Indian Standards.

8.2 PIPE SIZES

Pipe sizes shall be as required for the individual fluid flows. Various pipe sizes have been indicated on the Drawings, these are for Contractor's guidance only and shall not relieve contractor of responsibility for providing smooth noiseless balanced circulation of fluids. This item will be executed if specified in BOQ.

8.3 FLUID PIPING

a. All process water, steam piping and all fittings shall be stainless steel (heavy class) confirming to relevant BIS codes. All welding shall be done by qualified welders and shall strictly conform to BIS code of practice for welding of stainless steel.

b. All chilled / hot water pipes upto 150mm dia and condensing water pipes above 50mm dia and all fittings shall be M.S Class 'C' (Heavy Class) conforming to relevant BIS Codes. All jointing in the pipe system shall generally be by welding, unless otherwise mentioned, or directed at site. All welding shall be done by qualified welders and shall strictly conform to BIS Code of practice for manual metal arc, welding of Mild Steel. Condensing water pipes upto 50mm dia shall be GI class 'C' with threaded joints.

Pipes upto 150 mm dia shall be 'C' class as per BIS 1239 Part-I. All pipes above 150mm dia shall be MS factory rolled. Factory rolled MS pipes shall have following wall thickness :

i. Above 150 and upto 400mm diameter = 6.35mm

ii. 450mm to 750mm diameter = 7.13mm

iii. Above 750mm diameter = 7.92mm

c. All pipes and their steel supports shall be thoroughly cleaned and given one primary coat of red oxide paint before being installed. All welded piping shall be subject to the approval at site.

d. Fittings shall be malleable casting of pressure rating suitable for the piping system. Fittings used on welded piping shall be of the weldable type.

e. 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.

f. **Valves :**

i. Wafer Type Butterfly Valves :

The body of the valve shall be of Cast Iron IS:210 FG 220. The disc shall be of SG Iron IS:1865 Gr 420, shaft stainless steel (AISI – 410).The valve seat shall be integrally moulded on the body. The valve shall be suitable for working pressure 2 of 16 Kg/cm .The valves upto 150 mm shall be with pressed steel clutch type lever and 200mm and above shall be work gear operated. The valves with ISI Marked (IS:13095:1991) should be preferred.

ii. Wafer Type Non-return Valves :

The non-return valve shall be wafer type, dual plate with Cast Iron body and flap shall be of SG Iron (IS:1865 Gr 420), seat shall be integrally moulded of nitrle / 2 EPDM, suitable for W.P. of 11 Kg/cm .

iii. Balancing Valves (Manual) :

The valve shall be of GM Casting upto 40mm with screwed ends. 50mm and above angular flanged type body. The valve should have pressure drop measuring facility on the flanges. The valves upto 125mm shall have digital hand wheel with least count of 0.1 turns and for sizes 150mm and above shall have least count of 0.5 turns. The valves shall have suitable locking facility at desired setting. The 2 valves shall be suitable for working pressure of 11 kg/cm .

The balancing shall be carried out with "ON Line" computerized balancing instrument for direct measurement and documentation of differential pressure and measurement of flow. The contractor must save all data at site and submit print out of the same for each valve balanced thus. The print out shall have the details such as Valve ID code, Valves Sizes, Design Flow, Number of turns, differential pressure and Actual Flow.

iv. Dynamic Balancing & Flow Control Valves (2-in-one)

1. Pressure Independent Dynamic Control Valve :

Valve shall be electronic, dynamic, modulating, 2-way, control device. Maximum flow setting shall be adjustable to 51 different settings within the range of the valve size. The valve shall balance the flow as well as control the flow in response to signal of the thermostat.

2. Valve Actuator :

Valve actuator housing shall be rated to IP44. Actuator shall be driven by 24 VDC motor, and shall accept 2-10 VDC, 4-20 mA, 3-point floating or pulse width modulation electric signal and shall include resistor to facilitate any of these signals. Actuator shall be capable of providing 4-20 mA or 2-10 VDC feedback signal to control system. Optional fail safe system to power valve to either open or closed position from any position in case of power failure shall also be included.

Extended LED read – out of current valve position and maximum valve position setting shall be standard.

3. Valve Housing :

Housing shall be Ductile Iron, ASTM A536-65T, Class 60-45-18 rated 4000 kPa static pressure/Forged brass ASTM B584 rated 2500 kPa static pressure and 120 °C.

4. Flow Regulation Unit :

Flow regulation unit shall consist of 316 stainless steel and hydrogenated acrylonitrile butadiene rubber and shall be capable of controlling flow. Flow regulation unit shall be accessible, for maintenance.

Optional dual pressure / temperature test valves for verifying accuracy of flow performance shall be provided for all sizes of valves if so specified in BOQ.

Note : The tenderer shall provide manual or dynamic balancing valves as per description of material given in the BOQ.

Gate / Globe/ Butterfly valves conforming to the following specifications shall be provided as shown on Drawings :

Size	Construction	Ends	Type
a. 15 to 25 mm	Gun Metal	Screwed	Gate/Globe
b. 30 to 40 mm	Gun Metal	Flanged	Gate/Globe
c. 50mm and Over	Cast Iron body with Nitrile seat, SS Stem	Flange less Wafer Type	Butterfly : upto 150mm clutch lever and above Worm gear, 16kg/cm

Type and requirements shall be as indicated in Schedule of Quantities. Valves shall have non-rising spindles unless otherwise specified and shall be suitable for not less than 10 kg per sq.cm gage working pressure. Tail piece shall be used where required.

g. Flanges shall be of approved make. The supply of flanges shall also include supply of bolts and nuts and suitable asbestos fibre / rubber insertion gaskets (minimum 3 mm thick).

h. Non return (check) valves shall be provided as shown on the Drawings, conforming to relevant BIS Codes and in accordance with the following specifications :

Size	Construction	Ends
a. 15 to 25 mm	Gun Metal	Screwed
b. 30 to 40 mm	Gun Metal	Flanged
c. 50mm and Over	Cast Iron body with Nitrile seat.	Wafer Type

Air release and clean out plugs shall be provided and valves shall be suitable for not less than 10 kg per sq.cm gage working pressure.

j. Strainers shall be 'Y' type, or pot strainers as shown on the Drawings, with cast / MS bodies and permanent magnet designed for the test pressure specified for the gate valves. Y- Strainers shall have bronze/brass screen with 18-G (1.25 mm) thick 3 mm (16 nos. per sq.inch) perforations. Screen shall be removable and replaceable without disconnection of the main pipes. All strainers shall be provided with equal size isolating gate valves with non-rising spindles so that the strainer may be cleaned without draining the system. Strainers shall be provided on the inlet side of each air handling unit, at suction of each pump, and where shown on the Drawings. Pot strainers upto 100 mm dia pipes shall be fabricated out of 6 mm thick M S sheet, 125 to 300 mm dia pipes out of 8 mm thick and 350 to 600 mm out of 12 mm thick M S Sheet Basket for P S above 100 mm dia pipes shall be of 18 G (1.25 mm) thick stainless sheet having 3 mm perforator.

Pipe size (mm)	Pot Dia (mm)	Pot HT (mm)	Basket Dia (mm)	Basket HT (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
600	2000	2200	1500	1160
650	2100	2300	1550	1200

Basket shall be supported on brass disc mounted on solid blocks

k. All chilled water piping and fittings shall be pressure tested, then insulated and painted as described under the section "Insulation".

8.4 COLD WATER AND DRAIN PIPING

a. All pipes to be used for cold water (makeup) drain, condensate drain and fittings shall be galvanized steel class 'B' (medium class) conforming to relevant BIS Codes.

b. All jointing in the pipe system shall be by screwed/welded joints and / or by screwed flanges using 3 mm 3 ply rubber insertion gaskets. Pipe threads and flanges shall be as per relevant BIS Codes.

c. All pipes supports shall be galvanised mild steel.

d. Fittings shall be galvanized steel 'medium class' malleable casting of pressure rating suitable for the piping system. Flanges shall be of approved make. Supply of flanges shall include bolts, nuts, gaskets as required. Sufficient number of flanges and unions shall be provided for future cleaning and servicing of piping. Tee-off connection shall be through equal or reducing tees. All equipment and valve connections, or connections to any other mating pipes shall be through flanges required for the mating connections.

e. Gate valves, globe valves, check valves and strainers shall be similar to those specified for chilled, condensing and hot water piping.

f. All condensate drain piping shall be insulated as per the section "Insulation" if indicated in Schedule of Quantities.

g. After the piping has been installed, tested and run for atleast three days of eight hours each, all exposed and un-insulated piping shall be given two finish coats, 3 mils each of approved colour, conforming to relevant BIS Codes. The direction of flow of fluid in the pipes shall be visibly marked with identifying arrows for painting of insulated and clad pipes refer to insulation section.

8.5 REFRIGERANT PIPING

a. All refrigerant pipes and fittings shall be hard drawn copper tubes and wrought copper/brass fittings suitable for connections with silver solder, or the pipes and fittings shall be as per specs / standards of the manufacturer of the chilling machine.

b. All joints in copper piping shall be sweat joints using low temperature brazing and /or silver solder. Before jointing any copper pipe or fittings, its interiors shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while constructing the joints. Subsequently, it shall be thoroughly blown out using carbon dioxide/nitrogen.

c. Refrigerant lines shall be sized to limit pressure drop between evaporator and condensing unit to less than 0.2 kg. per sq. cm.

d. Removable type combination dryer cum filter with MS housing and brass wire mesh/punched brass sheet shall be installed in liquid line of the refrigeration system incorporating a three valve by pass. After ninety days of operation, liquid line drier cartridges shall be replaced.

e. Heat exchanger shall be of MS Class 'C' pipe in pipe type and without any welding joint in the inner pipe.

f. Horizontal suction line shall be pitched towards suction of the compressor for proper oil return.

g. After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using Freon mixed with nitrogen/carbon-di-oxide at a pressure of 20kg per sq.cm (high side) and 10 kg sq. cm. (low side). Pressure shall be maintained in the system for a minimum of 12 hours. The system shall then be evacuated to a minimum vacuum of 70 cm of mercury and held for 24 hours, during which time change in vacuum shall not exceed 12 cm of mercury. Vacuum shall be checked with a vacuum gage.

Note : All refrigerant piping shall be installed strictly as per the specifications, instructions and recommendations of OEM of chilling machine.

8.6 PIPING INSTALLATION

a. Tender Drawings indicate schematically the size and location of pipes. The Contractor, on award of the work, shall prepare detailed shop drawings, showing the cross- section, longitudinal sections, details of fittings, locations of isolating and control valves, drain and air valves, and all pipe supports. He must keep in view the specific openings in buildings and other structures through which pipes are designed to pass.

b. Piping shall be properly supported on, or suspended from, stands, clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchors, clamps and hangers and be responsible for their structural sufficiency. Vibration isolators shall be provided wherever required as per section "Vibration isolation".

All pipes in A/C plant room shall be supported with pipes and channels from floor only.

b. Pipe supports shall be of steel, adjustable for height and primer coated with red oxide paint and finish coated black. Where pipe and clamps are of dissimilar materials, a gasket shall be provided in between. Spacing of pipe supports shall not exceed the following :

Pipe size	Spacing between supports
Upto 12 mm	1.5 metre
15 to 25 mm	2.0 metre
30 to 150 mm	2.0 metre
150 mm to 300 mm	2.5 metre
Over 300 mm	3.0 metre

d. 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 slab by clamps or collars attached to pipe and with a 15 mm thick rubber pad or any resilient material. Where pipes pass through the terrace floor, suitable flashing shall be provided to prevent water leakage. Risers shall have a suitable clean out at the lower point and air vent at the highest point. This includes making holes / cutouts in slabs at all levels for providing chilled water pipes at no extra cost at locations shown in NIT drawings.

e. Pipe sleeves atleast 3 mm thick, 50 mm / 100 mm larger in diameter than condenser / chilled water pipes respectively shall be provided wherever pipes pass through wall and slabs. Annular space shall be filled with fibreglass and finished with retainer rings.

f. Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation. 20 gage (1.0 mm) thick metal sheet shall be provided between the insulation and the clamp, saddle or roller, extending atleast 15 cm both sides of the clamp, saddles or roller.

g. All piping work shall be carried out in workmen like manner, causing minimum disturbance to the existing services, buildings, roads and structure. The entire piping work shall be organized, in consultation with other agencies work, so that laying of pipe supports, pipes and pressure testing for each area shall be carried out in one stretch.

h. Cut-outs in the floor slabs for installing the various pipes are indicated in the Drawings. Contractor shall carefully examine the cutouts provided and clearly point out where the cut-outs shown in the Drawings do not meet with the requirements.

j. The Contractor shall make sure that the clamps, brackets, clamp saddles and hangers provided for pipe supports are adequate. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.

k. All pipes shall be accurately cut to the required size in accordance with relevant BIS Codes and burrs removed before laying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter. Where reducers are to be made in horizontal runs, eccentric reducers shall be used for the piping to drain freely. In other locations, concentric reducers may be used.

l. Flanged inspection pieces 1.5 meters long, with bolted flanges on both ends, shall be provided no more than 30 meters centres wherever shown in Approved-for- Construction shop drawings, to facilitate future cleaning of all welded pipes.

m. All buried pipes shall be cleaned and coated with zinc chromate primer and bitumen paint, then wrapped with three layers of fibreglass tissue, each layer laid in bitumen.

n. Insulated buried pipes shall be cleaned, derusted, then coated with rust-resistant primer.

Insulation shall be applied as per the section "Insulation", wrapped with GI wire and covered with polyethylene sheet and chicken wire mesh. Two coats (each 6 mm thick) of cement plaster shall be applied over chicken wire mesh lath. Buried insulated pipes shall be water-proofed using coat of Shalibond, or approved adhesive, over the plastered surface; wrapping one layer of fibreglass RP tissue and one layer of roofing tarfelt with sufficient overlaps, set and sealed with the adhesive, held in position by 16 gage GI wire tied at 15 cm intervals.

p. Purge valves shall be provided at all high points in the piping system for venting. Air valves shall be 15 mm pipe size valves with screwed joints.

Discharge from the air valves shall be piped through an equal sized mild steel or galvanized steel pipe to the nearest drain or sump. These pipes shall be pitched towards drain points.

8.7 PRESSURE GAGES AND THERMOMETERS

a. Pressure gages as specified under section "Automatic Controls and Instruments" shall be provided at the suction and discharge of pumps, chilled water supply and return at air handling units, at chillers and at condensers, as shown on the Drawings and included in Schedule of Quantities. Care shall be taken to protect pressure gages during pressure testing.

b. Thermometers as specified under section "Automatic Controls and Instruments" shall be provided at chilled water supply and return at air handling units, at chillers and at condensers, as shown on Drawings and included in Schedule of Quantities.

8.8 TESTING

a. All piping shall be tested to hydrostatic test pressure of at least two and half times the maximum operating pressure, but not less than 10 kg per sq.cm gage for a period of not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified and got approved at site.

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

c. System may be tested in sections and such sections shall be securely capped, then re-tested for entire system.

d. The Contractor shall give sufficient notice to all other agencies at site of his intention to test a section or sections of piping and all testing shall be witnessed and recorded by BHEL site representative.

e. The Contractor shall make sure that proper noiseless circulation of fluid is achieved through all coils and other heat exchange equipment in the system concerned. If proper circulation is not achieved due to air bound connection, the Contractor shall rectify the defective connections. He shall bear all expenses for carrying out the above rectifications including the tearing up and re-finishing of floors and walls as required.

f. The Contractor shall provide all materials, tools, equipment, instruments, services and labour required to perform the test and to remove water resulting from leakage and after testing.

8.9 BALANCING

a. After completion of the installation, all water system shall be adjusted and balanced to deliver the water quantities as specified / directed by Engineer-in-Charge.

b. Automatic control valves and two way diverting valves shall be set for full flow conditions during balance procedure. Water circuit shall be adjusted by balancing cocks provided for balancing; these shall be permanently marked after balancing is completed so that they can be restored to their correct positions, if disturbed.

c. Complete certified balancing report shall be submitted for evaluation and approval. Upon approval, four copies of the balancing report shall be submitted with the as-installed drawings and completion documents.

8.10 MEASUREMENT FOR PIPING

Unless otherwise specified, measurement for piping for the project shall be on the basis of centre line measurements described herewith.

a. Piping shall be measured in units of length along the centre line of installed pipes including all pipe fittings, flanges (with gaskets, nuts, and bolts for jointing), unions, bends, elbows, tees, concentric and / or eccentric reducers, inspection pieces, expansion loops etc. The above accessories shall be measured as part of piping length along the centre line of installed pipes, and no special multiples of pipe lengths for accessories shall be permitted.

b. The quoted rates for centre line linear measurements of piping shall include all wastage allowances, pipe supports including hangers, MS channel, wooden haunches, nuts, check nuts, vibration isolator suspension where specified or required, and any other item required to complete the piping installation as per the Specifications. None of these items will be separately measured or paid for.

c. However, all valves (gate/globe/check/balancing/purge/butterfly/drain etc.), strainers, thermometers, pressure gages shall be separately counted and paid for as per their individual unit rates. Piping measurements shall be taken before application of the insulation.

9.0 AIR DISTRIBUTION

9.1 SCOPE

The scope of this section comprises supply, fabrication, installation and testing of all sheet metal ducts, supply installation testing and balancing of all grilles and diffusers and supply and installation of aluminium sheet false ceiling/boxing in accordance with these specifications, BOQ and the general arrangement shown on the Drawings.

9.2 DUCT MATERIALS

All ducts shall be fabricated from galvanized steel sheets / aluminium sheets of the following thickness as indicated in Schedule/Bill of Quantities.

Larger side of Rectangle	G S S		ALUMINIUM		FLANGES
	Gauge	mm	Gauge	mm	
Rectangular ducts upto 75 cm	24	0.63	22	0.80	G S S
Rectangular ducts 76 to 150 cm	22	0.80	20	1.00	MS:25X25X3mm
Rectangular ducts 151 to 225 cm	20	1.00	18	1.25	MS:35X35X3mm
Rectangular ducts greater than 225 cm	18	1.25	16	1.60	MS:50X50X6mm

Sheet metal ducts shall be fabricated out of galvanized steel sheets conforming to relevant BIS Codes. Sheets used shall be produced by Hot Dip Process conforming to IS 277-1962 with latest amendment and galvanizing shall be Light Coating of zinc in the relevant 2 class, with nominal 120 gm / M of surface area. All GI sheets shall be checked before dispatch for hardness/ flexibility & water marks. After fabrication, if duct is found cracked or having water marks it shall be rejected.

Note : Tolerances in thickness as per BIS standards.

9.3 DUCT FABRICATION

All ducts shall be machine made thru Triplex lock former or Multiple lock former and shall be fabricated and installed in workmanlike manner, generally conforming to relevant BIS Codes IS 655-1963 with latest amendment. Round exposed ducts shall be die-formed for achieving perfect circle configuration.

a. Ducts so identified on the Drawings shall be acoustically lined with thermal insulation as described in the section "Insulation" and as indicated in Schedule of Quantities. Duct dimensions, shown on Drawings, are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in Schedule of Quantities.

b. Ducts shall be straight and smooth on the inside with neatly finished joints. All joints shall be made air tight/sealed with silicon sealant.

c. All exposed ducts upto 60 cm width within conditioned spaces shall have slip joints (no flanged joints). The internal ends of slip joints shall be in the direction of air flow. Ducts and accessories within ceiling spaces, visible from air conditioned areas shall be provided with two coats of mat black finish paint.

d. Changes in dimensions and shape of ducts shall be gradual. Air turns shall be installed in all vanes, arranged to permit the air to make the turn without appreciable turbulence.

e. Ducts shall be fabricated as per details shown on Drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees, or angles, of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing.

f. All sheet metal connection, partitions and plenums required to confine the flow of air to and through the filters and fans shall be constructed of 18 gauge GSS thoroughly stiffened with 25 mm x 25 mm x 3 mm angle iron braces and fitted with all necessary inspection doors as required, to give access to all parts of the apparatus. Doors shall be not less than 45 cm x 45 cm in size.

g. Plenums shall be panel type and assembled at site. Fixing of MS angle iron flanges on duct pieces shall be with rivets heads inside i.e. towards G S sheet and riveting shall be done from outside.

h. Rubber gasket 4 mm thick shall be used between duct flanges instead of soft rubber, in all ducting installation for complete sealing.

j. The thickness of all four sides shall be determined by the thickness required for the longest side of the duct.

k. The gauges, joints and bracings for sheet metal duct work shall conform to the approved shop drawing.

l. Ducts larger than 450 mm in width shall be cross broken.

m. Changes in section of duct work shall be affected by tapering the ducts with as long as taper as possible. All bracings shall be taken off at not more than 45° angle from the axis of the main duct unless otherwise approved by the Engineer.

n. All ducts shall be supported from the ceiling/slab by means of MS rods of 10mm dia, with MS angle size 40mm x 40mm x 6mm at the bottom for sizes upto 2250mm. Above size 2250mm supports shall be 12mm dia MS rod with MS angle size 50mm x 50mm x 6mm at the bottom.

p. The ducts for clean room shall be of aluminium construction with duct dampers and fire dampers and joints duly sealed by using sealing compounds.

q. No sound attenuaters shall be used in the clean room ducting since they have fibrous material as sound absorbing media. This fibrous sound absorbing media has high particle shedding properties.

r. All ducting used for clean room works shall have rubber gaskets, which shall be of soft quality and reasonable age.

s. All access doors for clean room applications shall be of bolted / hinged construction.

t. For clean room application, each duct piece shall be vacuum cleaned and blanked off at either end before suspending.

v. Since both the supply air and the return/exhaust air are to be ducted for the clean room works both these ducts should be insulated through the entire length inclusive of the AHU housing. Insulation of the AHU and ducts shall be carried out with non particle shedding and fire inhibiting material like TF quality expanded polystyrene covered with aluminium foil and joints duly sealed with PVC / aluminium tape.

w. The housing of the terminal mounted HEPA filters shall be such that no infiltration of dust is permitted. Also no air in the duct shall bypass the HEPA filters.

9.4 DUCT INSTALLATION

All ducts shall be installed generally as per tender Drawings and in strict accordance with approved shop drawings to be prepared by the Contractor.

a. The Contractor shall provide and neatly erect all sheet metal work as may be required to carry out the intent of these Specifications and Drawings. The work shall meet with the approval of Engineer or his site representative in all its parts and details.

b. All necessary allowances and provisions shall be made by the Contractor for beams, pipes, or other obstructions in the building, whether or not the same are shown on the Drawings. Where necessary to avoid beams or other structural work, plumbing or other pipes, and / or conduits, the ducts shall be transformed, divided or curved to one side, (the required area being maintained) all as per the site requirements.

c. If a duct cannot be run as shown on the Drawings, the Contractor shall install the duct between the required points by any path available, in accordance with other services and as per approval of Engineer or his site representatives.

d. All duct work shall be provided with adequate hangers or supports to ensure rigid support. The supports will also be provided with vibration isolators to prevent vibration. Hangers shall be in plumb and have provision for adjusting height with locking nut/washer arrangement. Spacing of duct supports shall not exceed 2.4 m centres.

e. Ducting over false ceiling shall be supported from the slab above, or from beams, after obtaining approval of Engineer site representative. In no case shall any duct be supported from false ceiling hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other Contractor's work on the building.

f. FOR BEAMS

Special care shall be taken while grouting the hanger on the beam to ensure that existing surface finish is retained. For fixing the hanger on the beam, the top of the hanger rod shall be welded to a sufficiently wide MS plate of square/rectangular or triangular shape and the plate shall be fixed along the side (not bottom) of the beam with dash fasteners. For each such support there shall be three dash fasteners located to form an equilateral triangle, two on the base line and the 3rd on the apex of the triangle.

FOR SLAB

Special care shall be taken while grouting the hanger in the slab to ensure that existing surface finish is retained. For grouting the support in the slab, strip will be welded to a rectangular sheet to form a 'T', dash fastener will be fixed on both sides of 'T' and the hanger will be welded on to the side of the 'T' section of the strip.

g. Where ducts pass through brick or partition wall within the opening and crossing ducts provided with heavy flanged collars on each side of angle iron frame work, so that duct crossing is made leak-proof.

h. All ducts shall be totally free from vibration under all conditions of operation. Whenever duct work is connected to fans, air handling units or blower coil units that may cause vibration in the ducts, ducts shall be provided with two flexible connections, located close to the unit, in mutually perpendicular directions. Flexible connections shall be constructed of fire retarding flexible duct at least 10 cm long securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting duct work rigidly held by independent supports on both ends. The flexible connection shall be suitable for static pressure specified for AHU at the point of installation.

j. All joints, tapping and seams in duct work shall be sealed to prevent air leakage. Sealant shall be fast setting or polysulphide or that remains flexible after drying.

k. The duct work shall be thoroughly cleaned of oils, grease, lubricants, dirt and dust upon the completion of fabrication.

l. During the construction, the contractor shall temporarily close duct openings with sheet metal covers to prevent debris from entering ducts and to maintain openings straight and square, as per direction of Engineer.

m. Great care shall be taken to ensure that the duct work does not extend outside and beyond height limits as noted on the drawings.

n. The ducts shall be reinforced where necessary, and must be so secured in place as to avoid vibration of the duct and its support.

p. All air turns of 45° or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration. All ducts shall be fabricated and installed in accordance with modern design practice. The sheet metal gauges and fabrication proceedings as given in IS specifications shall be adhered to and shall be considered as an integral part of these specifications.

q. The duct work shall be varied in shape and position to fit actual conditions at site. All changes shall be in accordance with accepted air conditioning duct design and subject to Engineer approval. Contractor shall notify the Engineer of any difficulty in carrying out his work before fabrication.

r. Flanges and supports are to be of black mild steel and are to be primer coated on all surfaces before erection and painted with aluminium paint thereafter. Accessories such as damper blades and access panels are to be of materials of appropriate thickness and finish similar to the adjacent ducting, as specified in BOQ.

s. Joints requiring bolting may be fixed by hexagonal nuts and bolts, stove bolts or buck bolts, rivets or closed center top rivets. Self tapping screws must not be used. All fixtures must have a permanently non-corrosive finish such as cadmium plating or galvanising as appropriate Spot Welds and bronze welds are to be coated on all surfaces with zinc rich paint, as approved by Engineer.

t. Flexible joints are to be fitted to the suction and delivery of all fans. The material is to be normally double heavy canvas confirming to fire retardant applications. On all circular spigots the flexible materials is to be screwed or clip band with adjustable screw or toggle fitting. For rectangular ducts, the material is to be flanged and bolted with a backing flat or bolted to mating flange with backing flat.

v. Flexible joints are to be not less than 75 mm and not more than 125mm between faces. Both ends of the ducts at such joints shall be provided with chicken wire mesh screen. The duct work should be carried out in a manner and such time as not to hinder or delay the work of other agencies especially boxing or false ceiling contractor.

9.5 DAMPERS

a. At the junction of each branch duct with main duct and split of main duct, GI volume dampers must be provided. Dampers shall be two gauge heavier than gauge of the large duct, and shall be rigid in construction to the passage of air.

b. Volume dampers shall be of an approved type lever operated and complete with locking devices, which will permit the dampers to be adjusted and locked in any positions.

c. The dampers shall be of splitter, butterfly or louver type. Damper blade shall not be less than 1.25mm (18 gauge) reinforced with 25mm angle 3mm thick along any unsupported side longer than 250mm. Angles shall neither interfere with the operation of dampers, nor cause any turbulence.

d. The damper shall be so fabricated as to avoid any leakage of air through the bearing space around damper leave rod.

e. Automatic and manual opposed blade dampers shall be complete with frames and bronze bearings. Dampers and frames shall be constructed of 1.6mm thick steel and blades shall not be over 225mm wide. Dampers for fresh air inlet shall additionally be with GI rain protection louvers with bird screen fixed on the air inlet side.

f. Wherever required for system balancing, provide a volume balancing opposed bladedamper with quadrant and thumb screw lock. Provide damper rod and damper block with upset screws.

g. After completion of the duct work, dampers are to be adjusted and set to deliver the required amounts of air as specified on the drawings.

h. Dampers shall be placed in ducts at every branch supply or return air duct connection, whether or not indicated on the drawings, for proper air-volume control and balancing of system.

9.6 ACCESS DOORS

All main duct work shall be accessible throughout using tight fitted hinged access doors. Doors shall be provided with neoprene rubber gaskets. Angle joints shall be provided with neoprene rubber gaskets for leak-tightness of the joints.

Access door/panels shall be provided at following places :

Near each smoke sensor.

Any other places specifically mentioned in the drawing or if envisaged by the Engineer-in-Charge during execution stage.

In case access doors are to be installed in the insulated ducts, the access door panel shall be double skin construction with insulation filled in, such that it can be operated without damaging the duct insulation.

9.7 FIRE & SMOKE DAMPERS

a. All supply and return air ducts at AHU room crossings and at all floor crossings shall be provided with approved make fire and smoke dampers of atleast 90 minutes fire rating as shown in drawing and included in schedule of quantities. These shall be multi-leaf fire dampers and provided with electrical actuator and electronic temperature sensor or smoke detector/sensor.

b. Fire damper blades and outer frames shall be of 16 G (1.6 mm) thick galvanised steel construction. The damper blade shall be pivoted on both ends using chrome-plated spindles in self-lubricated bronze bushes. Stop seals shall b e provided on top and bottom of the damper housing made of 16 G (1.6 mm) thick galvanized sheet steel. For preventing smoke leakage side metallic compression seals will be provided.

c. In normal position, damper blade shall be held in open position with the help of a 220 V operated electric actuators thereby providing normal air passage without creating any noise or chatter.

d. The electric actuator shall be energized either upon receiving a signal from smoke detector installed in AHU room / S.A. duct / R A duct o r temperature sensor. The fire damper shall also close upon sensing temperature rise in S A Ducts thru the electronic temperature sensor. Limit switch with Bakelite base shall be provided to stop fan motor.

e. Each fire damper shall be provided with its own control panel which shall incorporate necessary circuit required to step down voltage available from emergency system, to show status of the damper (open or close), to allow remote testing of damper and audible and visual alarm.

f. The Contractor shall also furnish to the Engineer, the necessary additional electrical actuating device (spare), if so recommended by the manufacturer, at the time of commissioning of the installation.

9.8 MISCELLANEOUS

a. All ducts above 450mm to be cross broken to provide rigidity to the ducts.

b. All duct work joints to be square or approaching square with all sharp edges removed.

c. Sponge rubber gaskets also to be provided behind the flange of all grilles.

d. Each shoot from the duct, leading to a grille, shall be provided with an air deflector to divert the air into the grille through the shoot.

e. Inspection doors measuring at least 450mm x 450mm are to be provided in each system at an appropriate location.

f. Diverting vanes must be provided at the bends exceeding 500mm and at branches connected into the main duct.

g. Proper hangers and supports should be provided to hold the duct rigidly to keep them straight to avoid vibrations. Additional supports to be provided where required for rigidity at no extra cost.

h. The duct should be routed directly with a minimum of directional change.

j. All duct supports, flanges, hangers and damper boxes etc shall be given 2 coats of red oxide paint before installation and one coat of aluminium paint after the erection at no extra cost .

k. All angle iron flanges are to be welded by electric arc welding and holes to be drilled.

l. All the angle iron flanges are to be connected to the GSS duct by rivets at 100mm centers.

m. All the flanged joints for the ducts to have 4mm thick felt packing stuck to the flanges with shellac varnish. The holes in the felt packing are to be burnt through.

n. The GSS duct should be tapped 6mm across the flanges.

p. The duct should be supported by approved type supports at a distance not exceeding 2.4m.

q. Sheet metal connection pieces, partitions and plenums required shall be constructed of 1.25mm (18 gauge), sheet thoroughly stiffened with 25mm x 25mm angle iron braces and fitted with access door.

r. Duct sections in general shall be provided with 16 gauge galvanised weld mesh with about 6mm center for rat protection in the supply air ducts at AHU/fan outlets, return air openings in AHU room and above return air slits in conditioned spaces at no extra cost.

9.9 SUPPLY AND RETURN AIR GRILLES

Supply & return grilles shall be of either mild steel or aluminium sections as specified in BOQ. Steel construction grilles shall have primer Coat finished and powder coated whereas extruded aluminium grilles shall be either Anodized or Powder Coated as given in BOQ. These grilles shall have individually adjustable louvers both horizontal and vertical. Supply air grilles shall be provided with key operated opposed blade MS volume control dampers painted in matt black shade with stove enamel paint. No MS grilles will, however, be used in air-conditioned areas.

The grilles shall be suitable for fixing arrangement having concealed or visible screws as approved by Engineer-in-Charge. Linear continuous supply cum return air grille shall be extruded Aluminium construction with fixed horizontal bars at 15 Deg. inclination & flange on both sides. The thickness of the fixed bar louvers shall be atleast 5.0 mm in front and 3.8 mm rounded edge in rear. Flange shall be 20mm-25mm wide as per standards of approved manufacturer. The grills shall be suitable for concealed fixing. Volume control dampers of MS painted with black stove enamel paint shall be provided in SA duct collars. For Fan Coil Units horizontal fixed bar grilles as described shall be provided with flanges on four sides and suitable for clip fixing.

a. All grilles shall be selected in consultation with the Engineer-in-Charge. Different spaces shall require horizontal or vertical face bars, and different width of margin frames. These shall be procured only after approval of the sample for each type of grille.

b. All grilles shall have a soft continuous rubber/foam gasket between the periphery of the register and the surface on which it has to be mounted. The effective area of the grilles shall not be less than 50 percent of gross face area.

c. Grilles shall be adjustable pattern as each grille bar shall be pivotable to provide pattern with 0 to ± 450 horizontal arc and upto 300 deflection downwards. Bars shall hold deflection settings under all conditions of velocity and pressure.

d. Bar longer than 45 cm shall be reinforced by set-back vertical members of approved thickness.

e. All volume control dampers shall be stove enamel painted in black color.

9.10 SUPPLY AND RETURN AIR DIFFUSERS

Supply and return air diffusers shall be as shown on the Drawings and indicated in Schedule of Quantities. Mild steel diffusers/dampers shall be factory powder coated with rust-resistant primer. Aluminium diffusers shall be powder coated & made from extruded aluminium section (as given in Schedule of Quantities).

a. Rectangular Diffusers shall be extruded aluminium construction, square & rectangular, diffusers with flush fixed pattern for different spaces shall be selected in consultation with the Engineer. Supply air diffusers may be equipped with fixed air distribution grids, removable key-operated

volume control dampers, and anti-smudge rings as required in specific applications, all as per requirements of schedule of Quantities. The extruded aluminium diffusers shall be provided with removable central core and concealed key operation for volume control damper.

b. Linear Diffuser shall be extruded aluminium construction with removable core one or two way blow linear diffusers. Supply air diffusers shall be provided with volume control/ balancing dampers within the supply air collar. Diffusers for different spaces shall be selected in consultation with the Engineer, and provided as per requirements of schedule of Quantities. All diffusers shall have volume control dampers of extruded aluminium construction anodized in matt black.

9.11 METALLIC FRAME

Supply and fixing of metallic frames for grilles and diffusers will be in the scope of ducting work.

9.12 MEASUREMENT FOR DUCTING

Unless otherwise specified, measurements for ducting for the project shall be on the basis of centre-line measurements described herewith.

a. Duct work shall be measured on the basis of external surface area of ducts. Duct measurements shall be taken before application of the insulation. The external surface area shall be calculated by measuring the perimeter comprising overall width and depth, including the corner joints, in the centre of each duct section, multiplying with the overall length from flange face to flange face of each duct section and adding up areas of all duct sections.

For tapered rectangular ducts, the average width and depth shall be considered for perimeter, whereas for tapered circular ducts, the diameter of the section midway between large and small diameters shall be adopted, the length of tapered duct section shall be the centre line distance between the flanges of the duct section.

For special pieces like bends, tees, reducers, branches and collars, mode of measurement shall be identical to that described above using the length along the centre line.

The quoted unit rate for external surface of ducts shall include all wastage allowances, flanges and gaskets for joints, nuts and bolts, hangers and angles and angle / flat with double nuts for supports, foam rubber between duct and support, vibration isolator suspension where specified or required, inspection chamber / access panel, splitter damper with quadrant and lever for position indication, turning vanes, straightening vanes, and all other accessories required to complete the duct installation as per the Specifications. These accessories shall NOT be separately measured nor paid for.

b. Special Items for Air Distribution shall be measured by the cross-section area perpendicular to air flow, as identified herewith :

i. Grilles : width multiplied by height, excluding flanges. Volume control dampers shall form part of the unit rate for grilles and shall not be separately accounted.

ii. Diffusers : cross section area for air flow at diffuser neck. Volume control dampers shall form part of unit rate for supply air diffusers and shall not be separately accounted.

iii. Linear Diffusers : shall be measured by cross-sectional areas and shall exclude flanges for mounting of linear diffusers. The supply air plenum forlinear diffusers shall be measured with ducting as described earlier.

iv. Fire Dampers : shall be measured by their cross sectional area perpendicular to the direction of air flow. Quoted rates shall include the necessary collars and flanges for mounting, inspection pieces with access door, solenoid valves etc. No special allowances

shall be payable for extension of cross section outside the air stream.

v. Flexible Connection : shall be measured by multiplying the periphery of duct by the straight distance between the two flanges of the ducts being jointed. Quoted rates shall include the necessary mounting arrangement, flanges, nuts and bolts and treated-for-fire requisite length of canvas cloth, and neoprene gasket.

9.13 TESTING AND BALANCING

After the installation of the entire air distribution system is completed in all respects, all ducts shall be tested for air leaks by visual inspection and smoke test. The entire air distribution system shall be balanced using an anemometer. Measured air quantities at fan discharge and at various outlets shall be identical to or less than 5 percent in excess of those specified and quoted. Branch duct adjustments shall be permanently marked after air balancing is completed so that these can be restored to their correct position if disturbed at any time. Complete air balance report shall be submitted for scrutiny and approval, and four copies of the approved balance report shall be provided with completion documents.

9.14 DESIGN PARAMETERS FOR DUCT

Design parameters for duct shall be :

a. Max. Flow velocity	**:** 450 M/min
b. Max. Friction	**:** 1 cm WG/100 M Run
c. Max. Velocity at supply air outlet	**:** 150 M/min

10.0 INSULATION

10.1 SCOPE

The scope of this section comprises supply and application of insulation conforming to these specifications. All insulation work shall be carried out by skilled workmen specially trained in this kind of work.

10.2a. MATERIAL

Insulation material shall be resin bonded fibre glass roll / sheet, TF (Treated for Fire) quality expanded polystyrene, chemically cross linked closed cell polyethylene FR-XPE Fire Retardant Grade or nitrile rubber as specified in BOQ. However, for air-conditioning application, following insulation materials shall be used unless otherwise expressed in BOQ. The method of applying the insulation may vary depending upon the type of insulating material specified. The method specified corresponding to the particular material should be followed.

SL. No.	Application	Material of Insulation	Density (Kg/ M)	`K' Value (Kcal/Hr/M/ C)	I.S./ B.S Code (Latest)
1	Thermal insulation of metallic duct for air distribution	Chemically Cross Linked Closed cell Polyethylene FR-XPE Fire Retardant grade / Nitrile Rubber	33±3	Not to exceed 0.029 at 23 °C mean temp.	BS2972/ 1989
2	Acoustic lining of duct, walls, ceiling etc.	Resin bonded glass wool slab or expanded polystyrene TF quality.	32	Not to exceed 0.028 at 10 °C mean temp.	IS8183
3	Chilled water pipes (circulating chilled / hot water)	Preformed pipe sections or slab / roll of chemically Cross Linked Closed Cell Polyethylene FR-XPE Fire Retardant grade / Nitrile Rubber	33±3	Not to exceed 0.029 at 23 °C mean temp.	BS2972/ 1989
4	Hot water pipes (circulating hot water only)	Polyurethane foam pre-moulded pipe sections for all sizes	32	Not to exceed 0.015 at 10 °C mean temp.	IS12436
5	Hot water generator	Resin bonded glass wool in the form of blanket of uniform thickness.	32	Not to exceed 0.028 at 10 °C mean temp.	IS8183
6	Double skin AHUs, out door packaged air-washers	Polyurethane molten foam injection / As per manufacturer of AHUs.	32	Not to exceed 0.001 at 10 °C mean temp.	IS12436
7	Pumps, chillers, expansion tank, pot strainer etc.	Chemically Cross Linked Closed Cell Polyethylene FR-XPE Fire Retardant grade/ Nitrile Rubber	33±3	Not to exceed 0.029 at 23 °C mean temp.	BS2972/ 1989
8	Pipe supports	Polyurethane foam (Molded Sections)	160	Not to exceed 0.04 at 10 °C mean temp.	IS 12438
9	Under deck/ over deck insulation	Chemically Cross Linked Closed cell Polyethylene FR-XPE Fire Retardant grade slabs / Nitrile Rubber	33±3	Not to exceed 0.029 at 23 °C mean temp.	BS2972/ 1989

Thickness of the insulation shall be as specified (in BOQ/ Drawing) for the individual application. Each lot of insulation material delivered at site shall be accompanied with manufacturer's test certificate for thermal conductivity values and density. Nitrile rubber wherever used as insulating material shall be provided with additional layer of vapour barrier in the form of polyethylene sheet or approved equivalent of adequate gauge / thickness.

Adhesive used for setting the insulation shall be :

i. Pidilite SR 998 for thermal / acoustic lining of ducts and chilled water pipes insulation and water based Fevicol for AHU room / Plant room acoustic lining and under deck insulation.

ii. Cold setting compound non-flammable, vapour proof adhesive, Shalimar CPRX compound, or approved equivalent cold setting compound.

iii. For insulating material having factory applied self-adhesive on one surface, no additional adhesive will be needed to be applied on the pipe / duct / equipment surface.

10.2b. Thickness of Insulating Material :

Insulation for Pipes : (*Material as specified in BOQ should be used.)

Insulating Material ↓ / **Pipe Size (mm) →**	**Thickness of Insulating Material(mm)***							
	10 to15	**20 to25**	**30 to65**	**80 to100**	**125 to150**	**200 to300**	**350 to500**	**above 500**
Polystyrene (TF Quality)	**25**	**50**	**50**	**50**	**75**	**75**	**100**	**125**
Chemically Cross Linked Closed Cell Polyethylene Fire Retardant Grade / Nitrile Rubber	**19**	**19**	**25**	**32**	**32**	**38**	**45**	**55**

Insulation for other equipments : (*Material as specified in BOQ should be used.)

Insulating Material	**Thickness of Insulating Material (mm)***				
	Water cooler	**Exp.Tank**	**Under-deck insulation**	**CHW Pump**	**CHW Pot Strainer**
Polystyrene (TF Quality)	**50**	**50**	**50**	**50**	**50**
Chemically Cross Linked Closed Cell Polyethylene Fire Retardant Grade / Nitrile Rubber	**19**	**19**	**25**	**As per size of pipe connection**	**As per size of pipe connection**

Insulation for Ducts : (*Material as specified in BOQ should be used.)

Insulating Material	Thickness of Insulating Material (mm)*		
	SA Duct in non-AC covered area	SA Duct in return path	SA Duct in open
Polystyrene (TF Quality)	**50**	**25**	**75**
Chemically Cross Linked Closed Cell Polyethylene Fire Retardant Grade / Nitrile Rubber	**25**	**12**	**38**

Note :

1. Thickness of insulation for condensate drain will be 50% of thickness of insulation for chilled water pipe (nearest standard size of thickness will be used).

2. One layer of insulation of specified thickness or two layers each of 50% (nearest higher size available) may be used ensuring proper sealing of longitudinal and transverse joints.

3. Outer surface of chemically cross linked closed cell polyethylene fire retardant grade insulating material may be in any of the following form as specified in BOQ :

i. Without lamination / coating.

ii. With lamination of :
   a. Metalized polyester foil.
   b. Pure aluminium foil.
   c. UV (Ultra Violet) barrier film.

10.3 PIPING INSULATION

All chilled and hot water, refrigerant, and condensate drain piping shall be insulated in the manner specified herein. Before applying insulation, all pipe work and fittings shall be brushed and cleaned, and dust, dirt, mortar and oil / grease removed and surface to be insulated kept dry. All MS and other pipes to be insulated shall be provided with two coats of cold setting adhesive compound for the insulating material without self-adhesive. The cold setting adhesive compound will not be required for insulating material having
one surface coated with adhesive. Insulating material shall then be applied.

Insulation shall be applied only after the piping system has been satisfactorily tested for leaks at 2.5 times the working pressure or at not less than 10 kg/sq.cm test pressure.

i. Pipes Running above Ground :

a. Insulation with Expended Polystyrene (TF Quality) :

Pre-moulded two halves of pipe sections shall be placed over the pipes, the longitudinal joints of these pipe sections shall be sealed with the adhesive compound. The traverse joints shall also be sealed with adhesive compound. The insulation shall be continuous over the entire run of piping, fittings and valves.

For sizes of pipes for which pre-moulded pipe sections of insulating material are normally not manufactured, wire cut slabs of the material will be used to insulate the pipe maintaining same method of sealing of joints.

All insulated pipes shall be covered with 2 layers of thick polythene sheet as vapour barrier. PVC straps at 400mm centre shall be used to hold the insulation & vapour barrier in position. Insulation for all pipes, running above ground in weather protected areas, shall be covered with 28 gauge (0.4 mm) aluminium sheet cladding in a neat & clean manner to achieve true surface. All longitudinal and transverse joints in the outer cladding shall have a minimum overlap of 50mm duly beaded and grooved and shall be sealed with approved quality of sealant. Use of screws for fastening may puncture vapour barrier, hence GI bands 0.5mm thick x 25mm wide shall be provided every 500mm to retain cladding in position.

b. Insulation With Chemically Cross Linked Closed Cell Polyethylene Fire Retardant Grade (FR-XPE) or Nitrile Rubber

• Pre-moulded Pipe Section :

The pipe surface shall be cleaned and adhesive applied on the pipe surface as explained above. The two halves of pipe section of insulating material will then be fixed on the pipe surface. It will then be uniformly pressed, preferably with a smooth roller, by clean hands or other means in such a way that the insulation sticks to the surface of the pipe with uniform pressure without leaving any gap or traces of air in-between.

• Roll of Insulating Material with Self-adhesive :

The pipe section shall be cleaned as explained above and then slab/roll of insulating material with self-adhesive on one surface shall be placed over the pipes after removing the adhesive protection-layer from the inner surface of insulation coming in contact with the pipe to be insulated. It will then be uniformly pressed, preferably with a smooth roller, by clean hands or other means in such a way that the insulation sticks to the surface of the pipe with uniform pressure without leaving any gap or traces of air in-between.

All longitudinal and transverse joints shall be sealed with a 50mm wide sealing tape of approved quality ensuring it provided full vapour barrier sealing. If the outer surface of insulation is provided with UV protection layer, the tape will also be with UV layer. PVC straps (25mm wide for pipes upto 150 mm dia and 50mm wide for pipes above 150 mm dia) at 400mm centre shall be used to securely hold the insulation & the tape in position. Tapes covering the circular joints shall be provided with PVC/Metallic straps of same width to properly hold the joint in position.

ii. Pipes Running Buried Underground :

a. Insulation with Expended Polystyrene (TF Quality) :

Insulated buried pipes shall be cleaned, derusted, then provided with two coats of rust-resistant primer. Insulation shall be applied as mentioned above, wrapped with GI wire and covered with polyethylene sheet and chicken wire mesh. Two coats (each 6 mm thick) of cement plaster shall be applied over chicken wire mesh lath. Buried insulated pipes shall be water- proofed using coat of Shalibond, or approved adhesive, over the plastered surface; wrapping one layer of fibreglass RP tissue and one layer of roofing tarfelt with sufficient overlaps, set and sealed with the adhesive, held in position by 16 gage G.I wire tied at 15 cm intervals or alternately spiral wrapped, maintaining a gap of 25cm between the bands, with 0.5mm thick and 25mm wide G.S. sheet.

b. Insulation With Chemically Cross Linked Closed Cell Polyethylene Fire Retardant Grade (FR-XPE) / Nitrile Rubber

Pipes shall be cleaned and de-rusted as explained above and then provided with two coats of rust-resistant primer. Insulation shall be applied as mentioned above, wrapped with two layers of bituminous gunny bag cloth/tarfelt. It will be further wrapped with two layers of thick polyethylene sheet and clamped with 50mm PVC/Metallic straps at 600mm centre. It will then be uniformly covered by loose earth from all sides and the trench thus dug

properly filled and uniformly rammed.

10.4 PUMP INSULATION

All chilled and hot water pumps shall be insulated with chemically cross linked closed cell polyethylene fire retardant grade or nitrile rubber in the manner specified herein. Thickness of insulation shall be same as specified for connecting suction / discharge pipes of the pump. The insulation shall be applied in the same way as for pipes and will be covered with polythene sheet, then wrapped with chicken wire mesh and finally provided with 1:3 ratio sand cement plaster giving a smooth surface finish. The pump will be insulated in two halves : lower volute and upper volute and the accessibility of nuts and bolts fastening both the volutes shall be properly maintained by providing plastered pockets around the nuts-bolts/studs. The pump insulation shall be considered as a part of pipe insulation.

10.5 SHELL INSULATION

The chiller shells shall be factory insulated in accordance with the manufacturer's instructions with a minimum of 75mm thick TF quality expanded polystyrene or 55mm thick Chemically Cross Linked Closed Cell Polyethylene Fire Retardant Grade (FR-XPE). If insulation is to be carried out at site, materials shall be cut and mitered to fit the contour of the vessel and banded in place with 15 mm wide galvanized steel bands on 30cm centres. Joints shall be pointed up with insulating compound. Joints shall be pointed up with insulating compound. Metal lath shall be applied over insulation, lacing edges, tightly together, then two coats of 10 mm each sand cement plaster shall be applied.
Removable heads shall be made of two sections (semi - circular) wooden frames to be made of two 50 mm x 50 mm Kail wood treated with solegnum so as to fit the chiller body properly. The frame shall be covered with 24 gage GI sheet. The inside of the frame shall be lined with 150 mm thick resin bonded fibreglass in polythene bags held in place with 20mm x 24 G GI wire matting covered with insulating cement. The heads should be such as to be able to remove them without damaging insulation. Removable head shall be required only in case of flooded chiller, DX chiller heads shall be plaster finished over insulation.

10.6 COLD WATER TANK AND EXPANSION TANK INSULATION

Cold water tank, and chilled water expansion tank shall be insulated as specified herein.

a. Insulation with Expended Polystyrene (TF Quality) :

The surface of the tank shall be thoroughly cleaned. Treated with solegnum wood battens 50 mm x 50 mm spaced not more than 60 cm centres shall be used on all sides of the tank to form a self-supporting frame work. The space within the battens shall be filled with 50mm thick TF Quality thermocole. The entire surface shall then be covered with 20mm x 24G GI chicken wire netting and 2 coats of 6mm thick sand cement plaster. All piping connections, gages, manholes and access doors etc. shall be left accessible through cutouts in the insulation. The insulation shall be covered totally with water proofing material.

b. Insulation With Chemically Cross Linked Closed Cell Polyethylene Fire Retardant Grade (FR-XPE) / Nitrile Rubber

The surface of the tank shall be thoroughly cleaned and then covered by 19mm thick cross linked closed cell polyethylene (FR-XPE) slab / roll with UV layer cut in convenient and suitable shape to properly and contiguously cover the entire surface to be insulated. All longitudinal and transverse joints shall be sealed with a 50mm wide sealing tape of approved quality ensuring it provided full vapour barrier sealing. The outer surface of insulation is provided with UV protection layer, the tape will also be with UV layer. 50mm PVC straps at 400mm centre shall be used to securely hold the insulation & the tape in position. Tapes covering the joints shall be provided with PVC/Metallic straps of same width to properly hold the joint in position. All piping connections, gages, manholes and access doors etc. shall be left accessible through cutouts in the insulation.

10.7 DUCT ACOUSTIC LINING

Ducts so identified and marked on Drawings and in Schedule of Quantities shall be provided with acoustic lining as follows :

a. Acoustic Lining:

The inside surface of the ducts shall be cleaned and covered with adhesive, and frame work of 20 gauge G. I. 'C' channel 50 mm × 't' mm ('t' being specified thickness of acoustic lining) with 25 mm integral flanges on either side spaced not more than 60 cm centres shall be fixed rigidly with the surface of duct creating suitable squares/rectangles on the surface. The gaps between frames shall be filled with 25 to 50mm thick(Density not less than 32 KG/CuMtr), about 60x60 cm wide cut panels of resin bonded fiberglass slabs.

These insulation panels shall be fixed to the sheet metal with cold setting adhesive compound or nail stickers. The inside surface of the duct shall be covered with fiberglass tissue (over the insulation panels) and 28 gauge perforated aluminium sheet having at least 15% perforation shall cover the fiberglass tissue. The aluminium sheet shall be screwed to GI frame using cup washer and neatly finished to give true inside surfaces. Use of nails shall not be permitted.

10.8 DUCT INSULATION

External thermal insulation on ducts shall be provided as follows :
The insulation for duct shall be carried out from elastomeric nitril rubber having a 'K' value of 0.030 W/M.K, temperature range -40 to +115˚C and a density of not less than 60 kg/cubm. Water vapour permeability 0.09 µ g-m/N-hr. Fire rating class 1/0 as per British standard BS 476 part VII/VI 1997 building regulation. Approval of sample to be obtained in writing prior to execution
The ducts shall be insulated with the insulation sheets as follows.

Duct insulation thickness shall be as follows :

- Duct in conditioned space - 9 mm thick
- Duct in unconditioned space - 13 mm thick
- Duct with treated fresh air - 13 mm thick

Installation

Clean the surface with a wire brush and make it free from rust and oil.

The cleaned surface shall be treated with one coat of adhesive on duct surface. The coating of adhesive will, however, not be required for insulating material provided with self adhesive coating on one surface.

One coat of adhesive on one side of insulation sheet simultaneously.
Leave it to dry.
Stick the insulation on ducts and press for smoothness.
The joints shall be sealed with the same adhesive.

The Ducts in areas exposed to the weather shall be additionally covered with one layer of tar felt B.H. The tar felt shall be stuck with bitumen R 85/40 or 80/25.

10.9 UNDERDECK INSULATION

Under-Deck Insulation of Providing and fixing under deck insulation to the roof of air conditioned spaces exposed to sun with 15 mm thick closed cell one side aluminium foil faced FR grade. The entire ceiling surface shall be cleaned and cleared of dust, cement and sand particles, oil etc., Apply a coat of suitable grade synthetic rubber adhesive on to the ceiling surface and the insulation sheet. Paste the insulation sheet to the ceiling surface when the adhesive becomes tacky and apply uniform pressure on the insulation sheet to ensure proper adhesion. However the insulation as to fix with GI Strips and washers at the interval every one metre.

10.10 MEASUREMENT OF INSULATION

Unless otherwise specified measurement for duct and pipe insulation for the project shall be on the basis of centre line measurements described herewith :

a. Pipe Insulation : Pipe Insulation shall be measured in units of length along the centre line of the installed pipe, strictly on the same basis as the piping measurements described earlier. The linear measurements shall be taken before the application of the insulation. It may be noted that for piping measurement, all valves, orifice plates and strainers are separately measurable by their number and size. It is to be clearly understood that for the insulation measurements, all these accessories including cladding, valves, orifice plates and strainers shall be considered strictly by linear measurements along the centre line of pipes and no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.

b. Duct Insulation and Acoustic Lining :

Duct Insulation and Acoustic Lining shall be measured on the basis of surface area of the duct including cladding, tapered pieces, bends, tees, branches, etc. as measured for bare ducting. However, the average of the inner and outer perimeters will be used for computing the surface area of the insulation.

For example, for a 12 ft long duct piece of size 48" x 18" provided with 2" thick insulation, the surface area of insulation will be worked out as shown below :

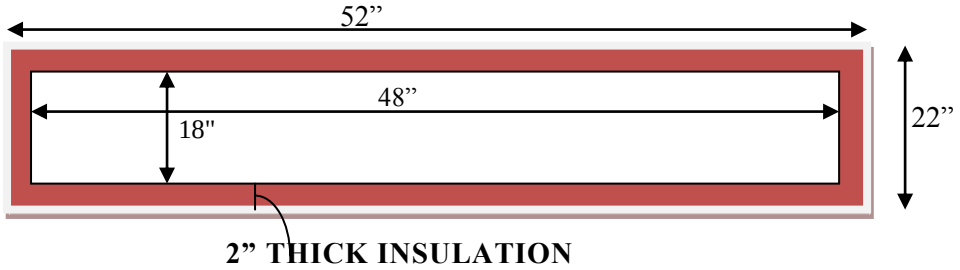

Fig. 1 : Cross Section of an Insulated Duct

Outer Perimeter : (52 + 22) x 2 = 148 Inches

Inner Perimeter : (48 + 18) x 2 = 132 Inches

Average Perimeter : (148 + 132) ÷ 2 = 140 Inches = (140 ÷ 12) ft.

Surface area of Insulation : Average Perimeter x Length
= (140 ÷ 12) x 12 = 140 SFT

Same procedure will be used for working out the surface area of acoustic lining within the duct where the duct will form the outer periphery and the inner surface of acoustic lining will form the inner periphery.

11.0 AUTOMATIC CONTROLS AND INSTRUMENTS

11.1 SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of automatic controls and instruments conforming to these Specifications and in accordance with the requirements of Drawings and Schedule of Quantities.

11.2 TYPE

All automatic controls shall be Electric/ Electronic controls as per the requirement of specifications as indicated in schedule of quantities.

11.3 AUTOMATIC ONTROLS

Automatic controls required for various types of machines have been described in the various sections of these Specifications and shown on the Drawings. The individual safety controls and selected automatic controls may be installed within the machines by the manufacturers before shipment. However the following automatic controls, if not already installed on the machines, may be installed at site by the Contractor, as indicated in Schedule of Quantities.

a. Three-way modulating valves for air handling units may be provided in chilled water line at each air handling unit as shown on the Drawings and included in Schedule of Quantities. Each valve shall be actuated by a space thermostat. Constant space condition shall be maintained by continuous proportional modulation of the chilled water through the coil. The valve shall revert to fully by pass position when fan is shut off.

Motor shall be proportional modulator motor and shall be suitable for 24 volts supply and shall have a cover mounted 220 / 24 volts transformer factory-installed.

b. Three-way Diverting Valves for FCUs may be provided in chilled water lines at each fan coil unit as shown on Drawings and included in Schedule of Quantities. The valve shall be actuated by space thermostat. Constant space conditions shall be maintained by allowing all of chilled water to either pass through the coil or bypass the coil and mix with the chilled water return. The valve shall revert to fully bypass position when fan is shut off.

Valves shall be similar to Honeywell two-position diverting valves 15 cm (1/2 inch) diameter with flare connection. Valves shall be selected for water flow rate of 5 - 6 US GPM Pressure drop across the valve shall not exceed 2 PSI Valve shall have the facility to replace motor actuator without removing the valve body.

c. Flow Switches shall be provided in chilled water outlet at the water chilling machines, and at the water-cooled condensing units for refrigeration system in cold stores, as shown on Drawings and included in Schedule of Quantities. Flow switch shall prevent the compressor from starting unless the cooling water flow is established in condensing water lines, and chilled water flow is established in chilled water lines.

c. **Thermostat** shall be electric, fixed differential type as specified herein, 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 profiles, mounting arrangement and exact location of the thermostats shall be as approved at site. Requirement of thermostats shall be as shown on drawings and included in Schedule of Quantities.

i. Proportional control thermostats for air conditioning application for actuating the three way modulating valve at each air handling unit, as shown on Drawings and included in Schedule of Quantities. Thermostat shall be equivalent line voltage cooling thermostat. Range shall be 56-84 °F, differential shall be 3 °F.

ii. Snap-acting fixed-differential type thermostat for air conditioning applications for actuating the three-way diverting valve at each fan coil unit as shown on Drawings and included in Schedule of Quantities.

Thermostat shall be cooling thermostat, for range 56-84 °F, differential 3 °F, with OFF-HI-LO fan switch, temperature adjustment NORMAL-COOL setting, switching off must break fan circuit.

iii. Snap-acting fixed differential heating thermostat for electric reheat applications for putting on/off power supply to electric reheat coils in air handling units as shown on Drawings and included in Bill of Quantities. Thermostats shall be two stage thermostat or equivalent.

iv. Safety thermostats for electric reheat application for cutting off power supply to strip heaters in case airflow across strip heater is not established. Thermostat shall be approved equal.

e. Humidistat may be provided with air handling unit for areas that require constant indoor humidity or humidity control with reheat, as shown on Drawings and included in Schedule of Quantities. 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 humidistats shall also de-energize these devices when the desired humidity is reached.

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

f. Airstat may be provided as shown on Drawings and included in Bill of Quantities, within air handling unit containing electric heating or reheat coils to prevent heaters from energizing unless the air flow is established.

11.4 INSTRUMENTS

Instruments required for different types of machines have been described in the various sections of these Specifications and shown on the Drawings. Following instruments may be provided as per the requirements indicated in the Bill of Quantities.

a. Thermometers : shall be dial type 100 mm dia. Thermometers shall be installed on chilled water supply and return at air handling units, supply and return at chillers and condensers as shown on the Drawings and included in Bill of Quantities. Range of scales shall be 30-120 degree F (0-50 degree C) for air conditioning applications of cooling only.

b. Pressure Gages : shall be installed on suction and discharge sides of pumps, chilled water supply and return at air handling units, inlet and outlet at chillers and condensers, as shown on the Drawings and included in Schedule of Quantities. Suction side gages at pumps shall be compound gages with 150 mm dia, range 75 cm - 10 kg (30" - 150 psi) mercury vacuum and pressure.

Discharge sides gages at pumps and at all other locations shall be 150 mm range 0-10 kg per sq.cm (0-150 psi) pressure. Gages shall be connected to the pipes by 6 mm diameter copper tubing through 6 mm dia shut-off-cocks, and U tube required for gage protection during testing.

c. Room Thermometers : shall be dial type, wall-hung temperature indicators, of appropriate range for cold stores and deep freezers, in accordance with the requirements of Drawings and Schedule of Quantities.

d. Room RH indicators : shall be dial type, wall hung, relative humidity indicators of appropriate range, for special areas, in accordance with the requirements of drawings and as included in Schedule of Quantities.

e. Electronic Thermometers : shall be electronically operated Digital temperature Indicator in accordance with requirement of Drawings and as included in Schedule of Quantities. The display shall be 3-5 digit Liquid Crystal Display (LCD). The thermometer shall consist of fully solid state integrated circuits. The thermometer shall have front LED 'on' indication and automatic low battery indication. The resolution shall be 0-1 degree centigrade. Thermometer shall be complete with suitable electronic sensor to accurately sense the temperature with sensor housed in suitable airwell/thermowell for air temperature/water temperature measurement. The thermometer shall be suitable for operation on 9V DC/ 230V AC. The display unit shall be housed in attractive sheet metal cabinet with prominent display of conversion charts of deg F & C on front plate. Thermometer shall be complete with separable socket type interconnecting cables of 2 m length suitable for installation within a radius of 2 m of the thermowell or air sensing point.

Thermometers may be installed at chilled water supply and return at air handling units as shown on Drawings. Range of scales shall be 30 degree F-120 degree F (0-50 degree C) for air conditioning applications.

11.5 MINI BUILDING MANAGEMENT SYSTEM (MINI BMS)

Design, manufacture, supply, installation, testing and commissioning of Mini BMS for Central Control-cum-Status-Indication of various equipments of HVAC system.

The BMS shall comprise a Master Controller, a PC, a Converter Card and required number of Slave Controllers.

The master controller shall be a microprocessor based, menu driven, digital controller with 8 character x 2 line, alphanumeric, dot matrix LCD display. The system should have arrangement to change the set points and other parameters of the slave controllers connected on the bus. It should also have arrangement to switch the equipment on/off through the controller from the control room as and when required.

The slave controllers shall also be micro-processor based controllers for controlling temperature, RH and other parameters or for switching on/off equipments. All these controllers shall have RS 485 bus connection capabilities and one bus shall be capable of taking 32 controllers. The system should have provision of connecting more controllers by configuring number of buses and using repeaters.

The scope of work shall also include all control wiring, conduiting etc between the equipments located at various places and the Mini BMS panel.

Mini BMS is Central Control-cum-Status-Indication of various equipments of HVAC system. The BMS shall comprise a Master Controller, a PC, a Converter Card and required number of Slave Controllers. The master controller shall be a microprocessor based, menu driven, digital controller with 8 character x 2 line, alphanumeric, dot matrix LCD display. The system should have arrangement to change the set points and other parameters of the slave controllers connected on the

bus. It should also have arrangement to switch the equipment on/off through the controller from the control room as and when required.

The slave controllers shall also be microprocessor based controllers for controlling temperature, RH and other parameters or for switching on/off equipments. All these controllers shall have RS 485 bus connection capabilities and one bus shall be capable of taking 32 controllers. The system should have provision of connecting more controllers by configuring number of buses and using repeaters.

The functions of control/indication shall be as mentioned below :

i. Remote Start/Stop & status indication for each chilled water pumps.

ii. Remote Start / Stop and status indication for each Air Handling Units.

iii. Remote Start/Stop and status indication of Hot Water Generators.

iv. Status : H (high), M (medium) : L (low) of water levels in expansion tank, including providing and fixing water level indicators for expansion tanks.

v. Hooter, mute switch and flashing light for any of the above fault annunciation and a pilot switch for testing that all status indications are in working order.

11.6 CALIBRATION AND TESTING

All automatic controls and instruments shall be factory calibrated and provided with necessary instructions for site calibration and testing. Various items of the same type shall be completely interchangeable and their accuracy shall be guaranteed by the manufacturer. All automatic controls and instruments shall be tested at site for accuracy and reliability before commissioning the installations.

12.0 ELECTRICAL INSTALLATION

12.1 SCOPE

The scope of this section comprises of fabrication, supply, erection, testing and commissioning of electric control panels, wiring and earthing of all air conditioning equipment, components and accessories, including supply, installation and wiring of remote control-cum-indicating light panel.

Designing, fabricating, transporting to site, installing, testing and commissioning of floor mounted, self supported, compartmentalized LT cubical pattern (Extendable Type) metal clad switch board, fabricated from 2mm (14 G) thick CRCA sheet steel suitable for 31 MVA rupturing capacity at 415 V, 3 phase, 4 wire, 50 HZ AC supply and equipped with PVC sleeved aluminium bus bars of specified rating and following switch gears inter connected by PVC sleeved solid conductors, including 7-tank cleaning, de-greasing, phosphating process and treatment of panel with anticorrosive zinc based primer paint before applying 2 coats of enameled paint of approved shade and oven baked, complete with earthing terminals, cable and bus bar alleys as required

Scope of work shall include power / control cabling/wiring/ GI earthing from Control Panel to various equipments and their starters like package chillers, Pumps, Hot water generators, AHUs Distribution Panel etc along with two dedicated earthing stations for the panel and GI strip connections between Panel and earth pits. Cable quantities, earthing, earth pit etcare identified separately under the heading “Cables” of this BOQ.

The LT panel will comprise ACBs and MCCBs as described below for incoming and outgoing power supplies. All incoming Air Circuit Breakers (ACBs) shall be 4-Pole electrically operated, and all outgoing ACBs shall be TPN electrically operated, draw out type (unless specified otherwise) with 230V AC spring charged motor, release for O/C, S/C and E/F Port (486/232) as per suitability and with 6 NO + 6 NC auxiliary contacts.

All incoming MCCBs shall be 4-Pole and outgoing MCCBs shall be 3-Pole, vertical type having operating mechanism. The indicating lamps used shall be LED type and not Neon type.

a.Features of Breakers

a.1 Incoming ACB Features

All the incoming air circuit breakers of panels shall consist of following accessories:

i. 0-500 V range digital voltmeter with selector switch and back up fuses. : 1 Set.

ii. Suitable range of digital ammeter with selector switch and CTs as mentioned in schedule. : 1Set

iii. I.D.M.T. relay. : 1 No.

iv. Power factor meter : 1 No.

v. Frequency meter 45 to 55 cycles range. : 1 No.

vi. Phase indicating lamps with back-up fuse protection. : 3 Sets.

vii. Breaker 'ON'/'OFF' indication lamp with backup fuse protection. : 2 sets.

viii. Energy Analyser : 1 No.

ix. Standard shunt trip and over load relays.

x. ON/OFF push buttons with motorized spring charged mechanism 230 V AC. : 1 No.

Incoming MCCB Features
All the incoming moulded case circuit breakers of panels shall consist of following accessories:

i. Suitable range digital voltmeter with selector switch and back up fuses. : 1 Set.

ii. Suitable range of digital ammeter with selector switch and CT as mentioned in schedule. 1 Set
M.T. relay. : 1 No.

iv. Breaker 'ON'/'OFF' indication lamp with backup fuse protection. : 2 sets.

v. K.W.H. meter with CT : 1 No.

vi. Standard shunt trip and over load relays.

vii. ON/OFF push buttons with motorized spring charged mechanism 230 V AC. : 1 No.

Outgoing MCCB Features :
Each outgoing MCCB of panel shall consist of following accessories :

i. Suitable range of digital ammeter with selector switch and CT as mentioned in schedule. 1 Set

ii. Phase indicating lamps with back-up fuse protection: 3 Sets

iii. Breaker 'ON'/OFF indication lamp with back-up fuse protection. 2 Sets

iv. Standard shunt trip and over load relays.

b.Capacities / Ratings of Breakers

i. Incoming ACBs
800 Amps 4-Pole ACB with 800/5A ratio Current Transformer, 0-800 A ammeter &selector switch along-with other accessories as specified. : 1 Set

ii. Bus Bars
1000 amps TPN electrolytic aluminium bus bars with heat shrinkable insulation cover sleeves. : 1 Set

Outgoings
(Cable quantities will be as identified separately under the heading "Cables" of this BOQ.)

i. 630A, TPN MCCB with 0-630A ammeter 630/5A Current Transformer & selector switch along with other accessories as specified above and aluminium conductor outgoing feeders of matching size to Chilling Machine. : 1 Set

ii. 150A, TPN MCCB with 0-150A ammeter 150/5A Current Transformer & selector switch along with other accessories as specified above and aluminium conductor outgoing feeders of matching size to Hot Water Generator: 1 Set

iii. TPN MCCBs with CT operated ammeter of respective range, selector switch, indication lamp with fuse and toggle switch for 'ON' status of equipment. The ratings will be as given below :

• 32 Amps MCCB with 10/15 HP automatic Star Delta starter, SPP and aluminium conductor outgoing feeder of matching size to Chilled Water Pump Motor/ Starter. : 2 Sets

• 63 A MCCB with 0-63 A digital ammeter 63/5A CTs and selector switch alongwith other accessories as specified above and aluminium conductor outgoing feeders of matching size to AHUs. : 2 Sets

Spare MCCBs :

- 630 Amps : 1 Set
- 150 Amps : 1 Set
- 63 Amps : 1 Set

LT panel as described above, as per specifications and complete in all respects.

Control Panels In AHU Room
Design, manufacture, supply, installation, testing and commissioning of the following cubicle type, dead front, sheet steel, wall mounted control panels, sleeve type aluminium bus bar including anchoring into the wall, wiring, earthing and terminating from electrical panel to motor, for each panel shall be provided by the HVAC Contractor.

All internal wiring and GI earthing of air handling unit motors from the panel shall be included. The panel shall include the following accessories :

a. TPN MCCB for incoming power as per rating given below.

b.i. Terminal block for power distribution.
ii. Contactors for heater (9KW) of humidifiers.

c. Single phase preventer.

d. Phase indicating lights and indicating lights for 'ON' status with toggle switches and control fuses.

e. Digital voltmeter with fuse of suitable range.

f. Digital ammeter of suitable range with CT's and selector switch.

g. Time delay relay for delayed automatic restart of air handling unit motor

h. 220 / 24 volts transformer.

j. 24 volts wiring to the 3-way diverting valve and space thermostat.

k. Wiring for micro-switch smoke sensor and electric actuator for stopping the fan when smoke / fire damper closes. (For AHUs provided with Fire Damper.)

l. Control wiring for heating thermostat.

m. ON/OFF Push buttons with toggle switch for remote start/stop and indicating light for 'ON'status at the Mini BMS Panel.

n. Bimetallic lugs shall be used at copper to aluminum joints.

p. Auto/Manual start/stop selector switch shall be provided for each equipment in the panel to facilitate remote operation from Central Indication Light Panel. Panels shall have adequate space for mounting transformers and other accessories related to control system.

AHU panels with above features and each with following starters and MCCBs.

a. 12.5 - 15.0 HP Star Delta starter with 40/80 amps MCCB and contactors.

15.5 - 20.0 HP Star Delta starter with 40/80 amps MCCB and contactors.

12.2 GENERAL

Work shall be carried out in accordance with the Specifications, Local Rules, Indian Electricity Act 1910 as amended upto date, and rules issued the render, Regulations of the Fire Insurance Company and relevant BIS Code of Practice.

12.3 CABLING /WIRING SYSTEM

All power wiring shall be carried out with 1100 volts grade PVC insulated, armoured, overall PVC sheathed aluminium conductor cables. Cables shall be sized by applying proper derating factor. All control wiring shall be carried out by using 650 volts PVC insulated copper conductor wires in raceways or in conduit. Minimum size of control wiring shall be 1.5 sq.mm PVC insulated copper conductor wires. Minimum size of conductor for power wiring shall be 4 sq.mm 1100 volts grade PVC insulated copper conductor wires in conduit.

12.4 C ONSTRUCTION FEATURES

The control panel shall be metal enclosed sheet steel cubicle, indoor type, dead front, floor mounting / wall mounting type. The control panel shall be totally enclosed, and vermin proof. Gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust proof. Control panels shall be arranged in multi-tier formation. All doors and covers shall be lockable. All mild steel sheets used in the construction of control panels shall be 14 gauge (2 mm) thick for floor mounted and 16 Gauge (1.6 mm) for wall mounting and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding slag grounded off and welding pits wiped smooth with Plumber metal.

All panels and covers shall be properly fitted and square with the frame and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with hank nuts. Self threading screws shall not be used in the construction of control panels. Base channel of 75 mm x 75 mm x 5 mm thick or 100 mm x 50 mm x 6 mm thick shall be provided at the bottom. Minimum clear space of 200 mm between the floor of control panel and bottom most units (MCB or Bus Bar) shall be provided. The control panels shall be of adequate size with a provision of 25% spare space to accommodate possible future additional switchgear. Knockout holes of appropriate size and number shall be provided in the control panels in conformity with the location of incoming and outgoing conduits / cables. All equipment such as meters and indicating lamps etc. shall be located adjacent to the unit with which it is associated and care shall be taken to achieve a neat and symmetrical arrangement. Facility shall be provided for termination of cables from both above and below the control panel. Where cables enter from below, cable boxes shall be fitted at the rear end arranged in tiers to facilitate making connections to the upper and lower units. Clamps shall be provided to support the weight of the cables. All power wiring inside the control panel shall be colour coded and control wiring ferruled for easy identification. Circuit diagram showing the arrangement of circuits shall be pasted on the inside of panel door and covered with transparent plastic sheet and all labeling shall be provided in engraved anodized aluminium / bakelite strips on the front face of the panel board.

12.5 CIRCUIT COMPARTMENT

Each circuit breaker, contactor and relay shall be housed in a separate compartment and shall have steel sheets on top and bottom of compartment. Sheet steel hinged lockable door shall be duly interlocked with the breaker in the 'ON' position. Safety interlocks shall be provided to prevent the breaker or contactor from being drawn out when the breaker is in 'ON' position. The door shall not form an integral part of the draw out portion of the panel. Sheet steel barriers shall be provided between the tiers in a vertical section.

12.6 INSTRUMENT ACCOMMODATION

Adequate space shall be provided for accommodating instruments, indicating lamps, control contactors and control fuses etc. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker and bus bar.

12.7 BUS BARS AND BUS BAR CONNECTIONS

The bus bar and interconnections shall be of copper and of rectangular cross sections suitable for full load current for phase bus bars, and half rated current for neutral bus bar and shall be extensible on either side. The bus bars and interconnections shall be insulated with PVC sleeve / tapes and shall be color-coded. Alternatively special insulating paints / materials may be used for the purpose.

All bus bars shall be supported on unbreakable, non-hygroscopic insulated supports at regular intervals, to withstand the forces arising in case of short circuit in the system. All bus bars shall be provided in separate chamber and properly ventilated. All bus bars connections, in main control panels shall be done by drilling holes with cadmium plated / hot dipped galvanized bolts, nuts and washers.

All bus bars connections in smaller control panels shall be done by drilling hole and connecting by brass bolts and nuts. All connections between the bus bar and breaker, and between breaker and contactor shall be through copper strips of proper size to carry rated current and shall be insulated with PVC sleeves. The bus bar size shall be kept @ 1 sqmm per ampere of current. The Contractor shall submit bus bar calculation showing derating factor.

12.8 RACEWAYS

A horizontal raceway with screwed covers shall be provided at the top to take interconnecting control wiring between different vertical sections.

12.9 CABLE COMPARTMENTS

Cable compartment of adequate size shall be provided in the control panels for easy termination of all incoming and outgoing cables entering from bottom or top. Adequate and proper supports shall be provided in cable compartments to support cables.

12.10 MATERIALS

All materials shall be of the best quality complying with the BIS (Bureau of Indian Standards) specifications. Materials used shall be subject to the approval of the Owner's site representative and samples of the same shall be furnished where required.

a. Air Circuit Breakers (ACBs) :

The ACBs shall be sheet metal enclosed flush front, draw out type, and shall be provided with a trip free manual operating mechanism with mechanical ON/OFF indications. The circuit breaker shall be suitable for continuous rating and of capacity as called for. It shall be possible to switch "ON" and "OFF" the Circuit Breaker without opening the circuit breaker compartment door. The operating handle and the mechanical trip push button shall be at the front of the breaker and integral with the breaker.

Cradle : The cradle shall be so designed and constructed as to permit smooth withdrawal and insertion of the breaker into it. The movement shall be free from jerks, easily operable and shall be on steel balls / rollers and not on flat surfaces.

Protective Devices : C.T operated IDMT Relays for short circuit and earth fault operation shall be provided for all air circuit breakers.

Suitable over and under voltage tripping mechanism for voltage greater or less than ± 10% of full rated voltage shall be provided.

Indication lights for earth fault, over load and short circuit trip of breaker shall be provided and shutter assembly shall be provided to protect from live part of breaker.

b. Moulded Case Circuit Breaker (MCCB) :

MCCB shall comprise switching mechanism, Contact system, are extinguishing device and the Tripping unit, contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses. Switching mechanism shall be of Quick Make-Quick Break type and the trip command shall over ride all other commands. MCCB shall employ maintenance free contact system to minimize the let thru' energies while handling abnormal currents.

The handle position shall give positive indication of 'ON' 'OFF' or 'Tripped'.

c. Rotary Switches :

Switches upto 60 amps shall be rotary type with compact and robust construction, built up from one or more stacks with contacts and a positioning mechanism with stop as requ ired. Rotary switches shall have HRC fuse fittings of appropriate rating.

d. Selector Switch :

Where called for, selector switches of rated capacity shall be provided in control panels, to give the choice of operating equipment in selective mode.

e. Switches :

Switches beyond 60 amps shall be panel mounted double break type and suitable for load break duty, quick make and break action, manufactured in accordance with relevant BIS Codes. Switch contacts shall be silver plated and shall be backed u p with HRC fuses of appropriate rating. The switch handle shall be located at the front. Switches shall be of approved make.

f. HRC Fuses :

Fuses shall be of High Rupturing Capacity and shall be in accordance with relevant BIS Codes and having rupturing capacity of not less than 20 MVA at 415 volts. The back up fuse rating for each motor / heater / equipment shall be so chosen that the fuse does not operate on starting of motor / heater / equipment. Fuses shall be of the same make as the switches / fuse fittings.

g. Starters :

Each motor shall be provided with a starter of suitable rating. Starters shall be in accordance with relevant BIS Codes. All Star Delta and ATS Starters shall be fully automatic.

Starters contactors shall have 3 main and 2 No s. NO / NC auxiliary contacts and shall be air break type suitable for making and breaking contact at minimum power facto r of 0 .35. For design consideration of contactors the starting current of connected motor shall be assumed to be 6 times the full load current of the motor in case of direct-on-line starters and 3 times the full load current of the motor in case of Star Delta / Reduced Voltage Starters. The insulation for contactor coils shall be of class "E".

Operating coils o f contactors shall be suitable for 220 / 4 15 ± 10% volts AC, 50 cycles supply system. The contactors shall drop out when voltage drops to 90% of the rated voltage. The housing of the contactors shall be heat resistan t and having high impact strength. Each starter shall have thermal overload protection on all three phases.

h. Over Load Relays :

Contactors shall be provided with a three element, positive acting ambient temperature compensated time lagged hand-reset type thermal over load relays with adjustable setting. Hand-reset button shall be flush with the front door for resetting with starter compartment door closed. Relays shall be directly connected for motors upto 35 HP capacity. C.T operated relays shall be provided for motors above 35 HP capacity. Heater circuit contactors may not b e provided with overload relays.

j. Current Transformers :

Current transformers shall be of accuracy class I and suitable VA burden for operation of the connected meters and relay s. These shall be resin bonded and epoxy coated.

k. Single Phase Preventers :

Single phase preventers shall be provided as per Schedule of Quantities and shall be in conformity with relevant BIS Standards. Single-phase preventers shall act when the supply voltage drops down to 90% of the rated voltage or on failure of one or more phases and also work on principle of negative sequence of current sensing.

l. Time Delay Relays :

Time delay relays shall be adjustable type with time delay adjustment from 0-180 second s and shall have one set of auxiliary contacts for indicating lamp connections.

m. Indicating Lamp and Metering :

All meters and indicating lamps shall be in accordance with BS 37 and BS 39. The meters shall be flush mounted and draw-out type. The indicating lamp shall be of low wattage type.

Each main panel shall be provided with voltmeter 0-500 volts with three way and off selector switch, CT operated ammeter of suitable range with three Nos. CTs of suitable ratio with three way and off selector switch, phase indicating lamps, and other indicating lamps as called for. Each phase indicating lamp shall be backed up with 5 amps fuse. Other indicating lamps shall be backed up with fuses as called for. The indicating lamps shall be multi LED type.

n. Toggle Switch :

Toggle switches, where called for, shall be in conformity with relevant BIS Codes and shall be of 5 amps rating.

p. Push Button Stations :

Push button stations shall be provided for manual starting and stopping of motors / equipment as called for. Green and Red colour push buttons shall be provided for 'Starting' and 'Stopping' operations. 'Start' or 'Stop' indicating flaps shall be provided for push buttons. Push buttons shall be suitable for panel mounting and accessible from front without opening door, Lock lever shall be provided for 'Stop'
push buttons. The push button contacts shall be suitable for 6 amps current capacity.

q. Conduits :

Conduits shall be of mild steel and shall be Hard drawn, stove enameled inside and outside with minimum wall thickness of 1.6 mm for conduits upto 32mm diameter and 2 mm wall thickness for conduits above 32 mm diameter. GI pull wires shall be installed in the conduit while laying the conduit.

r. Cables :

M.V. cables shall be PVC insulated aluminium conductor and armoured cables conforming to BIS Codes. Cables shall be armoured and suitable for laying in trenches, duct, and on cable trays as required. M.V Cables shall be termite resistant. Control cables and indicating panel cables shall be multi core PVC insulated copper conductor and armoured cables.

s. Wires :

1100 volts grade PVC insulated aluminium conductor wires in conduit shall be used.

12.11 WIRE SIZES

For all single phase / 3 phase wiring, 1100 volts grade PVC insulated copper conductor wires shall be used. The equipment inside plant room and AHU room shall be connected to the control panel by means of insulated aluminium conductor wires of adequate size in exposed conduits. Final connections to the equipment shall be through wiring enclosed in galvanized flexible conduits rigidly clamped at both ends. An isolator shall be provided near each motor / equipment wherever the motor / equipment is separated from the supply panel through a partition barrier or through ceiling construction. PVC insulated single strand aluminium conductor wires shall be used inside the control panel for connecting different components and all the wires inside the control panel shall be neatly dressed and plastic beads shall be provided at both the ends for easy identification in control wiring.

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The minimum size of control wiring shall be 1.5 sq.mm PVC insulated stranded soft drawn copper conductor wires drawn through conduit to be provided for connecting equipment and control panels.

Power wiring cabling shall be of the following sizes or as given in drawings / BOQ which were is more stringent :

i. Upto 5 HP motors/5 KW heaters.	3 x 4 sq.mm copper conductor wires.
ii. From 6 HP to 10 HP motors 6 KW to 7.5 KW heaters.	3 x 6 sq.mm copper conductor wires.
iii. From 12.5 HP to 15 HP motors.	2 Nos. 3 x 6 sq.mm copper conductor wires.
iv. From 20 HP to 25 HP motors.	2 Nos. 3 x 10 sq.mm aluminium conductor armoured cables.
v. From 30 HP to 35 HP motors.	2 Nos. 3 x 16 sq.mm aluminium conductor armoured cables.
vi. From 40 HP to 50 HP motors.	2 Nos. 3 x 25 sq.mm aluminium conductor armoured cables.
vii. From 60 HP to 75 HP motors.	1 No. 3 x 70 sq.mm aluminium conductor armoured cables.
viii. 100 HP motors.	1 No. 3 x 150 sq.mm aluminium conductor armoured cables.
ix. 150 HP motor.	1 No. 3 x 240 sq.mm aluminium conductor armoured cables.
x. 250 HP motor.	2 Nos. 3 x 240 sq.mm aluminium conductor armoured cables.
xi. 400 HP motor.	3 Nos. 3 x 240 sqmm aluminium conductor.
xii. 600 HP motor.	3 Nos. 3 x 400 sq.mm aluminium conductor armoured cables.

All the switches, contactors, push button stations, indicating lamps shall be distinctly marked with a small description of the service installed. The following capacity contactors and overload relays shall be provided for different capacity motors.

	TYPE OF STARTER	**CONTACTOR CURRENT CAPACITY**	**OVERLOAD RELAY RANGE**
5 HP Motors	D O L	16 amps	6-10 amps
7.5HP Motors	Star Delta	16 amps	10-16 amps
10 HP Motors	Star Delta	16 amps	10-16 amps
12.5HP Motors	Star Delta	25 amps	10-16 amps
15 HP Motors	Star Delta	32 amps	13-21 amps
20 HP Motors	Star Delta	32 amps	13-21 amps
25 HP Motors	Star Delta	32 amps	13-21 amps
30 HP Motors	Star Delta	40 amps	20-32 amps

	TYPE OF STARTER	CONTACTOR CURRENT CAPACITY	OVERLOAD RELAY RANGE
35 HP Motors	Star Delta	40 amps	20-32 amps
40 HP Motors	Star Delta	40 amps	28-42 amps
45 HP Motors	Star Delta	63 amps	28-42 amps
50 HP Motors	Star Delta	63 amps	28-42 amps
60 HP Motors	Auto Transformers /Reduced Voltage.	125 amps	45-70 amps
75 HP Motors	-do-	125 amps	90-150 amps
100 HP Motors	-do-	200 amps	CT Operated Relay
135 HP Motors	-do-	300 amps	-do-
150 HP Motors	-do-	300 amps	-do-
200 HP Motors	-do-	300 amps	-do-
250 HP Motors	-do-	400 amps	-do-
300 HP Motors	-do-	400 amps	-do-
400 HP Motors	-do-	600 amps	-do-
600 HP Motors.	-do-	900 amps	-do-

Note : The Contactor rating of the starter shall be selected as per manufacturer's Type-II coordination chart or above table, whichever is higher.

12.12 EARTHING SIZES

Earthing sizes shall be copper strips / wires, the main panel shall be connected to the main earthing system of the building by means of 2 Nos. 25 mm x 3 mm copper tapes. All single-phase metal clad switches and control panels be earthed with minimum 2 mm diameter copper conductor wire. All 3 phase motors and equipment shall be earthed with two numbers distinct and independent copper wires / tapes as follows :

i. Motors upto and including 10 HP rating.	2 Nos 3 mm dia copper wires.
ii. Motors 12.5 HP to 40 HP 10 HP rating.	2 Nos.4 mm dia copper wires.
iii. Motors 50 to 75 HP capacity.	2 Nos 6 mm dia copper wires.
iv. Motors above 75 HP.	2 Nos 25 mm x 3 mm copper tapes.

All switches shall be earthed with two numbers distinct and independent copper wires/tapes as follows :

i. 3 phase switches and control panels upto 60 amps rating.	2 Nos 3 mm dia copper wires.
ii. 3 phase switches and control panels 63amps to 100 amps rating.	2 Nos 4 mm dia copper wires.
iii. 3 phase switches and control panels 125 to 200 amps rating.	2 Nos 6 mm dia copper wires.
iv. 3 phase switches, control panels, bus ducts, above 200 Amps rating.	2 Nos 3mm × 25mm copper tapes.

The earthing connections shall be tapped off from the main earthing of electrical installation. The overlapping in earthing strips at joints where required shall be min. 75 mm. These straight joints shall be riveted with brass rivets & brazed in approved manner. Sweated lugs of adequate capacity and size shall be used for all termination of wires. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substance and properly tinned.

12.13 CABLE LAYING (MV CABLES)

Supplying and laying of following 1100 volt grade PVC insulated sheathed aluminium conductor armoured XLPE FRLS cables / copper cables on cable trays, in trenches (as per quantity of cable trays and trenches included in BOQ separately), on walls clamped to wall with suitable clamps, saddles, and fixing bolts, or laying in ground including cost of digging brick and sand protection, and including jointing / connecting / terminating, testing and commissioning

12.13.1 GENERAL

Cable shall be laid generally in accordance with BIS Code of Practice. Cables shall be laid on 14 gage perforated MS sheet cable trays, and cable drops / risers shall be fixed to ladder type cable trays fabricated out of steel angle. Access to all cables shall be provided to allow cable withdrawal / replacement in the future. Where more than one cable is running, proper spacing shall be provided to minimize the loss in current carrying capacity.

Cables shall be suitably supported with Galvanized saddles when run on walls / trays. Special care shall be taken to ensure that the cables are not damaged at bends. The radius of bend of the cables when installed shall not be less than 12 times the diameter of cable. 1.1 KV cable shall be buried 600 mm below ground level.

12.13.2 INSPECTION

All cables shall be tested and inspected at manufacturer's works. However, upon receipt at site cables shall be checked for physical damages during transit.

12.13.3 JOINTS IN CABLES

The contractor shall take care to see that all the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilisation and avoidance of straight cable jointing. This apportioning shall be got approved by the Engineer-in-Charge before the cables are cut to lengths.

Where straight joints in cable are unavoidable, the use and location of such straight joints shall be got approved by Engineer-in-Charge.

12.13.4 JOINTING BOXES FOR CABLES

Cable joint boxes shall be of appropriate size, suitable for PVC/ XLPE insulated armoured cables of particulars voltage rating.

12.13.5 JOINTING OF CABLES

All cable joints shall be made in suitable, approved cable joint boxes, jointing of cables in the joint boxes and the filling in of compound shall be done in accordance with manufacturer's instructions and in an approved manner. All straight joints shall be done in epoxy mould boxes with epoxy resin (Tropolin/M-Seal resin or approved equal). All terminal leads of conductors shall be heavy soldered upto at least 50mm length.

All cables shall be joined colour and tested for continuity and insulation resistance before jointing commences. The seals of cables shall not be removed until preparations for jointing are completed. Joints shall be finished on the same day as commenced and sufficient protection from the weather shall be arranged.

The conductors shall be efficiently insulated with high voltage insulating tape and by using spreaders of approved size and pattern. The joints shall be completely filled with epoxy compound and topped so as to ensure that the box is properly filled. Epoxy compound shall be filled as follows:

Equal quantities of resin and hardener shall be mixed thoroughly by hand until the mixture is free from white patches and has uniform colour. No water, oil or any other liquid shall be added to the mixture to make it soft as this will affect the properties of the compound. The mixture shall be used within 30-40 minutes of mixing. The surface on which epoxy compound is to be used, shall be free from dust, rust, oil, grease and shall be dry. The joint shall neither be disturbed nor moved till the epoxy compound is completely hardened. A smooth surface can be made before it sets. The joints shall be painted after it has completely hardened.

Alternatively, ready mix of epoxy cable jointing compound may also be used.

12.13.6 CABLE MARKERS/CABLE TAGS

a. CABLE MARKERS

All underground cables and cable joints shall be marked on the surface by markers generally manufactured and tested to the requirements of relevant BIS. Approved CI cable markers shall be provided at every of road crossing, indicating cable joints and cables as applicable. Special CI markers shall be provided at all buried cable joints indicating “Electrical Cable Joints”. CI plates duly engraved with the size of the cable and the place it serves shall be tied to the cable at regular intervals of 5M for easy identification of cables.

b. CABLE TAGS

Cable tags shall be made out of 2 mm thick aluminium sheets, each tag 32 mm in dia with one hole of 2.5 mm dia. 6 mm below the periphery shall be provided for clamping the same with cables.

Cable designation are to be punched with letter/number punches and the tags are to be tied to cables with piano wires of approved quality and size. Tags shall be tied inside the panels beyond the glands as well as below the glands at cable entries. Along trays, tags are to be tied at all bends on straight lengths, tags shall be provided at every 5 metre.

12.13.7 TERMINATION OF CABLES

Cable termination shall be done in terminal box or cable end box or distribution boards, or apparatus/equipments. Terminations are to be made with mechanical gland and of the tinned nickel plate, anti-corrosive, three piece improved pattern which is to grip inner and outer PVC sheaths as well as the armour of the cable. The cable ends or the core conductor are to be connected by solder-less lugs or sockets using tool of approved make for all cables.

All terminations of cable conductors and base conductors shall be mechanically and electrically sound and shall comply with the Requirements of relevant Standards and Indian Electricity regulations.

The connectors or connecting sockets are to have such dimensions so as to limit temperature rise.

When required the water tightness of the terminal boxes may be achieved by filling with a compound preferably plastic flame retarding and non-dripping type within the normal range of temperatures.

When the cable is cut during the course of installation the open ends are to be sealed immediately by means of self-adhesive non hygroscopic tape over a wax water seal to make an air and water tight joint.

12.13.8 INSTALLATION OF CABLES

Cable shall be laid in a manner as indicated on the drawings/in BOQ / specifications and as required at site Generally cables are laid in the following manner :

a. In the underground masonry trench.
b. On the cable tray/or on cable ladders.
c. Buried underground.
d. Through pipe sleeves/in hume pipes.

Various installation methods are discussed in the following paragraphs.

Cables shall be laid by skilled and experienced workmen using adequate rollers to minimize stretching of the cable. The cable drums shall be placed on jacks before unwinding the cable. The cable drums shall be rotated in a direction as indicated by the manufacturer. Care shall be exercised in laying cables to avoid forming kinks. The drums shall be unrolled and cables run over wooden rollers, placed at intervals not exceeding 2 metres.

a. PROTECTION

All cables shall be adequately protected against any risk of mechanical damage to which they may be liable in normal conditions of service.

When cables pass through holes in metal work, precautions shall be taken to prevent abrasion of the cables on any sharp edges.

In every vertical cable ladders, channel or duct or trunking or cable trench containing cables and exceeding three meters in length, internal barriers shall be provided so as to prevent the air at the top of the unit from attaining and excessively high temperature. In every vertical cable, ceiling, floor barriers against spread of fire and smoke shall be provided for compliable with IEE regulations. 'Viper' CABLEMASTIC for 903 fire resistant painting shall be applied on all PVC power cables.

Where cables pass through walls, ceiling, floor, it shall run through sleeve of PVC pipes or Hume pipes of adequate diameter. After pulling the cable through sleeve, both the ends of the sleeve shall be sealed water tight with fire resistance material to prevent spread of fire and seepage of water.

Generally along each cable route either in trench or in cable trays/ladders or in pipe separate two nos. of earth strips/wires shall run exposed.

Where an installation comprises medium voltage cables as well as extra low Voltage circuits, precaution shall be taken in accordance with relevant regulations and the two shall be physically separated by minimum of 300 mm distance.

Metal sheaths and armour of all cables, metal conduits, ducts, trunking, and bare earth continuity conductors associated with such cables, which might otherwise come into fortuitous contact with other fixed metal work shall be effectively bonded there to earth so as to prevent appreciable potential difference at such possible points of contact.

b. UNDERGROUND INSTALLATIONS

The cables shall be laid in an excavated trench. The depth of the trench shall be minimum 750 mm below the final ground level but shall be decided on the number of cables to be laid in the trench so that the vertical distance between two adjacent layers of cables shall not be less than 350 mm. The width of the trench shall be decided on the number of cables to be laid in the trench so tat the distance between two adjacent cables shall not be less than one cable diameter.

Before laying cables the bottom of the trench shall be well compacted and the cables shall be laid on a 100 mm fine sand bedding. The second layer of 150 mm of fine sand then shall be spread over the cable and shall be further covered by 150 mm of compacted soil. For the second layer of the cable same procedure shall be repeated.

The cables shall be protected by placing precast concrete tiles or burnt bricks over the cables on top layer of sand and for the full length of underground cables. Where more than one cable is running in the same trench, the concrete tiles/bricks shall cover all the cables and shall project a minimum of 80 mm on either side of the cables.

In any case the top layer of the cables shall be minimum 600 mm below the finished level of the ground.

The top of the cable trench shall be well compacted till the finished level of the ground and shall be approved by the Engineer-in-Charge. If required a laboratory compaction test shall be carried out in presence of the Engineer-in-Charge.

HV and MV cables shall not be lad in the same trench/cable tray and/or along side of water main.

Cables under road crossings and any surfaces subjected to heavy traffic shall be protected by running them through Hume pipes of suitable size.

The relative positions of the cables laid in the same trench shall be preserved and the cables shall not cress each other as far as possible. At all changes in direction in horizontal and vertical planes, the cable shall be bent smooth with a radius of bend not less than 15 times the diameter of the cable. Minimum 3 metres long loop shall be provided at both sides of every straight joint and 5 metres at each end of the cable. Distinguishing marks shall be made at the cable ends for identification.

Insulation tapes of appropriate voltage and in red, yellow, and blue colors shall be wrapped just below the sockets for phase identification.

All the excavation and back filling including timbering, shoring, and pumping required for the installation of the cables shall be carried out as indicated on the drawing and as per requirements laid down elsewhere or as per Engineer-in-Charge direction. Trenches shall be dug true to line and grades. Back fill for trenches shall be filled in layers not exceeding 150mm. At each layer compaction test shall be carried out in presence of Engineer-in-Charge or his representative.

Each layer shall be properly rammed and consolidated before laying the next layer. The contractor shall restore all surfaces, roadways, side walls, curds, walls, landscaping or other works cut for excavation to their original condition, to the satisfaction of the Engineer-in-Charge. Suitable approved type cable markers shall be installed along the cable route & wherever change of direction takes place.

c. CABLES INSTALLED INSIDE THE BUILDING

The cables inside the building shall be installed in one of the following manner, as indicated in the drawing and approved by the Engineer-in-Charge.

i. Installed In Built-Up Trench

The cables laid on the bottom of the structural trenches shall not lay freely upon the trench and shall be laid on angle iron brackets / cable tray / cable ladder / cable troughs / cable racks as indicated on the drawings, and as approved by the Engineer-in-Charge. Where cables are clamped to the wall a minimum clearance of 100mm shall be maintained between wall and cable and minimum 150mm vertical clearance shall be maintained between two cables. Where cables are laid on brackets the brackets shall not be fixed more than 500mm apart to avoid sag in the

cables. Where the cables are laid on cable tray / ladder / troughs / racks, minimum 300mm distance shall be observed between adjacent tier of tray / ladder / through / racks, and minimum of one cable diameter distance shall be observed between two adjacent cables. Cables shall be properly fixed with the tray / ladder / troughs / racks with cable tie or saddles or straps.

ii. Cables On Cable Trays/Ladders Under The Ceiling Or On Wall

Where cables are installed under or above suspended ceiling or below ceiling or on wall, they shall be laid on a ladder/perforated GI cable tray and shall run in such positions that they are not liable to be damaged by contact with the floor or the ceiling or other fixtures.

The perforated cable tray / ladder shall be properly fixed with tie rod, channels,angles, flats to the ceiling. The metal inserts for fixing the tie rod, channels, angles, flats shall be put in place while casting the slab. If insert plates are not placed in position, Anchor fasteners shall be used to support cable trays, if required. The cable tray route shall be coordinated with other services to avoid crisscross of various services. While laying the cables on the tray minimum one cable diameter distance shall be observed between two adjacent cables about 20% space shall be kept spare for the future installation.

The trays shall be made of 2mm thick perforated sheet having minimum 75mm depth and as per BOQ. The width of perforation shall be maximum 10mm spaced at maximum 20mm distance. The width of the cable tray shall be selected so as to accommodate required number of cables to be laid on it, with minimum separation of minimum one cable diameter between two adjacent cables. The cables shall be tied with the cable tray with nylon strip/Aluminium clamps/GI clamps.

All steel work shall be treated in accordance with the following procedure and in accordance with IS : 6005 “Code of Practice for Phosphating Iron and Steel”.

Oil, grease, dirt and swab shall be thoroughly removed by emulsion cleaning.

Rusting and scale shall be removed by Pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and over drying.

The phosphate coating shall be sealed by the application of two coats of ready mixed staving type zinc chromate primer.

After application of the primer, two coats of finishing stove enamelled paint shall be applied.

The final finished thickness of paint film on steel shall not be less than 50 microns and shall not be more than 100 microns.

Finish painted surface of steel shall present an aesthetically pleasing appearance free from uneven surface.
The finish painting shall be black matte as per BIS or as approved by Owners.

iii. Cables Installed In The Mechanical Room

The cable reaching the motors in the mechanical room or plant room or machines room or service area shall be laid on cable tray except where indicated in masonry underground trenches.
The cable reaching the motors shall be protected by rigid galvanized conduits up to a height of 300mm above the floor. Above that height, the cable shall be protected by means of oil tight flexible metallic G.I. conduits to the terminal box of the motor. The connection between the rigid conduit and the flexible conduit shall be done by a screwed coupling of an approved type. The flexible conduit shall be properly fixed with the terminal box of the motor by means of double hexagonal check nut.

12.14 LT (415 V) BUS DUCTS

12.14.1 SCOPE

This section covers design manufacture, supply, installation, testing and commissioning of enclosed type bus ducts, indoor type, for connection as described in drawings and BOQ.

12.14.2 C ONSTRUCTIONAL REQUIREMENTS

a. These bus ducts consist of non segregated type of bus bars with three phases & neutral bus bar permanently positioned with the degree of enclosure protection as IP-54, as per IS : 13947 (Part – I).

b. The bus duct shall not have any through bolts.

c. The enclosure shall be capable of withstanding momentary short circuit currents (peak).

d. Minimum thickness of CRCA sheet steel enclosures for various sizes of bus ducts are as per table below :

Max Width Of The Enclosure	Thickness Of Sheet
50 mm or smaller	1.6 mm
Over 150 mm but not over 270 mm	2.0 mm
Over 270 mm but not over 750 mm	2.6 mm
Over 750 mm	3.0 mm

e. The enclosure shall be rectangular in section, with height not exceeding 500 mm. It shall be dust & vermin proof.

12.14.3 PAINTING

All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivating and then spraying with a high corrosion resistant primer. The Primer shall be baked in an oven. The finishing treatment shall be by application of synthetic enamel paint of approved shade and shall be stoved thereafter. The insides of enclosure shall be treated with matt black paint.

12.14.4 BUS BARS

a. The bus bar shall be high conductivity aluminium conforming to relevant Indian Standard and temperature rise calculations and bus bar sizing calculations shall be furnished along with the shop drawings to the Engineer-in-Charge/Consultant for this approval. The neutral bus bar shall be insulated by means of PVC insulation tapes or sleeves.

Maximum bus bar temperature shall not exceed 85 °C under normal operating conditions. Joints for the bus bar shall be of butt joints of bolted construction with double cover fishplates and with adequate contact area. The connectors shall be of the same material as conductor and silver-plated.

b. Temperature of the bus bars shall not exceed 250 °C while carrying the specified short circuit current for 1 second, when fault occurs at operating temperature.

12.14.5 BUS BAR SUPPORTS

a. Bus bars shall be adequately supported and insulated. The bus bar shall be sheet metal casting (fibre glass).

b. Flexible braided tinned copper connections shall be provided at the equipment terminals.

12.14.6 VENTILATION

The bus duct shall be natural cooled. Under normal operating conditions, hot spot temperature of enclosure shall not exceed 70 °C.

12.14.7 INSPECTION COVERS

Inspection covers shall be provided at suitable intervals as required. Quick acting stainless steel clamps & gaskets shall be provided.

12.14.8 EXPANSION JOINTS

The bus bar shall be supported in such a way that the expansion/contraction does not have undue strain on the bus bar and at the terminal at both ends. Rubber bellows/flexible expansion joint shall be provided. Necessary bonding will be provided at above expansion joints if made of insulating material.

12.14.9 RATING

The trunking shall be designed for the continuous current rating as specified and shall have a rupturing capacity of 31 MVA at 415 V.

12.14.10 EARTHING

Providing **earthing stations** at locations as called for, including providing & laying 600 x600 x 6 mm thick GI electrode. 20 mm dia medium class GI pipe, CI funnel with 20 gauge GI wire mesh masonry chamber with concrete base, CI manhole cover with frame (300 x 300mm) and bitumastic paint and packing of mixture of charcoal and common salt around plate electrode complete with digging & back filling as required.

Two (2) Nos. earth bars of size 50 mm x 10 mm GI will run along the entire length of the bus ducts clamped to the bus duct frame. Two (2) Nos. of earth terminal shall be provided on the enclosure at either end, for earth connection, to the main earth system with 50mm x 10 mm GI strips as specified.

12.14.11 INSTALLATION

Bus ducts running along the wall should be supported at intervals not exceeding 1.5 m. In case of branching, there should be a support on all branches at a distance of 30 cms from the point of branching. Support should not be less than 65 mm x 65 mm x 6 mm MS angle-secured in an approved manner where runs are along the walls. In case of ceiling suspended bus ducts supports made of 65 mm x 65 x 6 mm MS angle iron or 12 mm diameter MS rods shall be provided. Disconnecting links & shorting links shall also be provided. The horizontal interval between two such supports shall be 1.0 meter. These supports shall be suspended from CI boxes or suitable approved suspension devices such as dash fastener of suitable sizes in the ceiling. Phase to phase clearance of bus bars shall be not less than 32 mm and phase to earth shall be not less than 22 mm. All above mounting accessories form part of installation of bus duct.

12.14.12 TESTS AT SHOP

All routine tests will be performed as per relevant IS Codes. Visual and dimensional checks will be carried out. Typical type test certificate shall be furnished.

12.14.13 TESTS AT SITE

The following tests shall be carried out at site and test results recorded and furnished to the Engineer-in-Charge/Consultant :

a. Insulation resistance test with 500 V megger. The insulation resistance shall not be less than 100 mega ohms. The testing shall be done as per IS : 8084 as far as it is applicable to LV installation.

b. Earth continuity test.

c. 2 KV rms withstand test for 1 minute.

d. Bus bar sizing and temperature rise readings recorded during the tests shall also be furnished.

12.14.14 TEST WITNESS

Tests shall be performed in the presence of Engineer-in-Charge/Consultant or his authorized representative. The contractor shall give at least thirty (30) days advance notice of the date when the tests are proposed to be carried out.

12.14.15 TERMINAL ENCLOSURES AND FLANGES

Three phase terminal enclosure shall be provided with flanged ends with drilling dimensions to suit the flanges at equipment terminals.

12.14.16 DRAIN PLUGS AND VENTS

Filter type drain plugs shall be installed at low points along run of bus duct to drain out automatically any moisture condensing within the bus enclosure.

12.15 EARTHING SYSTEM

12.15.1 EARTHING

All the non-current carrying metal parts of electrical installation shall be earthed properly. All metal conduits, trunking, cable sheaths, switchgear, distribution boards, light fittings and all other parts made of metal shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. All earthing shall be in conformity with Indian Electricity Rules and Indian Standards IS:3043-1966.

12.15.2 EARTHING CONDUCTORS

Earthing conductors shall be of Electrolytic Copper and shall be protected against mechanical injury or corrosion.

12.15.3 SIZING OF EARTHING CONDUCTORS

The cross sectional area of copper earthing conductor shall not be smaller than half of the largest current carrying conductor subject to an upper limit of 80 sq.mm. If the area of the largest current carrying conductor or bus bar exceeds 169 sq.mm. to provide atleast half the cross sectional area, of the current carrying conductor or bus bars. All fixtures, outlet boxes and junction boxes shall be earthed with 16 SWG copper wire. All single phase metal clad switches and distribution boards shall be earthed with 4 mm dia copper wire.

All 3 phase switches and distribution boards upto 60 amps rating shall be earthed with 2 Nos. distinct and independent 3 mm dia copper wires. All 3 phase switches and distribution boards upto 100 amps rating shall be earthed with 2 Nos. distinct and independent 4 mm dia copper wires. All switches, bus bar, ducts and distribution boards of rating 200 amps and above shall be earthed with a minimum of 2 Nos separate and independent 25 mm x 3 mm copper tape.

12.15.4 CONNECTION OF EARTHING CONDUCTORS

Main earthing conductors shall be taken from the earth connections at the main switch boards to an earth electrode with which the connection is to be made. Sub-mains earthing conductors shall run from the main switch board to the sub-distribution boards. Final distribution boards earthing conduits shall run from sub-distribution boards.

Circuit earthing conductor shall run from the exposed metal of equipment and shall be connected to any point on the main earthing conductor, or its distribution boards or to an earth leakage circuit breaker. Metal conduits, cable sheathing and armouring shall be earthed at the end adjacent to switch boards at which they originate, or otherwise at the commencement of the run by an earthing conductor in effective electrical contact with cable sheathing.

Where equipment in connected by flexible cord, all exposed metal parts of the equipment shall be earthed by means of an earthing conductor enclosed with the current carrying conductors within the flexible cord. Switches, accessories, light fittings etc which are rigidly secured in effective electrical contact with a run of metallic conduit shall not be considered as a part of the earthing conductor for earthing purposes, even though the run of metallic conduit is earthed.

12.15.5 PROHIBITED CONNECTIONS

Neutral conductor, sprinkler pipes, or pipes conveying gas, water, or inflammable liquid, structural steel work, metallic enclosures, metallic condu its and lighting protection system conductors shall not be used as a means of earthing system. The electrical resistance measured between earth co nnection at the main switchboard and any other point on the completed installation shall be low enough to permit the passage of current necessary to operate fuse or circuit breakers, and shall not exceed 1 ohm.

12.15.6 EARTH CONNECTIONS

All metal clad switches and other equipment carrying single phase current shall be connected to earth by a single connection.

All metal clad switches/equipment carrying medium voltage shall be connected with earth by two separate and distinct connections. The earthing conductors inside the building wherever exposed shall be properly protected from mechanical injury by running the same in GI pipe of adequate size. The overlapping in copper strips at joints where required shall be minimum 75 mm. The joints shall be riveted and brazed in approved manner. Swathed lugs of adequate capacity and size shall be used for termination of all conductor wires above 6 sq.mm. size. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substances and properly tinned.

12.15.7 RESISTANCE TO EARTH

The resistance of earthing system shall not exceed 1 ohm.

12.15.8 EARTHING STATION (PLATE EARTHING)

Earthing electrode shall consist of a tinned copper plate not less than 600 mm x 600 mm x 3 mm thick. The plate electrode shall be buried as far as practicable below permanent moisture level but in any case not less than 3 meters below ground level.

Wherever possible earth electrodes shall be located as near the water tap, water drain or a down take pipe as possible. Earth electrodes shall not be installed in proximity to a metal fence. It shall be kept clear of the building foundations and in no case shall it be nearer than 2 meters from the outer face of the wall.

The earth plate shall be set vertically and surrounded with 150 mm thick layer of charcoal dust and salt mixture. A 20 mm GI pipe shall run from the top edge of the plate to the ground level. The top of the pipe shall be provided with a funnel and a mesh for watering the earth through the pipes. The funnel over the GI pipe shall be housed in a masonry chamber approximately 100 mm x 300 mm x 300 mm deep.

12.16 DRAWINGS

Shop drawings for control panels and wiring of equipment showing the route of conduit/cable shall be submitted by the contractor for approval of Engineer-in-charge/Owners before starting the fabrication of panel and starting the work. On completion, four sets of complete "As-installed" drawings incorporating all details like, conduits routes, number of wires in conduit, location of panels, switches, junction/pull boxes and cables route etc. shall be furnished by the Contractor.

12.17 TESTING

Before commissioning of the equipment, the entire electrical installation shall be tested in accordance with relevant BIS Codes and test report furnished by a qualified and authorised person. The entire electrical installation shall be got approved by Electrical Inspector and a certificate from Electrical Inspector shall be submitted. All tests shall be carried out in the presence of Supervisor.

12.18 PAINTING

All sheet steel work shall undergo a process of degreasing, thorough cleaning, and painting with a high corrosion resistant primer. All panels shall then be backed in an oven. The finishing treatment shall be by application of synthetic enamel paint of approved shade.

12.19 MEASUREMENT OF ELECTRICAL CONTROL PANELS

Panels shall be counted as number of units. Quoted rates shall include as lump sum (NOT measurable lengths) for all internal wiring, power wiring and earthing connections from the control panel to the starter and to the motor, control wiring for inter-locking, power and control wiring for automatic and safety controls, and control wiring for remote start/stop as well as indication as per the specifications. The quoted rate for panel shall also include all accessories, switchgear, fuses, contactors, indicating meters and lights as per the specifications.

12.20 PANEL SHOP DRAWING

The shop drawing of electrical control panels shall be got approved by the Contractor from Engineer-in-Charge before their fabrication.

13.0 HEATING SYSTEM COMPONENTS

13.1 SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of ELECTRIC HOT WATER GENERATORS and associated accessories and controls for the central heating system. Hot water generators alongwith hot water pumps shall be installed within the plant room or any other space provided for the equipment. The water shall be centrally heated to required temperature and circulated by hot water pumps to various AHUs and FCUs. Water generator safety and automatic controls shall be supplied, installed, tested and commissioned under the scope of this work.

Supplying, installing, testing & commissioning of electrical Hot Water Generator made out of 1.6mm steel CRCA sheet duly powder coated. HWG shall be suitable for Degree of protection IP52 of IS:2147. Shell shall be 8mm thick with 10mm dish end MS sheet with electric fusion welded seams. The HWG shall be equipped with sufficient number of electrical immersion heaters. The pressure vessel shall be constructed as per ASME standards & insulated on all sides with 100 mm thick fiber glass and cladded with 0.80 mm Aluminium sheet in a neat and clean manner.

The generator shall be equipped with all automatic and safety controls such as manual reset high temperature water outlet, step controller and recycling relay, 'ON' 'OFF' switch thermostats, pilot light, low water cutoff and other controls as per manufacturers recommendations. All basic controls and terminals shall be located in an integral control cabinet factory wired & tested.

The generator shall be suitable for 415 ± 10% volts, 50 cycle, 3 phase power supply. The entire generator shall be factory assembled and tested at 300 psi pressure.

The price shall include gages and thermometers at HW generator water inlet and outlet connections.

63 KW hot water generator along with electrical control panel suitable for water entering temperature at 100 °F and leaving water temperature at 120 °F at water flow rate of hot water being circulated by chilled water pump. Hot water generator as described above and complete in all respects. (All working, no standby)

13.2 COMPONENTS:

The heating system shall consist of:

a. Electric hot water generators.
b. Thermostats with step controller.
c. Hot water circulating pump.
d. Pressure gages and thermometers at water inlet and outlet. Water connections of pumps and hot water generators.
e. Pressure relief valve.
f. Chilled water pumps to act as Hot Water Pumps for winter heating..
g. Expansion tank.
h. Electrical wiring.
j. Piping and drain valve.

13.3 HOT WATER GENERATOR

Hot water generator shall be vertical / horizontal and shall be constructed in accordance with the IASME code type for unfired pressure vessel. It shall be as indicated in drawings and schedule of quantities. Working pressure of the HWG shall be 125 p.s.i. and shell tested at 300 p.s.i. Hydraulic pressure at manufacturer's works. Hot water generator shall include 4" fibreglass insulation with 22-gauge aluminium cladding and fixed within a cabinet with removable panels. All the controls, contactors and fuses shall be mounted inside the cabinet.

13.4 EXPANSION TANK

The expansion tank designed for hot volume changes shall be horizontal type for floor mounting. The tank shall be fabricated of Mild Steel plates minimum 6mm thick all welded construction. The tank shall be installed at the highest point of the water re-circulation system, and shall be fitted with gage glass, having valves on both ends to allow replacements of gage glass during operation. The tank shall be complete with manhole cover on top panel, float valve at soft makeup water inlet, piping connections for hot water return, drain and over flow. The tank shall be provided with a minimum of 4 nos. 8 x 8 x 1cm clamp angles welded to tank in case it is to be hung from ceiling. An approved air release fitting shall be provided at the top of the tank as indicated in Schedule of Quantities. The tank shall be fitted with a drain valve for complete drain out. The tank shall be insulated as per the section "Insulation".

13.5 OTHER ACCESSORIES

Other accessories for the complete heating system, namely cold and hot water pumps, Air Handling Units, Fan Coil Units, ducting and air distribution outlets, hot water piping, insulation and electrical wiring are described under the individual sections of these specifications.

13.6 CONTROLS

The operation of the entire heating system shall be fully automatic. Temperature within each conditioned space shall be maintained at specified level. Operation of various stages of heating elements shall be with step controller, fully automatic, governed by the manually adjustable setting of hot water temperature. 3-way adjustable setting of hot water temperature. 3-way diverting valve at each Air Handling Unit, and 3-way diverting valve shall divert the flow of hot water either through the coil or completely by pass the coil in order to maintain preset constant temperature within each conditioned space. On shutdown, the diverting valve shall automatically allow the entire flow to bypass the coil.

13.7 PAINTING

Shop coats of paint on various components, that have become marred during shipment of erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop-painted surfaces.

13.8 PERFORMANCE DATA

The fan and pumps shall be selected for low operating noise levels of the equipment, generator performance ratings, fans and pump performance ratings and power consumption with operating points clearly indicated, shall be submitted at the time of Technical Bid and verified at the time of testing and commissioning of the installation.

13.9 TESTING

Heating capacity of the generator shall be computed from measurements of water flow and temperatures of water entering and leaving the hot water generator. Flow measurements shall be by a manometer and temperature readings by an accurately calibrated mercury-in-glass thermometer. Computed results shall conform to the specified capacities and quoted ratings. Power consumption for various components shall be computed from measurements of incoming voltage and input current.

14.0 V IBRATION ISOLATORS

Vibration isolators shall be provided for all moving (rotating) equipments to isolate vibration of equipment and prevent it from being transmitted to supports of the equipments which may be foundations or suspenders. Such equipments may be the water chilling machines, DG Sets, pumps, motors, AHUs, FCUs, fans etc. Vibration isolators shall also be provided for fluid / air carriers like pipes and ducts. The objective of these isolators will be to prevent the possibility of vibrations of equipments / materials getting transmitted to their foundations / supports / suspenders.

Depending upon the actual application different types of vibration isolators shall be provided to suit the actual requirement at site.

14.1 RUBBER FOOT ISOLATORS

The rubber foot mountings shall be so designed that the rubber is protected from oil and physical damage and only good quality of synthetic rubber shall be used. It shall be loaded in shear and compression, a combination to give longer life with the best load /deflection characteristics. It should retain its cushioning effect and should have no tendency to get compressed and gradually become solid in due course of time.

14.2 SPRING ISOLATORS

Spring isolators will be of categories :

a. Category-1 : Category-1 spring isolators will consist of MS housing, MS cap with rubber pads of good quality provided at top and bottom. The housing shall be provided with suitable retainer holes for fixing nuts and bolts to keep the housing in position. The upper part will be flat to provide floating support to the equipment. This is for lighter loads and requires no side guides.

b. Category-2 : Category-2 spring isolators will consist of steel casting housing with rubber pads provided at the top and bottom and side guides around the spring to keep the upper portion in position. Category-2 isolators are used for relatively heavier loads.

14.3 HANGING SUPPORTS /R UBBER IN SHEAR

These supports are mostly used in suspenders of pipes and ducts. The support is provided with spring and rubber pad on its top enclosed in a housing. The suspender (support) passes thru the rubber pad and spring below it, and comes out of the housing. The pipe or duct is suspended to this support. This can be single or twin depending upon the load and actual requirement.

14.4 RESISTOFLEX PADS

These are specially designed resilient materials in the form of pads to isolate vibration. The pads will be in standard size of 4" × 4", 6" × 6", 9" × 9" or even bigger size to suit the requirement. Thickness of the pad will vary according to load requirements. However, in place of thicker pad, two or three pads of smaller thickness may be used with adequate provision of retaining housing ensuring these pads in their position

15.0 FALSE CEILING

15.1 SCOPE

The scope of this section comprises the supply and fixing / installation of metallic false ceiling as shown in drawings and described in these specifications and BOQ of the tender.

Supply and installation/fixing of non-perforated metal ceiling system In grid size of 600mm x600mm Using bevel edge, clip-in-hinge down sliding panels made up of not less than 0.5mm thick powder coated galvanised mild steel (GMS) material, finished as polyester powder coated RAL 9016 (colour code) or any other shade approved by BHEL, of minimum 60 micron paint thickness.

The panels shall be supported by primary clip in profile, made of galvanized 0.6mm steel in 4000mm length and shall be reinforced with secondary clip in profile jointed with clip in carrier connector. The clip in profile shall be connect with clip in connector made of galvanized steel pin. The secondary clip in profile shall be suspended to soffit with M6 threaded rod for variations/cutouts for installation of luminaries as per requirement of lighting system.

15.2 MATERIAL

The material used shall be light weight, non hygroscopic, antistatic and shall have pleasing aesthetic appeal and excellent utility values like durability, weather resistance, corrosion resistance, fire safety, hygiene and acoustic control.

15.3 METALLIC TILE CEILING

15.3.1 Material of Tile :

The material of tile shall be not less than 0.5 mm thick powder coated Galvanised Mild Steel (GMS). The material shall be fire resistant and for reaction to fire it will conform to International Standard MO(S/EN 10204 2.1/UNE 23.737-90) or tested in accordance with British Standards, BS 476, part 23 ; 1987, section 5. The tiles shall be produced on advanced equipment, which includes several levelling stages in the process to ensure high quality precision engineering for tiles that are flat

and dimensionally stable.

15.3.2 Finish :

The material of panel shall be finished as polyester powder coated RAL 9016 of minimum 60 micron paint thickness.

15.3.3 Color (Shade) :

The shade of the panel shall conform to RAL 9016 or as approved in shop drawing.

15.3.4 Tile Size :

The Panel size (nominal size of tile) shall be 600mm x 600mm and the panel shall be of flush tile type to give a smooth and uniform surface of false ceiling with one plain.

15.3.5 Pattern of Ceiling :

The suspension system will form square grids of 600mm x 600mm size and the tiles shall be clipped into position in the Clip-in Profile of 0.60mm thick GI grid.These metallic tiles shall form a continuous pattern of false ceiling providing for a uniform uncluttered surface.

15.3.6 Suspension System :

The suspension system shall consist of a common 0.50mm profile, made of galvanized steel, which is used both as the upper primary member as well as the lower secondary member.

The tiles shall have a hidden suspension system for an uncluttered monolithic ceiling appearance having common primary and secondary runners, which can be easily assembled with rail connectors and a rigid grid system to ensure a consistently level ceiling. The suspension system

shall be hot dip galvanized steel and the sections will consist of the following members as per site requirement :

a. Clip-in Rail : To support the panels. Length 4 M.
b. Rail Splice : To continue the run of Clip-in Rails. Length 100mm.
c. Wall Bracket : To fix the Clip-in rail to the wall.
d. Standard End Clamp : Where the Clip-in rail is cut, this end clamp should be used to provide a secured location of the panels into the rail.
e. Locking Clip : To secure the hangers two clips shall be required.
f. Rod Hanger : Made of 4mm/5mm Ø, available in lengths of 250, 375, 500, 750 and 1000mm.
g. Rail Adjustment Spring : Made of galvanized (spring) steel, V-shaped with two holes to accommodate the rod hanger. The lower par t has two lugs to clip on the Clip-in rails.
h. Perimeter Section : Perimeter section running along the wall shall be angle shaped providing standard edge cover in L/W shaped profile with punched-out tounges of Al / GI in standard thickness.

15.4 WORKMANSHIP

The ceiling shall be created in a continuous sequence. Spans shall not exceed approved length. The work shall be carried out as per manufacturer's recommended procedures. The surface created will be exactly plain with uniform grooves. The manufacturing shall be quality controlled in accordance with DIN-ISO 9001.

15.5 MEASUREMENT

The area of false ceiling will be the actual area of surface created by such false ceiling or boxing with no deductions for light fittings, grilles / diffusers, columns etc.

15.6 Associated Civil Works

Foundation (Cast-In-Situ)

RCC/PCC foundation with 2" x 2" x 0.25" angle iron ring protection on top and proper plastering of the foundation for :

Water pumps. (RCC)
Hot water generators. (RCC)
Pot strainer. (RCC)
Main AC control panel. (PCC)
Mini BMS (PCC)
AHUs (PCC)
Floor mounted fresh air/exhaust fans (RCC)

Foundations as described above with necessary pockets for grouting foundation bolts and mounting vibration isolators as required and complete in all respects.

RCC foundation as described above with 1:1:2 (1cement : 1 coarse sand : 2 graded stone aggregate 20mm nominal size) including 10mm Ø size reinforcement with 75mm spacing.)

PCC foundation as described above with 1:1:2 (1cement : 1 coarse sand : 2 graded stone aggregate 20mm nominal size) with varying size of graded stones depending upon overall size of the foundation.

15.7 MULTI SPLIT AIR CONDITIONERS:

Supply ,Installation, Testing and commissioning of 3.0 Tr. Multi Split (1:2) Type Air-conditioner, as per BOQ

APPENDIX – II

16.0 LIST OF APPROVED MAKES FOR EQUIPMENT & MATERIAL

Only approved makes for different materials / equipments as given below shall be used for this air conditioning work. No other make shall be accepted. Any make listed below but not conforming to Technical Specs/ Standards prescribed in the Tender shall not be accepted.

S.N.	Details of Materials / Equipment Make	Make (Manufacturer's Name)
16.1	a. Air Cooled Screw Chilling Machine	Carrier / LG / Trane/Yark/Dumham Bush/Clivet/Bluestar/Voltas
	b. Type of Chilling Machine	Hermetic / Semi-Hermetic (not open type)
	c. Refrigerant	R-134a
	d. Performance Test at Works	At specified site conditions of tender.
16.2	Pumps	Kirloskar / Mather Platt / Maxflow
16.3	a. Air Handling Units (AHUs) (With Coil and Fan as below	MEI / Humidin / Saiver India/ Caryaire/Blue star/ Voltas/Zeco/Edgestech
	b. Cooling / Heating Coil	Coil Company/ Carrier Aircon/ Humidin/ Blue star/Voltas/Zeco/Edgestch
	c. AHU Fan	Nicotra / Humidin / Comefri
16.4	Fan Coil Units (FCUs)	Carrier Aircon/ Coil Company/ MEI
16.5	a. Centrifugal Fans	Nicotra / Humidin / Comefri/ systemaire/ Nuaire/ Alsthom
	b. Propeller Fans	Alsthom (GEC) / Crompton/ systemaire/ Nuaire
16.6	Hot Water Generator	KEPL / Humidin / Thermax
16.7	Pipes / Valves / Sheet :	
	a. MS Pipes upto 200mm dia	TATA Steel / Jindal Hissar/Zenith
	b. MS Pipes 250mm to 400mm dia	SAIL/Zenith/Jindal(HeavyDutyFactory Rolled)
	c. MS Pipes above 400mm dia	Jindal/SAIL (Heavy Duty Factory Rolled)

	d. GS Sheet : For All Thicknesses	SAIL/TATA Steel /Nippon/Jindal/ ISPAT
	e. Butterfly Valve	Audco / Advance / Castle/BBVI
	f. Balancing Valve (Manual)	Advance/Castle/NAVTECH/TA DIGITAL
	g. Gate / Globe Valve	Leader / Castle / Audco
	h. Check Valve	Advance / Castle / Audco
	j. Pot Strainer	Emerald / DS Engineering
	k. Y-Strainer	Emerald / DS Engineering
	l. Dial Type Thermome ter & Pressure Gauge	Japson / H Guru/FIEBIG
	m. Stem Type 'V' form Thermometer (Aluminium Alloy Body)	Japson / Emerald /FIEBIG
	n. Flow Meter	Rockwin / Castle
	p. Stainless Steel Water Pressure Gauge	Emerald / H Guru
16.8	a. Extruded-Aluminium Grilles/Diffusers (Powder Coated)	Dynamic / Opella / TANUS
	b. MS Grilles / Diffusers (Powder Coated)	TANUS / Dynamic / Ravi Star/AIR MASTER/DYNACRAFT/CARYAIRE
	c. i. Fire Damper	Mapro / MEI / Humidin / CARYAIRE/ Ravi Star/ConAir
	ii. Fire / Smoke Sensor	Apollo / Edwards / System Sensor
	iii. Fire Damper Actuator	Belimo / Siemens/Johnson controls
	d. Perforated Diffuser Plate (Laminar Flow Diffusers for Clean Room Areas)	Ravistar / Dynamic / Humidin
	e. Volume Control Dampers	Ravistar / Dynamic / Humidin
	f. Butterfly Damper	Ravistar / Dynamic / Humidin
	g. Fire Retarding Canvas for flexible	Navair / Pyroguard

connection

16.9	Metal False Ceiling	Durlum / Lindner / SAS/Luxalon
16.10	Insulation :	
	a. Cross linked closed cell polyethylene (FR-XPE)	Paramount / Vidoflex / Eurobatex Supreme/Superlon
	b. Expanded Polystyrene TF Quality	ARKC / Beardsell /Styrene-packaging/Debs Products/Coolite
	c. Fiberglass	Owens Corning /Supreme/Up-Twiga
	d. Hessian Fire Retarding	Navair / Pyroguard
	e. Expanded polyethylene	Kini Foam Armaflex/K-Flex/ Supreme
	f. Adhesive	Pidilite SR998 / Fevicol SR-X-Pres
16.11	Controls :	
	a.i. 3-Way Modulating Valve for AHUs	Honeywell / Johnson Controls / Landis & Staefa / Anergy
	ii. 3-Way Diverting Valves for FCUs	Honeywell / Johnson Controls / Landis & Staefa / Anergy
	b. Modulating Motor	Honeywell / Johnson Controls / Landis & Staefa/Anergy
	c. Room Thermostat / Humidistat	Honeywell / Johnson Controls / Landis &Staefa / Anergy
	d. Electronic Thermometers	Instruments Research Associates (IRA)/Johnson Controls
	e. HP / LP Cut-out	Penn / Danfoss / Renco
	f. Oil Pressure Safety Switch	Penn / Denfoss / Renco

S.N.	Details of Materials / Equipment Make	Make (Manufacturer's Name)
	g. Refrigerant Solenoid Valve	Sporlon / Danfoss
	h. Expansion Valves	Sporlon / Alco / Danfoss
	j. Chilled Water / Anti Freeze Thermostat	Honeywell / Penn / Danfoss / Renco
	k. Water Flow Switch	Danfoss / Switzer / Anergy/Rapid Control
	l. Airstat	Honeywell / Johnson Controls / Anergy
16.12	Miscellaneous :	
	a. Vibration Isolators :	
	• Springs, Neoprene Pads	Resistoflex / Emerald/Flexonics/ CORI
	• Flexible Connections	Flexonics Mason/Resistoflex/Easyflex/ CORI
	b. Prefilters, Fine & HEPA Filters	Kirloskar Snydergeneral / Thermodyne / Anfilco/ Humidin / Caryaire/ Aerosol /KLENZAIR/PURAIR/John Fowler
	c. Humidifier	KEPL / Emerald
	d. Auto Purge Valve	Flamco (Anergy)
	e. Arc Welding Electrodes	Advani / L&T
	f. Temperature and RH Indicator (Digital)	Instrument Research Associates (IRA) / Johnson Controls
	g. Paint	Asian / Nerolac / ICI
16.13	Electrical Items :	
	a. Air Circuit Breaker (ACB)	L&T/Siemens/EnglishElectric/GE/C&S/ ABB
	b. Moulded Case Circuit Breaker (MCCB)	L&T / EE / Crompton/Siemens/GE/MDS/ LEGRAND
	c. Miniature Circuit Breaker (MCB)	Indo Kopp / MDS / Havells / Siemens / L&T/GE/LEGRAND/INDOASIAN/BCH/ C&S
	d. Motors	Siemens/ Bharat Bijlee / Crompton / NGEF /ABB/BHEL/Kirloskar/Beacon/AEI
	e. Closed Transition Star Delta Starter	BCH / KEPL / Mysore Electrical Industries Jyoti/Siemens /L&T/BCH
	f. Starters, Contactors, Push Button and Overload Relays	L&T / Siemens / Crompton /BCH

g. Single Phase Preventer	L&T / Minilec Siemens /C&S/BCH/ Schneider
h. Current Transformers	Automatic Electric /kappa Telk/ Siemens/Indcoil/AEL/Kalpa
j. Capacitors	Genelac / Khatau Junker / L&T
k. Switches / Fuse Units	L&T / Siemens / English Electric/GE
l. Rotary Switches	L&T / Siemens/Kaycee/Reco
m. HRC fuses and Fuse Fittings	L&T / Siemens / English Electric
n. Toggle Switches, Selector Switches	Kaycee/ L&T / Siemens/Reco
p. Changeover Switches	HH Elcon / Control & Switchgear /C&S/ Havells/ L&T/AE/ NECO/ IMP
q. Ammeter and Voltmeter	Automatic Electric/ AE/ NECO/ IMP
r. Indicating Lamps Wires / LED	L&T / Siemens / BCH/Technic
s. MV Cables (Power Cables) Accessories	CCI/Skytone/Finolex/ Universal/Nicco/ Polycap
t. Control Cables & PVC Insulated Wires	National / Finolex / Skytone/ Anchor/ Wincap
v. Rising Mains / Bus Duct	Tricolite / KEPL / Trinitron
w. Time Delay Relays	LT-LK / Bhartiya Cutler Hammer / L&T/ Siemens/ BCH/EE/ C&S/ Schneider
x. MS Conduits and its Accessories	Steel Craft / BEC
y. LT Control Panel / DBs / CILP (CPRI Approved Vendor)	Trinitron / KEPL / Tricolite/Stahllform Technik pvt. Ltd/ Shanthi Enterprises Electricals pvt.ltd/Brite Engineering / Lotus Power Gear/pragathi Controls
z. Mini BMS	Honeywell / Anergy / Johnson Controls / Landis & Staefa

Note : If make of any equipment / material required for the work is not available in this list, the same should be brought to the notice of BHEL by the tenderer in writing before submitting his offer.

APPENDIX – III

17.0 LIST OF BUREAU OF INDIAN STANDARDS CODES

17.1	IS : 1239 (Part - I)-1979	Mild Steel tube
17.2	IS : 1239 (Part - II)-1982	Mild Steel Tubulars & other wrought steel pipe fittings.
17.3	IS : 4736 - 1968	Hot-dip zinc coatings on steel tubes.
17.4	IS : 823 - 1964	Code of procedure for manual metal arc welding of Mild Steel.
17.5	IS : 780 - 1980	Sluice valves for water works purposes.
17.6	IS : 778 - 1980	Copper alloy gate, globe and check valves for water works purposes.
17.7	IS : 1536 - 1976	Flanges configurations.
17.8	IS : 5312 (Part-I) - 1984	Swing-check type reflex non-return valves for water works
17.9	IS : 2379 - 1963	Colour code for the identification of pipelines.
17.10	IS : 554 - 1975	Dimensions for pipe threads where pressure tight joints are required on the threads.
17.11	IS : 655 - 1963	Metal air ducts.
17.12	IS : 277 - 1977	Galvanized steel wire for fencing.
17.13	IS : 4064 - (Part-II)-1978	Specific requirements for the direct switching of individual motors.
17.14	IS : 3854 - 1969	Switches for domestic & similar purposes.
17.15	IS : 694 - 1977	PVC insulated (HD) electric cables for working voltage upto & including 1100 volts.
17.16	IS : 9224 (Part-II)-1979	HRC cartridge fuse links up to 650 volts.
17.17	IS : 8544 (Part-I to IV)-1979	Starters.
17.18	IS : 732 (Part-III) - 1982	Inspection and testing of installation.
17.19	IS : 659- 1964	Air conditioning (Safety Code)
17.20	IS : 660 - 1963	Mechanical Refrigeration (Safety Code)
17.21	IS : 4894 - 1987	Test Code for Centrifugal Fan.
17.22	IS : 3103 - 1975	Code of practice for Industrial Ventilation.

APPENDIX – IV

18.0 SCHEDULE OF TECHNICAL DATA

a. The technical parameters/particulars/details as called for below form part of vital informations needed for Technical evaluation of Tenderer's offer and should be furnished in full details and clarity in the required format failing which the offer MAY BE REJECTED without any consideration.

b. Exact detail as asked for should be furnished AGAINST EACH ITEM along with the offer of the tenderer.

c. Any subsequent details furnished/submitted by the tenderer on his own will not be considered as a part of his offer and the same MAY NOT BE CONSIDERED for evaluation of the offer. The BHEL, however, is at liberty to ask for any clarifications.

d. Failure to furnish these details along with tenderer's offer will render the tender incomplete and the tender MAY NOT be considered.

e. Replies like 'to suit duty', 'as per manufacturers standard', 'as per OEM supply', 'shall be furnished later', 'as per list of makes attached', 'to be provided during detailed engineering', 'as per NIT', 'as per proprietary design information', 'proprietary information /data' etc shall be considered irrelevant and will be of no consequence so far as the evaluation of the bid is concerned and the tender will be considered incomplete.

f. Different makes of equipments/materials have been given in the tender and the tenderer has to offer from the same. Tenderer can pick-up any one make of his choice/convenience and identify the same in his offer by giving details as asked for below. In this regard the offer of the tenderer should be very categorical and to the point. Any makes of equipments/materials offered by the tenderer which do not appear in the Approved Makes of the tender shall not be considered.

g. With regard to difficulty, if any, in interpretation or intent of informations / details asked for in this section, the tenderer may contact Engineer-in-Charge for clarifications prier to submitting his offer.

PARAMETERS	TENDERER'S OFFER

18.1 A IR COOLED WATER CHILLING MACHINE

I. THE CHILLING MACHINE

1. Air Cooled ? (Confirm) .....

2. Manufacturer (Make) .....

3. Country of Origin .....

4. Model No. . .....
(Give exact and complete details)

5. Overall dimensions of chilling Machine (L x W x H : mm) .....

6. Weight of machine as shipped (kg) .....

7. Operating weight of machine at site (kg) .....

8. Actual capacity of chilling machine at specified tender conditions (TR) .....

9. Refrigerant used (R-134a ?) .....

10. Quantity of refrigerant charged (kg) .....

11. Compressor :

a. Make of compressor .....

b. Model no. of compressor .....

c. Max revolutions per minute (RPM) .....

d. Working pressure (psi)

i. Suction .....

ii. Discharge .....

12. Mode of start .....

13. Power Consumption :

a. Total power consumption (including condenser fans) at full load (Kw)at site conditions specified in the tender. .....

PARAMETERS	TENDERER'S OFFER
b. IKW/TR (including condenser fans) at actual tender conditions :	
i. 100% load	.....
ii. 75% load	.....
iii. 50% load	.....
iv. 25% load	.....
14. No. of refrigerant circuits (each machine)	.....
15. Type of Capacity Control	.....
16. Range of capacity variation	.....
17. Safety Devices/control	.....
18. Monitoring Controls Microprocessor based control panel, (Furnish Details).	.....
19. Type of bearings.	.....
20. Type of vibration Isolation for water chilling machine.	.....
21. Over all total space required for placing 2 (two) chilling units together in linear fashion : M x M	.....
II. COMPRESSOR MOTOR	
1. Motor Manufacturer.	.....
2. Type	.....
3. HP	.....
4. Electrical Characteristic (415 V + 10%, 3Ø, 50 Hz)	.....
5. Method of starting	.....
6. Class of insulation	.....
7. Starter manufacturer	.....

PARAMETERS	TENDERER'S OFFER

8. Full load current (Amps) .....

9. Starting current (Amps) .....

10. No Load Current (Amps) .....

III. CONDENSER

1. Manufacturer / Make .....

2. Model No. .....

3. Type (Air Cooled ?) .....

4. Exhaust air upward ? .....

5. No. of Fans each machine .....

6. Air Quantity (CFM) per fan .....

7. Fan Air Velocity (FPM) .....

8. Static Pressure (mm) .....

9. HP of each Fan .....

10. Type of control. . .....

11. Safety / protection. .....

12. Tube material .....

13. Wall thickness of tube (mm) .....

14. Tube diameter (mm) .....

IV. CHILLER

1. Manufacturer/Make .....

2. Model .....

3. Type .....

4. Shell Material .....

5. Shell dia (mm) .....

6. Tube length (mm) .....

7. Tube material .....

PARAMETERS	TENDERER'S OFFER

8. Wall thickness of tube (mm) . .....

9. Tube diameter (mm) .....

10. Total No. of tubes. .....

11. Type of fins. .....

12. Refrigerant Temp (degree F)
    i. Entering .....

    ii. Leaving .....

13. No. of passes. .....

14. Water flow (USGPM) .....

15. Water velocity (FPM) .....

16. Pressure drop (Ft. of water) .....

17. Size of water pipe connection. .....

18. Water temperature :
    a. Entering - degree F .....

    b. Leaving - degree F .....

19. Type of control. .....

20. Safety / protection. .....

18.2 AIR HANDLING UNITS (OPERATING DATA)

AHU No.	Air Qty (CFM)	S P (Inch)	Coil Face Area (SFT)	Coil Face Vel (FPM)	Outlet Vel. (FPM)	No. of Rows	Motor HP
AHU-1	29000						
AHU-2	29000						
AHU-3	26000						
AHU-4	26000						

PARAMETERS	TENDERER'S OFFER
18.3 AIR HANDLING UNITS (COMPONENTS)	**Double skin**
I. General	
a. Manufacturer	.....
b. Type of unit. (single / double skin)	.....
c. Insulating Material (CFC free PUF injection for Double Skin **: Confirm**)	.....
d. Overall dimension. L x W x H (mm)	.....
e. Noise level (dB).	.....
f. Material and thickness of casing.	.....
g. Material and thickness of drain pan.	.....
h. Operating weight (Kg.)	.....
II. Fan Section	
a. Manufacturer.	.....
b. Type of fan (Forward/Backward)	.....
c. Fan speed (RPM).	.....
d. No. of fans in one AHU.	.....
e. Fan wheel diameter (mm)	.....
f. Drive arrangement.	.....
g. No. of belts with the belt drive.	.....
h. Material and thickness of fan wheel and blades	.....
i. Material and thickness of housing.	.....
j. Fan outlet area (Sq.Ft.)	.....
k. Outlet velocity (FPM)	.....
l. Total air quantity CFM	.....
m. Static pressure at outlet (inch water gage)	.....

PARAMETERS	TENDERER'S OFFER

n. Whether statically and dynamically balanced .....

p. Type of bearings. .....

q. Type of vibration isolators. .....

III. Motors

a. Manufacturer .....

b. Type .....

c. Electrical characteristics (415 + 10%V, 3ø, 50 Cycles). .....

d. Class of insulation .....

e. Motor speed (RPM) .....

f. Starter Manufacturer .....

IV. Cooling Coil

a. Manufacturer .....

b. Type .....

c. Material of tubes. .....

d. Material of fin .....

e. Tube diameter. .....

f. Tube wall thickness .....

g. Fin thickness .....

h. Method of bonding of tube and fins. .....

j. No. of fins/cm .....

k. Total tube surface area, outside (Sqm) .....

l. Test pressure. (Kg/cm2) .....

m. Flow rate of water (USGPM) .....

n. Pressure drop in coil (ft. of water) .....

PARAMETERS	TENDERER'S OFFER	
V. Air Filters.	**Prefilter**	**Fine filter**
a. Manufacturer		
b. Material of frame work and its thickness (mm)	.....	.....
c. Filter medium	.....	.....
d. i. Rated flow (CFM)	.....	.....
ii. Face velocity (FPM)	.....	
e. Size of filter		
i. Flange to flange (mm)	.....	.....
ii. Cassette dimension (mm)	.....	.....
f. Particle size (micron)	.....	.....
g. Efficiency of filter %	.....	.....
h. No. of folds	.....	.....
j. Filter Medium Area	.....	.....
k. Initial pressure drop at rated flow (mm)	.....	.....
l. Final pressure drop at choked condition (mm)	.....	.....
m. Velocity of air flow (FPM)	.....	.....
n. Face velocity across filters.(FPM).	.....	

18.4 CENTRIFUGAL PUMPS **CHILLED /HOT WATER**

a. Manufacturer .....

b. Type / Model .....

c. Capacity (USGPM) .....

d. Head (ft.) .....

e. Efficiency (%) .....

PARAMETERS	TENDERER'S OFFER

f. Pump (RPM) .....

g. Motor B.H.P. .....

h. Motor – HP .....

j. Motor make .....

k. Permissible voltage fluctuations (415 ± …...%V) .....

l. Method of Starting .....

m. Starter make .....

n. Impeller material .....

p. Impeller diameter (mm) .....

q. Suction/discharge dia (mm) .....

r. Type of water seals .....

s. Vibration isolation .....

t. Operating weight (Kg) .....

v. Overall dimensions (mm) .....

18.5 HOT WATER GENERATOR

a. Make .....

b. Shell material .....

c. Shell thickness .....

d. No. of steps .....

e. Make of heaters .....

f. Total rating (KW) .....

g. Test Pressure .....

h. Float switch .....

j. Flow switch .....

k. Thermostats .....

PARAMETERS	TENDERER'S OFFER

l. Pressure, temp relief valve. .....

m. Thermometers .....

n. Pressure Gauge .....

p. Step controller/make .....

q. Circulating water quantity USGPM. .....

r. Water temp Degree F : IN .....

OUT .....

18.6 ELECTRICAL CONTROLS

I. 3-way motorized valves for Air Handling Units

a. Make of valve .....

b. Model / type .....

c. Modutrol motor make .....

d. Modutrol motor model .....

e. Transformer make & model .....

g. Selected Cv. .....

h. Valve linkage make and model. .....

II. Thermostats for Air Handling Units

a. Make .....

b. Model/type .....

c. Range .....

d. Differential .....

e. Electrical characteristics .....

III. Additional make and model No.
of following controls/instruments
(Wherever required).

a. Single Phase Preventor .....

b. Damper Actuator .....

PARAMETERS	TENDERER'S OFFER

c. Static pressure gauges .....

d. Electronic Temperature Indicators .....

e. PH sensor cum switch .....

f. Expansion valve .....

g. Flow switch .....

18.7 ELECTRICAL ACCESSORIES

Make of the following :

a. Electrical Panels / Control Panels .....

b. Mini BMS .....

c. Air Circuit Breaker (ACB) .....

d. Rising Mains / Bus Duct .....

e. Switch fuse units and HRC fuses .....

f. M C C B .....

g. Rotary Switches .....

h. Capacitor Switches .....

j. Closed Transition Star Delta Starter .....

k. Star Delta Starter .....

l. Contactors .....

m. Current Transformers . .....

n. Single phase preventors .....

p. Push Buttons .....

q. Ammeter & Voltmeter .....

r. Relays .....

s. Indication lamps .....

t. Cables .....

v. Wires. .....

PARAMETERS	TENDERER'S OFFER

w. Energy meter .....

18.8 WATER PIPING

I. a. Make and class of GI pipe .....

b. Make of MS Pipe .....

c. Wall thickness of MS pipe (mm)
i. Upto 150 mm dia .....

ii. Above 150 and to 400mm dia .....

iii. 450mm to 750mm dia .....

iv. Above 750mm diameter .....

II. Valves
a. Make of Valves / Strainers .....

b. Balancing valve makes .....

c. Gate valve makes .....

d. Check valve make . .....

e. Ball valve make .....

f. Butterfly valve make. .....

g. Pot strainers .....

h. Y Strainers .....

III. Pressure Gauge
a. Make .....

b. Range .....

c. Dial size .....

IV. Flow Meter
a. Type and make .....

b. Size of flow meter. .....

c. Make of Manometer. .....

PARAMETERS	TENDERER'S OFFER

18.9 GRILLES DIFFUSERS/D AMPERS

Make, material and gauge of the following :

a. Fire Dampers .....

b. Grilles / Diffusers .....

c. Duct Damper / FA Damper .....

d. Butterfly Damper .....

e. Zero Leak Damper .....

f. Perforated Diffuser .....

18.10 INSULATION

a. Manufacturer / Make .....

b. K value .....

c. Size upto which pipe section is available .....

d. Pipe insulation material .....

e. Density - Pipe sections insulation. Kg/M3 .....

- Slab/Roll insulation. Kg/M3 .....

18.11 METAL FALSE CEILING

a. Make of False Ceiling Material .....

b. Size of panels .....

c. Material of Sheet .....

d. Thickness of Sheet .....

18.12 PAN HUMIDIFIER

a. Make .....

b. Material of Vessel .....

c. Capacity (KW) .....

d. Size (mm) .....

PARAMETERS	TENDERER'S OFFER

18.13 VIBRATION ISOLATION SYSTEM

a. Manufacturer .....

b. Type .....

18.14 T ESTING AND BALANCING EQUIPMENT

Furnish the complete list to be used on this project. .....

Note : For all the equipments mentioned above, the tenderer is required to supply manufacturer's write up / technical literature / catalogue alongwith his technical bid.

LIST OF DRAWINGS

S.No Drg. No. Description

1. HVAC-01 Ground Floor Plan : Location of AHUs, Piping and Ducting Layout
2. HVAC-02 Air Conditioning System : Equipment / Piping Layout in Plant Room
3. HVAC-03 Section 'X-X' Showing Ducting Layout & False Ceiling
4. HVAC-04 Air Conditioning System : Equipment /Piping Layout (Schematic)
5. HVAC-05 Main AC Control Panel : Single Line Diagram
6. HVAC-06 Under-Deck Insulation (Typical Arrangements)
7. HVAC-07 Under-Deck Insulation : GI 'U' Channel Frame
8. HVAC-08 Under-Deck Insulation : Fixing Arrangements
9. HVAC-09 Schematic Arrangement of False Ceiling
10. HVAC-G:01 Typical Arrangements : Pipe Insulation & AHU Coil Connection
11. HVAC-G:02 Typical Arrangements : Chilling Machine Header & Propeller / Axial Fans
12. HVAC-G:03 Typical Arrangements : Duct Supports & Accessories.
13. HVAC-G:04 Typical Arrangements : Double Skin AHU
14. HVAC-G:05 Typical Arrangements : Pot Strainer and Hot Water Generator

LIST OF INDIAN STANDARD

I.S. 325	-	-	Three phase induction Motors.
I.S. 1822	-	-	Motor starters of voltage not exceeding 1000 volts
I.S. 3624	-	-	Borden tube pressure and vacuum gauge.
I.S. 1620	-	-	Horizontal centrifugal pumps and for clear, cold fresh water.
I.S. 996	-	-	Single phase small A.C. and universal motors.
I.S. 277	-	-	Galvanized steel sheets.
I.S. 655	-	-	Metal Air ducts.
I.S. 900	-	-	Code of practice for installation and maintenance of induction motors.
I.S. 2208	-	-	HRC cartridge fuse-links upto 650 volts.
I.S. 1554 (I)		-	PVC insulated (heavy duty) Electric cables for working voltage upto and including 1100 volts.

APPENDIX - III

I.S. SAFETY CODES

I.S. 660	-	-	-	Safety code for mechanical refrigeration.
I.S. 659	-	-	-	Safety code for air conditioning
I.S. 3016	-	-	-	Code of practice for fire precautions in welding and cutting operations.
I.S. 818	-	-	-	Code of practice for safety and Health requirements in electrical & gas welding and cutting operations.
I.S.5216	-	-	-	Code for safety procedures and practices in Electrical works.
I.S. 3696	-	-	-	Safety code for scaffolds and ladders.

ANNEXURE-II

Questionnaire

Questionnaire to be answered by the tenderer by ticking the suitable boxes

S.No.	Description	Yes	No
01	Whether the tenderer has understood the scope of work as indicated in the tender. (If there is any clarification required, the same may be got cleared from the Executive in charge, before submitting the offer.)		
02	Whether the tenderer has agreed to all terms and Conditions given in the tender. (If there is any deviation, the same may be mentioned in separate sheet.		
03	Whether the tenderer agrees for the payment terms mentioned in the tender.		
04	Whether the tenderer has their own code for ESI and PF. (If the tenderer does not possess their own code their offer will not be considered. Paying the PF and ESI on another agency's name / sister concern is not acceptable.)		
05	Whether the tenderer agrees to comply with all statutory regulation.		
06	Whether the tenderer agrees to give validity of offer for 3 months from the date of opening of technical bid.		
07	Whether the tenderer agrees to company with all safety Standards as mentioned in the tender specification.		
08	Whether the tenderer has agreed to submit EMD of Rs. 200,000/- (Rs Two Lakh) and has submitted the same along with technical bid. (If not enclosed, the tender will not be considered.)		
09	Whether the tenderer has enclosed the DD for Rs. 1,000/- towards the cost of Tender Document, along with the Technical bid. (In case of tender documents are down loaded from BHEL web site.)		
10	Whether the tenderer has service Tax registration No. (If they do not have the same, the offer will not be considered.)		
11	Whether the tenderer has agreed to submit Security Deposit immediately after receipt of the work order as mentioned in the tender.		

S.No.	Description	Yes	No
12	Whether the tenderer has enclosed the list of clients with addresses and contact person.		
13	Whether the tenderer has enclosed the list of similar works already done / being done with the addresses and contact person.		
14	Whether the tenderer has enclosed the certificates received from Government / Reputed organization for the similar work done.		
15	Whether the tenderer has enclosed the list of technical personnel their qualification and experience who will be in charge for this work.		
16	Whether the tenderer has indicated the address of their local offer in Banglore along with the phone no. & fax no. etc.		
17	Whether the tenderer has enclosed the solvency certificate obtained from a bank for a value not less than the estimated cost of the work.		
18	Whether the tenderer has enclosed the copy of Power of Attorney (if applicable)		
19	Whether the tenderer has enclosed the certificate to establish that the tenderer is an independent contractor working on his own.		
20	Whether the tenderer has agreed to supply materials as per the Approved makes as mentioned in the tender.		
21	Whether tenderer has agreed to insure all supplying materials and his labours.		

Note : If any of the question is not applicable, please mention as “Not Applicable”

ANEXURE: 'B'

GENERAL CONDITIONS 0F CONTRACT

It is hereby agreed by me/us that the BHEL General Conditions of Contract including subsequent amendments/ additions/ deletions to clauses if any, and conditions pertaining to the settlement of disputes by Arbitration form an integral part of the tender documents and that the tender submitted by me / us is subject to the aforesaid BHEL General Conditions of Contract which has been read and accepted by me/us.

ANNEXURE 'C'

CLAUSE 20 OF GENERAL CONDITIONS OF CONTRACT

LABOUR

The Contractor shall employ labour in sufficient numbers either directly or through sub-contractors to maintain the required date of progress and of quality to ensure workmanship to the degree specified in the contract and to the satisfaction of the Engineer-in-charge. The contractor shall not employ, in connection with the works, any person who has not completed eighteen years of age.

The Contractor shall furnish to the Engineer-in-charge, at the intervals specified by him, a distribution return of the number and description by trades of the work people employed on the works. The Contractor shall also submit on the 4th and 19th of every month to the Engineer-in-charge a true statement showing in respect of the second half of the preceding month and the first half of the current month (i) the accidents that occurred during the said fortnight showing the circumstances under which they happened and the extent of damage and injury caused by them and (ii) the number of female workers who have been allowed maternity benefits as provided in the Maternity Benefit Act, 1961 or Rules made there under and the amount paid to them.

The Contractor shall pay to labour employed by him, either directly or through sub-contractors, wages not less than fair wages, as defined in the Contractor's Labour Regulations.

The Contractor shall in respect of labour employed by him, either directly or through sub-contractors, comply with or cause to be complied with contractor's labour Regulations in regard to all matters provided therein.

The Contractor shall comply with the provisions of the payment of Wages Act, 1936, Minimum Wages Act, 1948, Workmen's Compensation Act 1923, Industrial Disputes Act, 1947, Maternity Benefit Act 1961, or any modifications thereof or any other law relating there to and rules made thereunder from time to time.

The Contractor shall be liable to pay his contribution and the employees' contribution of the State Insurance Scheme in respect of all labour employed by him for the execution of the contract, in accordance with the provision of "The Employees' State Insurance Act, 1948," as amended from time to time. The Contractor shall apply to the ESI Authorities, get himself registered with them and obtain a code Number. He shall pay the remittances under his Code Number only.

The Contractor shall be liable to his contribution and the employees contribution towards PF as per Provident Fund Rules and Regulations, in respect of all labour employed by him for the execution of the contract. The Contractor shall apply to the PF Authorities, get himself registered and obtain a code number from them. He shall pay the remittances towards PF under his code number only.

The Engineer-in-charge shall, on a report having been made by an Inspecting Officer as defined in the Contractor's Labour Regulations, have the power to deduct from the moneys due to the contractor any sum required or estimated to be required, for making good the loss suffered by a worker or workers by reason of non fulfillment of the conditions of the contract for the benefit of workers, non-payment of wages or of deductions made from his or their wages which are not justified by the terms of the Contract of non observance of the said Contractor's Labour Regulations.

The Contractor shall indemnify BHEL against any payment to be made under and for observance of the Regulations aforesaid without prejudice to his right to claim indemnity from his sub-contractors.

In the event of the Contractor committing a default or breach of any of the provisions of the aforesaid contractor's Labour Regulations, as amended from time to time or furnishing any information or submitting or filling any form / Register / Slip under the provisions of these Regulations which is materially incorrect, then, on the report of the Inspecting Officers as defined in the Contractors Labour Regulations, the Contractor shall without prejudice to any other liability pay to BHEL a sum not exceeding Rs. 50/- as liquidated damages for every default, breach, or furnishing, making, submitting, filling materially incorrect statements as may be fixed by the Engineer – In – Charge and in the event of the contractor's default continuing in this respect, the liquidated damages may be enhanced to Rs. 50/- per day for each day of default subject to a maximum percent of the estimated cost of works put to tender. The Contractor shall defend the case by himself any action brought in by such Government Agencies for non-compliance of any Labour Regulations and / or reimburse the expenses incurred by BHEL in this regard.

The Engineer-in-charge shall deduct such amount from bills or security deposit of the Contractor and credit the same to the welfare fund constituted under Regulations. The decisions of the Engineer-in-charge in this respect shall be final and binding.

MODEL RULES FOR LABOUR WELFARE

The Contractor shall, at his own expense, comply with or cause to be complied with Model Rules for Labour Welfare as appended to these conditions or rules framed by Government from time to time, for the protection of health and for making sanitary arrangements for workers employed directly or indirectly on the works. In case the Contractor fails to make arrangements as aforesaid, the Engineer-in-charge shall be entitled to do so and recover the cost thereof from the contractor.

SAFETY CODE

RESPOSIBILITIES OF THE CONTRACTOR IN RESPECT OF
SAFETY OF MEN, EQUIPMENT, MATERIAL AND ENVIRONMENT

1. Before commencing the work, the contractor is required to submit a "SAFETY PLAN" to the authorised BHEL Official. The 'Safety Plan' shall indicate, in detail, the measure that would be taken by the contractor to ensure safety of men, equipment, material and environment during execution of the work. The plan shall take care to satisfy all requirements specified hereunder. The contractor shall submit safety plan along with his offer. During negotiations before placing of work order and during execution of the contract, BHEL shall have right to review and suggest modification in the Safety Plan. The contractor shall abide by BHEL's decision in this respect.

2. The contractor shall take all necessary safety precautions and arrange for appropriate appliances as per direction of BHEL, or its authorised officials, to prevent loss of human lives, injuries to personnel engaged, and damage to property and environment.

3. The contractor shall provide to its work force and ensure the use of the following personal protective equipment as found necessary and as directed by the authorised BHEL officials:-

   (i) Safety Helmets conforming to IS – 2925: 1984.
   (ii) Safety Belts conforming to IS – 3521: 1983.
   (iii) Safety Shoes conforming to IS – 1989: 1978.
   (iv) Eye and Face Protection devices conforming to IS – 8520: 1977 and IS – 8940: 1978.
   (V) Hand and body protection devices conforming to:
   IS – 2573: 1975
   IS – 6994: 1973
   IS – 8807: 1978
   IS – 8519: 1977.

   All tools, tackles, lifting appliances, material handling equipment, scaffolds, cradles, safety nets, ladders, equipment etc. used by the contractor shall be of safe design and construction. These shall be tested and certificate of fitness obtained, before putting them to use and from time to time as instructed by authorised BHEL official who shall have the right to ban the use of any item.

   All electrical equipment, connections and wiring for constructions, power, its Distribution and use shall conform to the requirement of Indian Electricity Act and Rules. Only electricians licensed by the appropriate statutory authority shall be employed by the contractor to carry out all types of electrical works. All electrical appliances including portable electric tools used by the contractor shall have safe plugging system to source of power and be appropriately earthed.

   The Contractor shall not use any hand – lamp energised by electric power with supply voltage of more than 24 Volts. For work in confined spaces, lighting shall be arranged with power source of not more than 24 Volts.

   The contractor shall adopt all fire safety measures as laid down in the "Code for Fire Safety at Construction sites" issued by the Safety Department of the Construction management

   (HQ) of BHEL and as per the directions of the authorised BHEL official. A copy of the above referred

   "Code of Fire Safety at Construction Sites" shall be made available by BHEL to the contractor for reference, on demand by the contractor, during tendering stage itself.

Where it becomes necessary to provide and/or store Petroleum Products, explosives, chemicals and liquid or gaseous fuel or any other substance that may cause fire or explosion, the contractor shall be responsible for carrying out such provisions and/or storage in accordance with the rules and regulations laid down in the relevant government acts, such as Petroleum Act, Petroleum and Carbides of Calcium Manual of the Chief Controller of Explosives, Govt. of India etc., Prior approval of the authorised BHEL official at the site shall also be taken by the contractor in all such matters.

The contractor shall arrange at his cost (wherever not specified), appropriate illumination at all work spots for safe working when natural daylight may not be adequate for clear visibility.

The contractor shall be held responsible for any violation of statutory regulations local, state or central and BHEL instructions, that may endanger safety of men, equipment, material and environment in his scope of work or another contractor's or agency's. Cost of damages if any, to life and property arising out of such violation of statutory regulations and BHEL instructions, shall be borne by the contractor.

In case of a fatal or disabling injury / accident to any person at construction sites due to lapses by the contractor, the victim and/or his/her dependents shall be compensated by the contractor as per statutory requirements. However, if considered necessary, BHEL have the right to impose appropriate financial penalty on the contractor and recover the same from payments due to the contractor for suitably compensating the victim and/or his/her dependents. Before imposing any such penalty, appropriate enquiry shall be held by BHEL giving opportunity to the contractor to present his case.

In case of any damage to property due to lapses by the contractor, BHEL shall have the right to recover cost of such damages from payments due to the contractor after holding an appropriate enquiry.

In case of any delay in the completion of a job due to mishaps attributable to lapses by the contractor, BHEL shall have right to recover cost of such delay from payments due to the contractor, after notifying the contractor suitably and giving him opportunity to present his case.

If the contractor fails to improve the standards of safety in its operation, to the satisfaction of BHEL, after being given a reasonable opportunity to do so and / or / if the contractor fails to take appropriate safety precautions or to provide necessary safety devices and equipment or to carry out instructions regarding safety issued by the authorised BHEL official, BHEL shall have the right to take corrective steps at the risk and cost of the contractor, after giving a notice of not less than seven days, indicating the steps that would be taken by BHEL.

The contractor shall submit report of all accidents, fires and property damage, dangerous occurrence to the authorised BHEL official immediately after such occurrence, but in any case not later than twelve hours of the occurrence. Such reports shall be furnished in the manner prescribed by the contractor to the authorised BHEL official from time to time as prescribed.

Before commencing the work, the contractor shall appoint/nominate a responsible officer to supervise implementation of all safety measures and liaison with his counterpart of BHEL.

If the Safety record of the contractor is to the satisfaction of Safety Department of BHEL, issue of an appropriate certificate to recognise the safety performance of the contractor may be considered by BHEL after completion of the job.

ANNEXURE: 'D'

CLAUSE 38 OF BHEL GENERAL CONDITIONS OF CONTRACT

INSURANCE OF WORKS AGAINST DAMAGE AND LOSS DUE TO FIRE, STRIKE, TEMPEST, FLOODS, EARTHQUAKE, RIOT AND AGAINST DAMAGE BY AIRCRAFT

The contractor shall, within one month after the date of acceptance of the contract, insure the work against loss and damage by fire, tempest, floods, earthquake, riots, strike and against damage by aircraft with an insurance office approved by the accepting officer, from the date of acceptance of work or actual commencement of work whichever is earlier. Such insurance shall be effected in the name of BHEL and shall be for the full value of the contract sum. The contractor shall lodge with BHEL the policies and receipts of the premiums for such insurance and shall maintain such policies in force until the entire completion of the work as certified by the Engineer – In - Charge.

If the contractor fails to comply with the terms of this condition, the accepting officer may insure the work and may deduct the amount of premiums from any money that may become payable to the contractor or may at his discretion refuse payment of any advance/payment to the contractor until the contractor shall have complied with the terms of this condition.

Such insurance whether effected by the Accepting officer or the Contractor shall not be a limit or bar to the liability and obligation of the contractor to complete the entire work in all respects as certified by the Engineer – In – Charge.

In case of such a loss or damage as aforesaid, the money payable under any such insurance shall be received and may be retained by BHEL until the work is finally completed and shall then be credited to the contractor in the final statement of accounts in the event of the contract not having been previously cancelled under these conditions, after taking into account the delay in completion, settlement to his workers for damages, damage to BHEL's Property etc.

ANNEXURE 'E'

CLAUSE 58 OF GENERAL CONDITIONS OF CONTRACT

ARBITRATION:

Except where otherwise provided for in the contract, all questions and disputes relating to the meaning of the specifications, designs, drawings and instructions herein before mentioned and as to the quality of workmanship or materials used on the work or as to any other question, claim, right, matter or thing whatever in any way arising out of or relating to the contract, designs, drawings, specifications, estimates, instructions, orders or these conditions or otherwise concerning the works, or the execution or failure to execute the same whether arising during the progress of the work or after the completion or abandonment thereof shall be referred to the sole arbitration of the Executive Director/General Manager of BHEL and if the Executive Director/General Manager is unable or unwilling to act to the sole arbitration, some other person appointed by the Executive Director/General Manager, willing to act as such Arbitrator. There will be no objection if the arbitrator so appointed is an employee of BHEL-EDN or an employee of any other unit of BHEL and that he had to deal with the matters to which the contract relates and that in the course of his duties as such he had expressed views on all or any of the matters in dispute or difference. The Arbitration to whom the matter is originally referred being transferred or vacating his office or being unable to act for any reason, such Executive Director/General Manager as aforesaid at the time of such transfer, vacation of office or inability to act, shall appoint another person to act as Arbitrator in accordance with the terms of the contract. Such person shall be entitled to proceed with the reference from the stage at which it was left by his predecessor. It is also a term of this contract that no person other than a person appointed by such Executive Director/General Manager or an employee appointed as Arbitrator as aforesaid should act as Arbitrator and the Arbitrator shall give reasons for the award.

Subject as aforesaid the provision of the Arbitration Act, 1940 or any statutory modification or re-enactment thereof and the rules made thereunder and for the time being in force shall apply to the arbitration proceeding under this clause.

It is a term of the contract that the party invoking arbitration shall specify the dispute or disputes to be referred to arbitration under this clause, together with the amount or amounts claimed in respect of each such dispute.

The arbitrator (s) may from time to time with consent of the parties extend the time, for making and publishing the award.

The work under the contract shall, if reasonably possible, continue during the arbitration proceedings and no payment due or payable to the contractor shall be withheld on account of such proceedings.

The arbitrator shall be deemed to have entered on the reference on the date he issues notice to both the parties fixing the date of the first hearing. The arbitrator shall give a separate speaking award in respect of each dispute or difference referred to him.

The venue of arbitration shall be such place as may be fixed by the arbitrator in his sole discretion. The award of the arbitrator shall be final, conclusive and binding on all parties to this contract.

ANNEXURE 'F'

HEALTH, SAFETY & ENVIRONMENTAL POLICY

The Management is committed to be an environmentally sound company in its activities, products, services and to provide safe and healthy working environment covering its employees, products & services as an integral part of business performance through :

- **C**ompliance with applicable Legislation and Regulations
- **S**etting objectives and targets to eliminate / control / minimise environmental pollution, risks due to Occupational Health and Safety Hazards
- **P**romotion of activities for conservation of resources by environmental management with focus on oil, electrical energy and chemicals
- **E**nhancement of Environmental, Safety and Occupational Health awareness amongst employees, customers, suppliers, contractors by pro-active communication
- **R**egular evaluation and pro-active measures for prevention & control of environmental pollution/accidents / occupational diseases
- **A**ppropriate training of employees and interested parties on Health, Safety & Environmental (HSE) aspects
- **F**ormulation and maintenance of HSE Management Programs for continual improvement
- **P**eriodic review & audit of HSE Management System to ensure its continuing suitability, adequacy and effectiveness
- **C**ommunication of HSE Policy to all employees and interested parties
- **C**o-operation with concerned agencies / regulatory bodies engaged in HSE activities.

EXECUTIVE DIRECTOR
BHEL (EDN) BANGALORE

BHARAT HEAVY ELECTRICALS LIMITED

ELECTRONICS DIVISION

BANGALORE – 560026

GENERAL CONDITIONS OF CONTRACT

FOR

LUMP-SUM, ITEM-RATE AND PERCENTAGE

CONTRACT

REVISED GENERAL CONDITIONS OF CONTRACT w.e. f. 1-4-1975

CONTENTS

36. Inspection of the work
37. Responsibility for building

38. Insurance of works against damage and loss, due to fire, tempest, floods etc.
39. Damage or loss to private property and injury to workman.
40. Completion
41. Compensation for delay.
42. Laws governing the contract.
43. Cancellation of contract for corrupt act.
44. Cancellation of contract for insolvency, assignment or sub-letting of contract
45. Cancellation of contract for default.
46. Termination of contract for death.
47. Special powers or determination.
48. Fair wage.

CHAPTER-IV
VALUATION & PAYMENT

49. Records and measurements.
50. Valuation of deviations.
51. Reimbursement / refund on variation in price.
52. Advances on account.
53. Final bill.
54. Payment of bills.
55. Recovery from contractor.
56. Post-technical audit of work and bills.
57. Refund of security deposit.

Annexure-'A'

BHEL contractor's Labour Regulation and BHEL safety code (See Condition 20)

DEFINITIONS

In these general conditions of contract, the following terms shall have the meaning hereby assigned to them except where the context otherwise requires:

a) The "CONTRACT" means the documents forming the tender and acceptance thereof , together with all the document referred to therein including general and Special Conditions of Contract, Schedules 'A', 'B', 'C', 'D', 'E' and/or General Summary attached to the form of tender, the Karnataka P.W.D. Schedule of Rates as amended up to 1979-80 the specifications and the Drawings. All these documents as applicable taken together shall be deemed to form one contract and shall be complementary to one another.

b) The ''TENDER DOCUMENTS'' means the form of tender, the applicable schedules 'A', 'B', ' C', 'D', 'E' and / or General summary, General and Special conditions of contract and the specifications and / or drawings as given to contractors on payment for the purpose of preparing their tenders

c) The 'WORK' means the work described in the tender documents, in individual work orders and/ or accompanying drawings and specifications as may be issued from time to time to the Contractor by the senior Engineer (Civil) deputy manager (projects) or the Engineer- in- charge within the powers conferred upon them, including all modified or additional works and obligations to be carried out either at the site or at any Factory workshop or other place as required for the performance of the contract.

d) The ''SITE'' means the land and /or other places on, in, into or through which the work is to be executed under the contract or any adjacent land , path or street which may be allotted to or used for the purpose of carrying out the contract.

e) The ''CONTRACTOR'' means the individual, firm or company, whether incorporated or not, undertaking the work and shall include the legal personal representatives of such individuals or the persons composing the firm or company, or the successors of the firm or Company and the permitted assigns of such individual or firm or company.

f) The abbreviations DGM/P, Sr. M/P, S.E/C means Dy. General Manager /Projects, Senior Manager / Projects, and Senior Engineer / Civil respectively, who direct the contract and the letters E/C means Engineer / Civil in-charge of the particular work pertaining to the contract.

g) The "Engineer – in – charge" means the Engineer / Civil deputed by Senior Engineer / Civil to supervise the work, or part of the work.

h) "APPROVED" and "DIRECTED" means the approval or direction of the DGM/P. Sr. M/P, or S.E/C. or person deputed by them for the particular purpose.

i) "BHARAT HEAVY ELECTRICALS LIMITED" hereinafter referred to as BHEL Shall mean the board of directors, Resident Director, General Manager/ Project Administrator or other Administrative Officers, of the said company including the project officer, Sr, Manager / Projects, or Senior Engineer / Civil, Engineer/ Civil authorised to invite tenders and enter into

the contracts for works on behalf of "Bharat Heavy Electrical Limited", unit : Electronics Division, Mysore Road, Bangalore – 26.

j) In the case of lumpsum contracts, CONTRACTOR'S PERCENTAGE" means the percentage offered by the contractor as addition to or deduction from the cost of buildings, or other works listed in schedule, 'A' to provide a lump sum quotation for performance of the contract inclusive of all extra costs, profit, establishment charges, carriage, insurance etc., complete.

1. In the case of percentage rate contracts, " Contractor's percentage" shall, if the context so permits, mean the uniform percentage tendered by the contractor and accepted by the Accepting Officer, and the expression " CONTRACT RATE" shall like wise mean the rates in the K.P.W.D. schedule of rate as amended up to 1979-80 as adjusted by the said Contractor's percentage, if any.

k) The " CONTRACTOR SUM" means the sum accepted, or the sum calculated in accordance with the
prices accepted in the tender and / or the contract rates as payable to the Contractor for the entire execution and full completion of the work.

l) the "FINAL SUM" means the actual amount payable under the contract by BHEL, to the Contractor for the entire execution and full completion of the work.

m) The " DATE OF COMPLETION" is the date or dates for completion of the whole or any part of the work as set out in or ascertained in accordance with the individual work orders or the tender documents ,or any subsequent agreed amendments thereto.

n) A "WEEK" means seven days without regard to the number of hours worked or not worked in any day in that week.

o) A"DAY" means a day of 24 (Twenty four) hours irrespective of number of hours worked or not in that day.

p) A "WORKING DAY" means any day other than that prescribed by the Negotiable instruments ACT as being a holiday , consists of the number of hours of labour as commonly recognised by good employers in the trade in the District where the work is carried out or as laid down in the BHEL Regulations.

q) "DEVIATION ORDER" means an order given by the Senior Engineer/Civil or Engineer-in-charge to effect an alteration ,addition or deduction, which dose not radically affect the scope of nature of the contract.

r) "EMERGNCY WORK" means any urgent measures which , in the opinion of the Engineer-in-charge , become necessary during the progress of the work to obviate any risk of accident or failure or which become necessary for security.

s) "PROVISIONAL SUM" or "PROVISIONAL LUMPSUM" means a lump-sum included by the BHEL in the tender documents and represents the estimated value of work for which details are not available at the time of inviting the tender.

t) "PROVISIONAL ITEMS" means items for which approximate quantities have been included in the tender documents.

u) "DAY WORK" means on item of work requiring the employment of labour with or without materials as the case may be , which, in the opinion of the Senior Engineer /Civil-in-charge, is not capable of being evaluated by the accepted methods of measurement or assessment and is paid for on the basis of the actual labour and materials utilised on the particular item of work referred to.

Chapter-II

SCOPE OF CONTRACT

1. HEADING TO THE CONTRACT

The heading to these conditions shall not affect the interpretation thereof

2. CONTRACT DOCUMENTS:

The accepting officers shall furnish to the Contractor on demand "FREE OF COST" three copies of signed Drawings and one copy of the signed agreement comprising of preamble to Agreement , General and Special Specifications , Schedules 'A' 'B' 'C' 'D' and 'E' etc. ,(but excluding General Conditions of Contract and Drawings) and three copies of all further drawings issued during the progress of work.

However , for any additional copies of the agreement or drawings required by the Contractor , the same will be supplied on payment of the Specified Cost.

The contractor shall keep one copy of all the drawings and of the specifications on the site and the Engineer-in-charge or his representative shall at all reasonable times have access to them.

3. WORK TO BE CARRIED OUT :

The Contract shall, expect as provided under Schedules 'B' and 'C' include all labour , materials, tools, plant , equipment and transport which may be required in preparation for , and in the entire execution and full completion of the work. Schedule 'A' shall be deemed to have been prepared in accordance with good practice and recognised principles and unless otherwise stated, the descriptions given therein shall be held to include waste on materials, carriage and cartage, lead, return of empties, hoisting, setting, fitting in position and all other labour necessary in and for the entire execution and full completion aforesaid. Any error in description or quantity in Schedule 'A' or any omission therefrom shall not vitiate the Contract or release the Contractor from the execution of the whole or any part of the work comprised therein according to the drawings and specifications, or from any of his obligations under the contract. The insertion of the name of any firm of suppliers in the Tender Documents is for the purpose of obtaining a particular class or quality of materials or workmanship but the articles or materials specified may be obtained from any other firm subject to the prior written approval of the Senior Engineer / Civil / Engineer/Civil.

In the case of a discrepancy between Schedule 'A' the Specifications and/or the Drawings, the accepting officer shall be the sole deciding authority as to which shall prevail and his decision shall be final and conclusive. If neither drawings nor specifications contain any mention of minor details of construction, which in the opinion of the Accepting Officer whose decision shall be final and conclusive, are reasonable and obvious and fairly intended
for the satisfactory completion of the work, such details shall be provided by the Contractor without any extra cost as if they were specially mentioned and shall be deemed to be included in the contract.

The Contractor will be deemed to have satisfied himself as to the nature of the site , local facilities of access and all matters affecting the execution and completion of the work. **No extra** charges consequent on any misunderstanding in these respects or otherwise will be allowed.

4. PROVISIONAL ITEMS:

The full amount of provisional lump-sum and the value annexed to each provisional item inserted in the Tender documents shall be deducted from the contract sum and the value of work ordered and executed there under shall be ascertained by measurement or valuation as for deviations.

No work under these items is to be begun without instructions in writing from the Engineer- in –charge.

The extent of quantities or items described as " provisional " shall not be held to guarantee or limit the amount and description of the work to be executed by the Contractor either in respect of the item concerned or the work as a whole.

No addition or deduction shall be made by the Contractor to the amount of the provisional lump-sums as included in the tender documents.

5. DIVIATIONS:

The contractor shall not make any alteration in addition to or omission from the work as described in the tender documents except in pursuance of the written instruction of the Engineer –in charge. No such deviation from the work described in the tender documents shall be valid unless the same has been specifically confirmed and accepted by the Accepting Officer in writing and incorporated in the contract.

The accepting Officer may deviate, either by way of addition or deduction, from the work so described, provided that the contractor sum be not thereby varied on the whole by more than the percentage set out in the tender documents. The value of all additions and deductions will be added to , or deducted from the contract sum. Whenever the Accepting Officer intends to exercise such a right, his intention shall specify the deviation which are to be made, the lump sum assessment or the proposed basis of payment, the extra time allowed, if, any and the date for completion of the entire contract.

Any objection by the Contractor to any matter concerning the order shall be notified by him in writing to the Senior Engineer (Civil) / Engineer-in-charge within SEVEN DAYS from the date of such order, but under no circumstances shall the work be stopped (unless so ordered by the Senior Engineer/Civil /E/C) owing to differences or controversy that may arise from such an objection. In the absence of such a notification of objection, by the contractor, he will be deemed to have accepted the order and the conditions stated therein. In the event of the contractor, failing to agree with the Senior Engineer/ Civil /E/C regarding the terms of the proposed deviation, the objections shall be referred to the DGM/P/Sr.M/P, whose decision shall be final, conclusive and binding on the Contractor.

6. TIME:

Time is the essence of the contract and is specified in the tender document or in each individual work order.

As soon as possible after the contract is let or any substantial work order is placed and before work under it is begun, the Senior Engineer/Civil or Engineer-in-charge and the contractor shall (if so required by the Sr. E/C) agree to a time and Progress chart. The chart shall be prepared in direct relation to the time stated in the tender documents or the Work Order for the completion of the individual items thereof, and/or the contract or Orders as a whole. It shall indicate the forecast of the dates for the commencement and completion of the various trade processes or sequences of the work, and shall be amended as may be required by agreement between the Sr. E/C or Engineer-in-charge, and the contractor within the limitation of the time imposed in the tender documents or ORDER.

In the absence of any specific Time and Progress Chart to be agreed to between the Contractor and the Sr. E/C. or Engineer –in-charge, the contractor shall ensure and maintain uninterrupted progress of the work such that the entire work shall be completed within the time imposed in the tender document or order and that the proportion of work completed up to any time in relation to the entire work to be done under the Contract or Order shall not be less than the proportion that the time elapsed bears to total time of completion provided in the Tender Documents or Order.

The Contractor shall suspend the execution of the work, or any part or parts there of whenever called upon in writing by the Engineer –in –charge to do so, and shall not resume work thereon until so directed in writing by the Engineer –in –charge. The Contractor will be allowed an extension of time for completion not less than the period of suspension but no other claim in this respect for compensation or otherwise how so ever will be admitted. This may also be extended to allow for alteration of work made by the deviation order.

7. STORES AND MATERIALS:

The contractor shall, at his own expense , supply all stores and materials required for the contract, other than those listed in Schedule 'B' which may be provided by Bharath Heavy Electricals Limited at the rates detailed therein subject to their availability at the place of issue indicated therein. All stores and materials to be supplied by the Contractor shall be of the best kind as described in the Specifications and the Contractor shall, if required by the Engineer –in-

charge furnish him with proof to his satisfaction that the stores and materials so comply with the specifications.

The contractor shall, at his expense and without delay, supply samples of stores and materials proposed to be used in the execution of the work for the approval of the Engineer-in charge, who may reject all stores and materials not corresponding either in quality or character to the approved samples.

In the case of stores provided under Schedule 'B' the Contractor shall bear the cost of loading, transporting to site, unloading, storing under cover as required, assembling & jointing the several parts together as necessary and incorporating & fixing these stores & materials in the work, including all preparatory work of whatever description that may be required, and closing, preparing, loading and returning empty cases or containers to the place of issue without any extra charges.

8. DELAY AND EXTENSION OF TIME:

If, in the opinion of senior Engineer/Civil/engineer/Civil the work is delayed:

i) by reason of abnormally bad weather, or

ii) by reason of serious loss or damage by fire, or

iii) by reason of civil commotion, local combination of workmen, strike or lockout, affecting any of the trades employed on the work, or

iv) by delay on the part of the agency or tradesman engaged by BHEL in executing work not forming part of this contract, or

v) by reason of any other cause which in the absolute discretion of the Sr. M/P. Sr. E/C. or E/C is (when he is the Accepting Officer of the Contract) beyond the contractors control, then in any such case, the Accepting Officer, on the recommendation of the Sr. E/C., E/C (or higher authority) may make fair and reasonable extension in the completion dates of the individual items of work or the contract as a whole. Such extension which will be communicated to the contractor by the Sr. E/C./E/C. in writing shall be final and binding on the contractor. No other claim in this respect for compensation or other wise howsoever is admissible. Upon the happening of any such event causing delay, the contractor shall immediately give notice thereof in writing to the Sr. E/C/E/C but shall nevertheless use constantly his best endeavour to prevent or make good the delay and shall do all that may reasonably be required to the satisfaction of the Sr. E/C/E/C to proceed with the work.

9. PATENT RIGHTS:

The contractor shall fully indemnify BHEL, or the agent, servant, or employee of BHEL, against any action, claim or proceeding relating to infringement or the use of any patent or design or any alleged patent or design rights, and shall pay any royalties which may be payable in respect of any article/ or part thereof included in the contract.

In the event of any claims being made or action brought against BHEL, or any agent, or servant or employee of BHEL., in respect of any of the matters aforesaid, the contractor shall immediately be notified thereof for taking necessary action provided that payment of indemnity shall not apply when such infringement has taken place in complying with the specific directions issued by the BHEL….but the contractor shall pay any royalties payable in respect of any such use.

10. **OCTROI AND OTHER DUTIES**:

All charges on account of octroi, Terminal or Sales Tax and / or other duties on materials obtained for the work (excluding materials provided by BHEL, on payment) shall be borne by the contractor.

11. ROYALTIES:

Royalties fixed from time to time as per prevalent local rules will be recovered for materials, which the contractor may be allowed to remove from quarries situated on land which is in charge of the BHEL ., authorities.

12. PLANT AND EQUIPMENT:

The contractor, shall at his own expenses, supply all tools, plant and equipment (herein-after referred to as T & P) required for the execution of the contract, as specified in the tender documents.

13. ASSIGNMENT OR TRANSFER OF CONTRACT:

The contractor shall not, without the prior written approval of the Accepting Officer, assign or transfer the contract or any part thereof , or any share, or interest therein to any other person. No sum of money which may become payable under the contract shall be payable to any person other than the contractor unless the prior written approval of the Accepting Officer to the assignment or transfer of such money is given.

a) SUB-CONTRACT:

The contractor shall not sub-let any portion of the contract without the prior written approval of the Accepting Officer

14. COMPLIANCE TO REGULATION AND BYE-LAWS :

The contractor shall conform to the provisions of any statute relating to the work and regulations and bye-law of any local authority and of any water and lighting Companies or Undertakings with those system the works is proposed to be connected. He shall before making any variation from the drawings or the specification that may be necessiated for such connection give the Senior Engineer /civil /E/C notice, specifying the variation proposed to be made and the reason therefore and shall not vary out any such variation until he has received instructions from the Senior Engineer/ Civil /E/C in respect thereof. The contractor shall be bound to give all notices required by statute regulations or bye-laws as aforesaid and to pay all fees and taxes payable to any authority in respect thereof.

CHAPTER-III

PERFORMANCE OF THE CONTRACT

16. SECURITY DEPOSIT:

i) The amount of security money to be deposited for proper fulfillment of the contract will be as follows:

a)	For contract valued upto Rs. 1.00 lakh.	…….	10% of the contract value.
b)	For contract valued above Rs. 1.00 lakh but not exceeding Rs. 2.00 lakhs.	…….	10% on the 1st Rs. 1.00 lakh Plus 7 ½ % on the balance of the contract Value.
c)	For contracts valued above Rs. 2.00 lakhs.	…….	10% on the 1st Rs. 1.00 lakh Plus 7 ½ on the next Rs.1.00 lakh Plus 5% on the balance of the contract value.

ii) The contractor whose tender may be accepted shall within seven days of receipt by him of the notification of acceptance of his tender, deposit with the BHEL, Unit: Bangalore the prescribed sum as per Clause 16 (i) above towards security deposit.

The Earnest Money Deposited at the time of tender will be treated as part of the Security Deposit and the balance amount to make up the full Security Deposit as refereed to in Clause 16(i) above may be furnished in Cash or in any of the following forms duly pledged to the BHEL Limited.

a) Call Deposit Receipt, Pay Order or Demand Draft.
b) Post Office cash certificates, National Savings Certificates, Treasury Saving Deposit Certificates, National Plan Saving Certificates, 12 year National Defence Certificates and 10 year Deposit Certificates.
c) Fixed Deposit Receipt issued by State Bank of India/ Nationalised Bank/ Scheduled Bank.
d) Bank Guarantee from Nationalised /Scheduled Bank valid for a period inclusive of the maintenance period also after the date of completion of the work, wherever warranted.
e) Insurance Guarantee issued by L.I.C. or any of the four General Insurance Corporations valid for a period inclusive of the maintenance period also after the date of completion of work, where warranted.

Alternatively the requisite amount to make up the full Security Deposit may also be deducted, from each Running bill in respect of the particular contract concerned at 10% (ten percent) of the value of the work done by the Contractor as billed till such deductions along with the Earnest money already deposited by him shall make up the full Security Deposit as per para 16 (i) above.
No interest shall be allowed on Security Deposits.

BHEL, shall not be responsible for any loss of Securities due to liquidation or any other reason whatsoever or any depreciation in the value of the Securities while in their charge or for any loss of interest thereon.

iii) All compensation or other sums of money payable by the Contractor to BHEL under the terms of this contract or under any other contract with BHEL, may be deducted from the Security Deposit or realised by the Sale of Securities or from the Interest arising there-from or from any sums which may be due or may become due to the Contractor payable by BHEL, on any account whatsoever against this contract or any other contract with BHEL, and in the event of his Security Deposit being reduced by reason of such deduction or sale as aforesaid, the contractor shall, within seven days thereafter, make good in cash or in securities endorsed as aforesaid , any sums by which the Security Deposit has been so reduced.

iv) 50% of the Security Deposit may be refunded on completion of the work after payment of the final bill and the balance 50% of the Security Deposit is refunded only after the expiry of the maintenance period of six (6) months from date of completion of work or as stipulated in the contract concerned.

17. ORDERS UNDER THE CONTRACT:

All orders, notices etc. to be given under the contract shall be in writing, type script of printed and if sent by registered post to the address given in the tender of the contractor, shall be deemed to have been served on the date when in the ordinary course they would have been delivered to him.

The contractor shall carry out without delay all orders given to him.

18. ADMISSION TO SITE:

The contractor shall not enter on (other than for inspection purposes) or take possession of the site unless permitted to do so by the Senior Engineer/Civil/E/C. The portions of the site to be occupied by the Contractor will be clearly defined and marked on the site plan, and the contractor will on no account be allowed to extend his operations beyond these areas. The Contractor shall provide, if necessary, or required at the site, temporary access thereto and shall alter, modify and maintain the same as required from time to time. He shall take out and clear away the access route when no longer required restoring the area to its original conditions.

The Senior Engineer/Civil/E/C shall have power to execute other works (whether or not connected with the work in the contract agreement) in the site contemporaneously with the execution of the original work and contractor shall give reasonable facilities for this purpose.

BHEL, reserves the right of taking over, at any time, and portion of the site which they may require and the contractor shall at his own expense clear such portion forthwith. No photographs of the site or of the work or any part thereof shall be taken, published or otherwise circulated, without the prior approval of the Senior Engineer/Civil/E/C.

No such approval shall however exempt the contractor from complying with any statutory provisions in regard to the taking and publication of such photographs.

BHEL officials connected with the contract shall have the right of entry to the site at all times.

Senior Engineer/Civil/E/C shall have the power to exclude from the site any person whose admission thereto may, in his opinion, be undesirable for any reason whatsoever.

19. CONTRACTORS SUPERVISION:

The Contractor shall either himself supervise the execution of the Contract or shall appoint a competent Agent approved by the senior Engineer/Civil/E/C to act in his stead.

The contractor shall employ an Engineer/Agent having atleast a 'Degree of Bachelor of Civil Engineering' from a recognised University/on any work with a Contract value exceeding rupees two lakhs and having atleast a 'Diploma in Civil Engineering' from a recognised college on work with a contract value exceeding Rs. 50,000/- but not exceeding rupees two lakhs.

The employment of an Engineer/Agent as aforesaid, shall not be necessary if the contractor is in possession of a recognised technical qualification and is in opinion of the Senior Engineer/Civil/E/C capable of receiving instructions of the Engineer-in-charge and of executing the work to the satisfaction of the Engineer-in-charge.

If the contractor fails to appoint a suitable Engineer/Agent as aforesaid, the Senior Engineer/Civil/E/C shall have full powers to suspend the execution of work and stop payment of any advances that may have become due until such date as a suitable Engineer/Agent is appointed and the contractor shall be held responsible for the delay caused to the work and no extension of time on this account shall be given to him as stipulated in condition (9) above.

Orders given to the contractors Agent/Engineer shall be considered to have the same force as if they had been given to the contractor himself.

The contractor or his agent shall be in attendance at the site during all working hours and shall superintendent the execution of work with such additional assistance in each trade as the Senior Engineer/Civil/E/C may consider necessary.

The contractor or his accredited agent shall attend, when required and without making any claim for doing so, either the Office of the Engineer-in-charge or the work-site to receive instructions.

The Senior Engineer/Civil/E/C shall have full powers, and without assigning any reason, to require the contractor immediately to cease to employ in connection with this contract any agent, servant or employee whose continued employment is, in his opinion, undesirable.

The contractor shall not be allowed any compensation on this account.

20. LABOUR:

The contractor shall employ labour in sufficient numbers either directly or through sub-contractors to maintain the required date of progress and of quality to ensure workmanship of the degree specified in the contract and to the satisfaction of the Engineer-in-charge. The

contractor shall not employ in connection with the works any person who has not completed his fifteen years of age.

The contractor shall furnish to the Engineer-in-charge at the intervals specified by him, a distribution return of the number and description by trades of the work people employed on the works. The contractor shall also submit on the 4th and 19th of every month to the Engineer-in charge a true statement showing in respect of the second half of the preceding month and the first half of the current month (i) the accident that occurred during the said fortnight showing the circumstances under which they happened and the extent of damage and injury caused by them and (ii) the number of female workers who have been allowed maternity benefit as provided in the maternity benefit Act, 1961 or Rules made there under and the amount paid to them.

The contractor shall pay to labour employed by him either directly or through sub-contractors wages not less than fair wages as defined in the contractors labour regulations.

The contractor shall in respect of labour employed by him either directly or through sub-contractors comply with or cause to be complied with contractors Labour Regulations in regard to all matters provided therein.

The contractor shall comply with the provisions of the payment of Wages Act, 1936, Minimum Wages Act, 1948, Employers Liability Act 1938. Workman's Compensation Act, 1923, industrial Disputes Act, 1947, Maternity Benefit Act, 1961 and Mines Act 1952 or any modifications therof or any other law relating there to and rules and there under from time to time.

The contractor shall be liable to pay his contribution and the employees contribution to the State Insurance Scheme in respect of all labour employed by him for the execution of the contract, in accordance with the provision "The Employees" State Insurance Act, 1948" as amended from time to time. In case the contractor fails to submit full details of his account of labour employed and the contribution payable, the Engineer-in-charge shall recover from the running bills of contractor an amount of contribution as assessed by him. The amount so recovered shall be adjusted against the actual contribution payable for employees' State Insurance.

The Engineer-in-charge shall on a report having been made by an inspecting Officer as defined in the contractors labour regulations have the power to deduct from the moneys due to the Contractor any sum required or estimated to be required for making good the loss suffered by a worker or workers by reason of non-fulfillment of the conditions of the contract for the benefit of workers, non-payment of wages or of deductions made from his or their wages which are not justified by the terms of the contract or non-observance of the said contractors labour Regulations.

The contractor shall indemnify the BHEL against any payments to be made under for observances of the Regulations aforesaid without prejudice to his right to claim indemnify from his sub-contractors.

In the event of the Contractor committing a default or breach of any of the provisions of the aforesaid Contractors Labour Regulations, as amended from time to time or furnishing any information or submitting or filling any form/Register/Slip under the provisions of these

regulations which is materially incorrect, then on the report of the Inspecting Officers as defined in the Contractors Labour Regulation, the contractor shall without prejudice to any other liability pay to the BHEL a sum not exceeding to Rs.50/- as liquidated damages for every default breach or furnishing, making, submitting, filling materially incorrect statement as may be fixed by the Engineer-in-charge and in the event of the contractors default continuing in this respect, the liquidated damages may be enhanced to Rs. 50/- per day for each day of default subject to a maximum percent of the estimated cost of woks put to tender.

The Engineer-in-charge, shall deduct such amount from bills or security deposit of the contractor and credit the same to the Welfare fund constituted under Regulations. The decision of the Engineer-in-charge in this respect shall be final and binding.

MODEL RULES FOR LABOUR WELFARE:

The contractor shall at his own expense comply with or cause to be complied with model Rules for Labour Welfare as appended to these conditions as rules framed by Government from time to time for the protection of health and for making sanitary
arrangements for workers employed directly or indirectly on the works. In case the contractor fails to make arrangements as aforesaid, the Engineer-in-charge shall be entitled to do so and recover the cost thereof from the Contractor.

SAFETY CODE:

The contractor shall at his own expense arrange for the safety provisions as appended to these conditions or as required by the Engineer-in-charge, in respect of all labour directly or indirectly employed for performance of the works and shall provide all facilities in connection therewith. In case the contractor fails to make arrangements and provide necessary facilities as aforesaid, the Engineer-in-charge shall be entitled to do so and recover the cost thereof from the contractor.

Failure to comply with model Rules for Labour Welfare, Safety Code, or of the provisions relating to report on accidents and to grant of maternity benefits to female workers shall make the Contractor liable to pay to the BHEL as liquidated damages an amount not exceeding Rs 50/- for each default or materially incorrect statement. The decision of the Engineer-in-charge in such matters based on reports from the Inspecting Officers as defined in the contractors Labour Regulation as appended to these conditions shall be final and binding and deductions for recovery of such liquidated damages may be made from any amount payable to the Contractor.

21. WATER :

The contractor shall allow in his tender and provide at his cost all water required for the work or his employees on the work, together with all pipes and fittings or other means that may be necessary or required to ensure a proper and ample supply of water for all purposes connected with the work.

In the event of a provision existing in the Tender documents for supply of water on payment by Bharat Heavy Electricals Limited, water will be supplied from the BHEL supply System, or other sources at any points fixed by the Senior Engineer/Civil on the site of work. The contractor shall make necessary arrangement for lifting, pumping, carrying or conveying the

water as required at his own cost. The levy of water charges to be borne by the Contractor in such case shall be specifically mentioned in the Tender documents.

22. TEMPORARY WORKSHOPS, STORES ETC :

The Contractor shall, during the progress of the work provide, erect and maintain at his own expenses all necessary temporary workshops, stores, offices etc., required for the proper and efficient execution of the work. The planning, sitting and erection of these bldgs. Shall have the approval of the Engineer-in-charge and the Contractor shall at all times keep them tidy and in a clean and sanitary condition to the entire satisfaction of the Engineer-in-charge.

On completion of the work all such temporary buildings shall be cleared away and the site restored and left in a clean and tidy condition to the entire satisfaction of the Engineer-in-charge.

23. STORES AND MATERIALS ON SITE :

All stores and materials required for the work are to be deposited by the Contractor only in places to be indicated by the Engineer-in-charge.

Where in accordance with the contract stipulations certain Stores and Materials (for incorporation in the work) are to be issued to the Contractor by the BHEL as detailed under Schedule 'E' such times will be so issued only to the extent required for the actual completion of the work as stipulated in the Contract. The decision of the Senior Engineer/Civil/E/C regarding the quantities to be issued as above shall be final and binding on the Contractor. For any excess quantities consumed on the work their cost will be recovered from the Contractor at punitive rates which will be 100%(hundred percent) more than the issue rates of the BHEL.

In regard to the materials and stores which may be issued to the contractor by BHEL the Contractor shall give the Engineer-in-charge reasonable notice in writing of his requirements of such stores and materials and on the approval of his demand being notified to him, he shall make immediate arrangements for drawing the same. Such stores and materials shall be transported by Contractor at his own expenses direct from the place of issue to the site of the work, unless prior written approval is obtained from the Engineer-in-charge to take them to a store or workshop elsewhere.

The Contractor shall have to build a weather-proof shed for the storage of cement required for 15 days consumption of the work.

BHEL officers connected with the Contract shall have the power at any time to inspect and examine any stores or materials indented to be used in or on the work, whether on the site or at any factory or workshop or other place where such stores or materials are being fabricated or manufactured or at any place where the same are lying and the contractor shall give necessary facilities for such inspection and examination.

The Engineer-in-charge shall be entitled to have tests made of any stores or materials supplied by the Contractor who shall provide at his own expense all facilities which the Engineer-in-charge may require for this purpose. If at the discretion of the Engineer-in-charge an independent expert is employed to make any such tests his charges shall be borne by the

contractor only if the test discloses that the said stores or materials are not in accordance with the provisions of the contract.

Should the Senior Engineer/Civil/E/C consider at any time during the construction or re-construction, on prior to the expiry of the 'MAINTENANCE PERIOD', that the stores or materials provided by the Contractor are unsound or of a quality inferior to that contracted for, or otherwise not in-accordance with the Contract, (in respect whereof the decision of the Senior Engineer/Civil/E/C shall be final and conclusive) the contractor shall on demand, in writing from the Sr. E/C. E/C specifying the stores or materials complained of, not withstanding that the same may have been inadvertently passed, certified and paid for, forthwith remove the stores or materials so specified and provide other proper and suitable store or materials at his own expense; to the entire satisfaction of the Sr. E/C. E/C and in the event of his failing to do so within a period to be specified by the Sr. E/C. E/C in his demand aforesaid, the Sr. E/C.E/C may replace within others the stores or materials complained of at the risk and expense in all respects of the Contractor. The liability of the contractor under this condition shall not extend beyond the maintenance period aforesaid except as regards stores or materials, which the Sr. E/C.E/C shall have previously given notice of to the contractor to replace. (Maintenance period for any work under this organisation will be six months from the date of actual completion of the particular work and handing over to BHEL).

All stores and materials brought to the site shall become and remain the property of BHEL and shall not be removed from the site without the prior written approval of the Senior Engineer/Civil/E/C. However, when the work is finally completed the Contractor shall at his own expense forthwith remove from the site all surplus stores and materials originally supplied by him and upon such removal, the same shall re-vest in and become the property of contractor. All BHEL stores and materials issued to Contractor for incorporation or fixing in the work and which, making due allowance for reasonable wear and tear/or waste, have not on completion of the work been so incorporated of fixed, shall be returned by the Contractor at his own expense to the place of issue.

Credit for surplus and/or materials returned by the contractor to BHEL will be given to him at a price based on the prevailing market rate but not exceeding that at which the said stores and materials were originally issued to him but due consideration shall be given to the allowance claimed by BHEL in respect of any depreciation or damages suffered by the stores and/or materials whilst in the custody of the contractor regarding which the decision of Sr. E/C/E/C shall be final and conclusive.

If , in the opinion of the Sr. E/C/E/C (which shall be final and conclusive) any stores supplied by BHEL have either during currency of the work or after completion of the work whilst under the custody of the contractor, become damaged to such an extent that they cannot be usefully utilised, either in the same work or in other works, the Sr. E/C.E/C shall not accept the stores and in the extent of his rejecting , the Contractor shall be charged for the said stores at a rate fixed by the Accepting Officer. The Contractor shall not be entitled to any claim what-so-ever on this account.

23(a).DEFECTS LIABILYTY PERIOD :

The contractor shall be responsible to make good and remedy at his own expenses within such period as may be stipulated by the Engineer-in-charge, any defect which may develop or may be noticed before the expiry of the maintenance period of six months hereto from the certified

date of completion and intimation of which has been sent to the contractor within seven days of the expiry of the said period by a letter sent by hand delivery or by registered post.

24. TOOLS AND PLANT ON SITE :

All tools, plant and equipment brought to the site shall become the property of BHEL and shall not be removed from the site without the prior written approval of the Senior Engineer/Civil/E/C. When the work is finally completed or the Contractor is determined for reasons other than the defaults of the contract, he shall forthwith remove from the site all tools, plants, equipment etc., (other than those as may have been provided by BHEL) and upon such removal, the same shall re-vest in, and become the property of the contractor.

25. **STATEMENT OF HIRE CHARGES** :

A monthly detailed statement of the hire charges incurred in respect of BHEL tools, plants, equipment etc., shall be given to the contractor by the Engineer-in-charge.

26. PRECAUTIONS AGAINST RISK :

The contractor shall be responsible for providing at his own expense, for all precautions to prevent loss or damage from any and all risks and to minimise the amount of any such loss or damage and for the necessary steps to be taken for the said purpose until the works have been handed over complete in all respects to the Engineer-in-charge.

The contractor shall provide all watchmen necessary, for the protection of the site, the work, the materials, tools, plant, equipment and anything else lying on the site during the progress of the work. He shall solely be responsible for and shall take all reasonable and proper steps for protecting, securing, lighting and watching all places on or about the work and the site which may be dangerous to any person whom so ever.

27. NOTICES AND FEES :

The contractor shall give all notices required by any statutory provision or by the regulations and/ or bye-laws of any local authority and / or of any Public Service, Company or Authority affected by the work or with whose system the same are or will be connected. The contractor shall pay and indemnify BHEL against any fees and charges, demandable by law under such

Acts, Regulations and/ or bye-laws in respect of the work and shall make and supply all drawings and plans required in connection with any such notice.

28. SETTING OUT OF THE WORKS AND PROTECTIVE AND MAINTAINING SIGNALS AND WORKS :

The engineer-in-charge shall supply dimensioned drawing, levels and other information necessary to enable the contractor to set out the work. The contractor shall at his own expense set out accurately according to the drawing and figured dimension thereon, all the work comprised in the contract and any extras or additions thereto and shall be solely responsible for their being so set out and executed.

All bench marks, pegs, signals, on the surface, alignment stones, milestones and all similar marks whether put in by BHEL Authority for the purpose of checking the contractors work or in the nature of permanent survey marks will during the tenure of the contract, be under the care of the contractor who shall , at his own expense , take all proper and reasonable precautions and care to preserve and maintain them in their true position. In the event of these marks being disturbed or obliterated by accident or due to any other cause whatsoever, the same may, if deemed necessary to replaced by the Sr.E/C/. E/C at the contractors expense and the cost thereof deducted from any money than or thereafter becoming due to the contractor.

Where requested by the contractor, the level marks center line and chainage pegs corresponding to those shown on the drawing will be pointed out to the contractor on the ground but all bench marks or chainage pegs additional to those shown on the drawing will be set out by BHEL authorities.

29. SITE DRAINAGE :

All water that may accumulate on the site during the process of the work, or in trenches and excavations shall be removed to the entire satisfaction of the Engineer-in-charge and at Contractors expense.

30. EXCAVATIONS, RELICS, ETC :

Material of any kind obtained from excavation on the site shall remain the property of BHEL and shall be disposed off as the Engineer-in-charge directs.

All gold, silver, oil and other minerals of any description and all precious stones, coins, treasured, relics, antiquities and other similar items which may be found in or upon the site shall be the property of Bharat Heavy Electricals Limited and Contractor shall duly preserve the same to the satisfaction of the BHEL and shall from time to time deliver the same to such person or persons as the Bharat Heavy Electricals Limited, may appoint to receive the same.

31. FOUNDATIONS :

The contractor shall not lay any foundations until the excavations for the same have been examined and approved in writing by the Engineer-in-charge.

32. COVERING-IN WORK :

The contractor shall give reasonable notice in writing to the Engineer-in-charge whenever any work is to be permanently covered up or concealed, whether by earth or other means so that it can finally be inspected or measured, if necessary. In default of so doing, the contractor shall, if required by the Engineer-in-charge uncover such work at his own expense.

33. APPROVAL OF WORKS BY STAGES :

All work embracing more than one process shall be subject to examination and approval at each stage thereof and the contractor shall give due notice in writing to the Engineer-in-charge when each stage is ready. In default of such notice being received, the Engineer-in-charge shall be entitled to approve the quality and extent thereof at any time he may choose and in the

event of any dispute, the decision of the Senior Engineer/Civil thereon shall be final and conclusive.

34. EXECUTION OF THE WORK :

The work shall be executed in a workman-like manner and to the satisfaction in all respects of the Engineer-in-charge.

The Engineer-in-charge will communicate or confirm his instructions to the Contractor in respect to the execution of the work in a " work Site Order Book " maintained at his office and contractor shall visit this office daily and shall confirm receipt of such instructions by signing the relevant entries in this book. Such entries will rank as order or notices in writing within the intent and meaning of these conditions.

35. DAY WORK :

No day-work shall be performed without the prior written instructions of the Accepting Officer.

The Contractor shall give to the Engineer-in-charge reasonable notice of the start of any work ordered to be executed by day-work and shall deliver to the Senior Engineer/Civil-in-charge/E/C within two days of end of each pay-week return in duplicate giving full detailed accounts of labour and materials for that pay week. One copy of each of these returns, if found correct, will be certified by the Engineer-in-charge and returned to the contractor and must be produced at the time of adjustment of accounts.

An invoice in duplicate signed by the Contractor or his agent shall be sent with each delivery of materials for day-work and the contractor will be furnished with a receipt signed by the Engineer-in-charge specifying the description, quantities weight or measurement (as the case may be) of the articles approved, reference will be made in this receipt in the return aforesaid and the receipt itself is to be produced in support of the Contractors bill.

In the case of Lump-sum contracts, the rates to be changed and the percentage addition for profit and establishment charges, etc, will be agreed upon between the Accepting Officer and the Contractor prior to the execution of the work.

36. INSPECTION OF THE WORK :

BHEL Officers concerned with the Contractor shall have power at any time to inspect and examine any part of the work and the contractor shall give such facilities as may be required to be given for such inspection and examination.

Should Sr.E/C/E/C consider at any time during the expiry of maintenance period, that any work has been executed with unsound, imperfect or unskilled workmanship or of quality inferior to that contracted for or not otherwise in accordance with contract (in respect whereof the decision of the sr. E/C. shall be final and conclusive) the contractor shall, on demand in writing from the Sr. E/C.E/C specifying the fault notwithstanding that the same may have been inadvertently passed, certified and paid for, forthwith rectify or remove and reconstruct the work so specified, in whole or in part as the case may be require at his own expense to the entire satisfaction of the Sr. E/C. & E/C in the event of his failing to do so within a period to be

specified by the Sr.E/C. E/C in his demand aforesaid, the Sr. E/C. may carry out the work by other means at the risk and expense in all respect of the contractor. However, the liability of the contractor under this condition shall not extend beyond the maintenance period except as regard workmanship which the Sr. E/C .E/C shall have previously given notice of to the contractor to rectify.

37. RESPONSIBILITY FOR BUILDING :

In the event of any building, or part of any building being handed over to the Contractor for the execution of work thereto under the provisions of the Contract, he shall give a written receipt for all fixtures, glass etc., and he shall be required to make good at his own expense all damages resulting from any cause whatsoever while in his charge and on completion of the work to deliver up the said building or part thereof a clean state complete in every particular to the entire satisfaction of the Engineer-in-charge.

38. INSURANCE OF WORKS AGAINST DAMAGE AND LOSS DUE TO FIRE, TEMPEST, FLOODS, EARTHQUAKE, RIOT AND AGAINST DAMAGE BY AIR-CRAFT.

The contractor shall, within one month after the date of acceptance of the contract, insure the work against loss and damage by fire, tempest, floods, earthquake, riots and against damage by air-craft with an insurance office approved by the Accepting Officer. Such insurance shall be affected in the name of BHEL and shall be for the full value of the contract sum. The Contractor shall lodge with the BHEL policies and receipt of the premiums for such insurance and shall maintain such policies in force until the entire completion of the work as certified by the Senior Engineer/Civil/E/C.

If the contractor fails to comply with the terms of this condition that the Accepting Officer may insure the work and may deduct the amount of premiums from any money become payable to the contractor or may at his discretion refuse payment of any advances to the Contractor until the contractor shall have complied with the terms of the condition.

Such insurance whether effected by the Accepting Officer or the Contractor shall not be a limit or bar to the liability and obligation of the contractor to complete the entire work in all respects as certified by the Senior Engineer/Civil/E/C.

In case of such a loss or damage as aforesaid, the money payable under any such insurance shall be received and may be retained by the BHEL until the work is finally completed and shall then be credited to the contractor in the final statement of accounts in the event of his contract not having been previously cancelled under these conditions.

39. DAMAGE AND LOSS TO PRIVATE PROPERTY & INJURY TO WORKMAN :

The contractor shall at his own expense reinstate and make good to the satisfaction of the Sr. E/C/E/C and pay compensation for any injury, loss or damage occasioned to any property or rights whatever including property and rights of BHEL, (or Agents, servants or employees of BHEL) the injury loss or damage arising out of or in any way in-connection with the execution of purported execution of the contract and further the contractor shall indemnify BHEL against all claims enforceable against BHEL (or any agent, servant or employee of BHEL or which would be so enforceable against BHEL) where a private person , in respect of any such injury

(including injury resulting in death loss or damage to any person) whosoever or property, including all claims which may arise under the workman's Compensation Act or otherwise.

40. COMPLETION:

The works shall be completed to the entire satisfaction of the Engineer-in-charge and in accordance with the Contractors forecast of Time and Progress where operative, and all unused stores and materials, tools plant, equipment, temporary buildings, and things shall be removed and the site and work cleared of rubbish and all waste materials and delivered up clean and tidy to the satisfaction of the Engineer-in-charge at the Contractors expense on/or before the Scheduled date of completion.
The BHEL shall have power to take over from the Contractor from time to time such sections of the work as have been completed to the satisfaction of the Engineer-in-charge.

The Senior Engineer /Civil/E/C shall certify to the Contractor the date on which the work is completed and the state thereof.

The Senior Engineer/Civil/E/C shall also certify, to the Contractor the state of the work at the end of the maintenance period, where applicable.

41. COMPENSATION FOR DELAY:

If the contractor fails to maintain the required progress in terms of condition 7 or to complete the work and clear the site on or before the contracted or extended date period of completion, he shall, without prejudice to any other right or remedy of the BHEL on account of such breach, pay as agreed compensation an amount calculated as stipulated below or such smaller amount as may be fixed by the BHEL on the contract value of the work for every week that the progress remains below that specified in condition 7 or that the work remains incomplete.

This will also apply to items or a group of items for which separate period of completion has been specified.

For this purpose the term 'contract value' shall be the value at contract rates of the work as ordered.

a) Completion period (as originally stipulated)
not exceeding 6 months. …… @ 1 percent per week

b) Completion period (as originally stipulated)
Exceeding 6 months and not exceeding 2 years …… @ 1/2 percent per week

c) Completion period (as originally stipulated)
exceeding 2 years ……. @ 1 /4 percent per week

Provided always that the total amount of compensation for delay to be paid under condition shall not exceed the under noted percentage of the contract value or of the contract value of the item of group of items of work for which a separate period of completion is given :

a) Completion period (as originally stipulated) not exceeding 6 months.	……	10 percent
b) Completion period (as originally stipulated) Exceeding 6 months and not exceeding 2 years	……..	7 ½ percent
c) Completion period (as originally stipulated) Exceeding 2 years	…..…….	5 percent

The amount of compensation may be adjusted or set off against any sum payable to the Contractor under this or any other contract with the BHEL.

42 LAWS GOVERNING THE CONTRACT :

This contract shall be governed by the Indian Laws for the time being in force.

43 CANCELLATION OF CONTRACT FOR CORRUPT ACTS :

The Accepting Officer, whose decision shall be final and conclusive, shall, without prejudice to any other right or remedy which shall have accrued or shall accrue thereafter to Bharat Heavy Electricals Limited, cancel the contract in any of the following cases and the contractor shall be liable to make payment to BHEL for any loss or damage resulting from any such cancellation to the same extent as provided in the case of cancellation for default.

If the contract shall :

a) Offer or give or agree to give to any person in BHEL, service any gift or consideration of any kind as an inducement or reward for doing or forbearing to do or for having done or forborne to do any act in relation to the obtaining or execution of this or any other contract for BHEL service,

OR

b) Enter into a contract with BHEL in connection with which commission has been paid or agreed to be paid by him or with his knowledge, unless the particulars of any such commission and the terms of payment thereof have previously been disclosed in writing to the Accepting Officer,

OR

c) Obtain a contract with BHEL as a result of RING tendering or by non-bonefide methods of competitive tendering without first disclosing the fact in writing to the Accepting Officer.

44. CANCELLATION OF CONTRACT FOR INSOLVENCY, ASSIGNMENT OR TRANSFER OR SUB LETTING OF CONTRACT :

The Accepting Officer, without prejudice to any other right or remedy which shall have accrued or shall accrue thereafter to BHEL shall cancel the contract in any of the following cases:-

If the contractor:

a) Being an individual, or if a firm any partner thereof, shall at any time be adjusted bankrupt or have a receiving order or orders for administration of his Estate made against him of shall take any preceedings, for liquidation or composition under Bankruptcy Act for the

time being in force or make any conveyance or assignment of his effects of composition or arrangements for the benefit of his creditor or purport to do so, or if any application be made under any Bankruptcy Act for the time being in force for the sequestration of his estate or if a trust deed be granted by him on behalf of his creditors;

OR

b) Being a company, shall pass a resolution or the court shall make an order for the liquidation of its affairs, or a Receiver or a Manager on behalf of the debentures holders shall be appointed or circumstances shall arise which entitle the court or debentures holders to appoint a Receiver or Manager;

OR

c) Assigns, transfers, sub-let or attempt to assign transfer or sub-let any portion of the work without the prior return approval of the Accepting Officer.

Whenever the Accepting Officer exercise his authority to cancel the contract under this condition he may complete the work by any means at the contractor risk and expense provided always that in the event of the cost of completion (as certified by Sr. E/C/E/C which is the final and conclusive) being less than the contract cost, the advantage shall accrue to the BHEL and that if the cost of completion exceeds the moneys due to the contractor under the contract, the contractor shall either pay the excess amount ordered by Sr. E/C/E/C or the same shall be recovered from the contractor by other means.

In case of BHEL completes the work under the provisions of this condition the cost of such completion to be taken into account in determining the excess cost to be charged to the contractor under this condition shall consist of the cost of material purchased and /or labour provided by the BHEL with an addition of such percentage to cover superintendence and establishment charges as may be decided by the Sr. Manager (P) Sr. E/C/E/C whose decision shall be final and conclusive.

45 CANCELLATION OF CONTRACT IN PART OR IN FULL FOR CONTRACTOR'S DEFAULT :

If the contractor;

a) Makes default in commencing the work within a reasonable time form date of handing over of the site and continues in that state after a reasonable notice from senior/Engineer /Civil E/C;

OR

b) In the opinion of the Sr. E/C/E/C at any time, whether before or after the date or extended date for completion, make default in proceeding with the work , with due diligence and continues in that state after a reasonable notice from Sr.E/C/E/C.

OR

c) Fails of comply with any of terms and conditions of the contract or after reasonable notice in writing with orders properly issued thereunder :

OR

d) Fails to complete the work, work order and items of work with individual dates for completion and clear the site on or before the date of completion, or fails to achieve the progress as set out under clause 7 of these General Conditions of Contract.

The Accepting Officer may, without prejudice to any other rights or remedies which shall have accrued or shall accrue thereafter to BHEL cancel the contract as a whole or in part thereof or only such work order or items of work in default from the contract. Whenever the Accepting Officer exercises his authority to cancel the contract as a whole or in part under this condition he may complete the work at the contractor risk and cost, provided always that in the event of the cost of completion (as certified by Sr,. E/C/E/C which is final and conclusive) being less than the contract cost, the advantage shall accrue to the BHEL if the cost of the excess amount ordered by Sr. M.P./Sr. E/C/E/C or the same shall be received from the contractor by other means.

In case the BHEL completes the work or any part thereof under the provisions of this condition the cost of such completion to be taken into account in determining the excess cost to be charged to the contractor under this condition shall consist of the cost of the materials purchased and /or labour provided by the BHEL with an addition of such percentage to cover superintendence and establishment charges as may be decided by the Sr. M.P./Sr.E/C/E/C. whose decision shall be final and conclusive.

46 **TERMINATION OF CONTRACT FOR DEATH** :

Without prejudice to any of the rights or remedies under this contract, if the contractor dies, Accepting Officer shall have the opinion of terminating the contract without compensation to the contractor.

47. **SPECIAL POWER OF DETERMINATION:**

If at any time after the Acceptance of the tender, BHEL shall for any reason whatsoever not require the whole or any part of the work, to be carried out, the Sr. M.P./Sr. E/C/E/C shall give notice in writing of the fact to the contractor who shall have no claim to any payment of compensation or otherwise how-so-ever on account of any profit or advantage which he might have derived from the execution of the work in full but which he did not derive in consequence of the force-closing of the work.

He shall be paid at Contact rate, for the full amount of the work executed including such additional works, e.g. clearing of site, etc., as may be rendered necessary by the said force-closing. He shall also be allowed reasonable payment (as decided by the Accepting Officer) for any expenses sustained on account of labour and materials collected but which could not be utilised on the work, as verified the Sr. E/C Neither shall the contractor has any claim for compensation on account of any alterations having been made in the original specifications, drawings, designs and instructions, involving any curtailment of the work as originally contemplated.

48. FAIR WAGE :

a) The Contractor shall pay not less than the 'Fair Wage' to labourers engaged by him on the work.
'Fair Wage' means wage whether for time or piece work notified at the time of inviting tenders for the work and where such wages have not been notified, the wages prescribed by the Sr. Manager/Projects/Sr.E/C/E/C for the stations at which the work is done.

b) The contractor shall, not withstanding the provision of any contract to the contrary, cause to be paid a 'Fair Wage' to labourers indirectly engaged on the work, including any labour engaged by his sub-contractors in connection with the said wok, as if the labourers had been directly employed by him.

c) In respect of all labours directly or indirectly employed on the work for the performance of the contractor's part of this Agreement, the contractor shall comply with or cause to be complied with the BHEL contractor's labour Regulations (appended hereto as Annexure 'A' to these conditions) in regard to payment of wages, wage period, deductions from wages, recovery of wages, not paid and deductions, unauthorisedly made, maintenance of wage book, wage slips, publication of scale of wages and other terms of employment, inspection and submission of periodical returns and all other matters of a like nature.

d) The Senior Engineer /Civil/E/C concerned shall have the right to deduct from the moneys due to the Contractor any sum required or estimated to be required for making good the loss suffered by a worker or workers by reason of non-fulfillment of the conditions of the contract for the benefit of the workers, non-payment of wags or of deductions made from this or their wages which are not justified by the terms of the contract or non-observance of the regulations.

e) Vis-à-vis BHEL, the Contractor shall be liable primarily for all payments to be made under the contract and for the observances of the Regulations aforesaid without prejudice to his right to claim indemnity from his sub-contractors.

f) The regulations aforesaid shall be deemed to be a part of this contract and any breach thereof shall be deemed to be a breach of this contract.

CHAPTER-IV

VALUATION AND PAYMENT

49. RECORDS AND MEASUREMENTS :

All items having a financial value shall be entered in the BHEL Measurement Book so that a complete record is obtained of all works performed under the contract.

Building etc. priced in schedule 'A' as a unit lump-sum will be entered by number at the unit lump-sum. Work carried out for agreed lump-sums will be described and similarly recorded.

Lump-sum omissions will be entered for deduction. Measurement shall be restricted to that required to ascertain the financial liability of BHEL under the contract.

Work which fails to be measured in detail shall be measured physically, without reference to any local custom that may obtain excepting where it may otherwise be directed in the tender documents. The measurements shall be taken jointly by any person duly authorised on the part of the BHEL and by the contractor.

The Engineer-in-charge shall give reasonable notice in writing to the Contractor of appointment for measurement.

The contractor shall, without extra charge, provide assistance with appliances and other things necessary for measurement.

The Contractor shall bear all the cost of measurement of his work.

Measurement shall be entered in the BHEL Measurement book and signed and dated by both parties each day at the site on completion of measurement. If the contractor objects to any of the measurement recorded on behalf of the BHEL a note to that effect will be made in the BHEL measurement book or against the item or items objected to; and such note shall be signed and dated by both the parties engaged in taking the measurement.

If, as a result of such objection, it becomes necessary to re-measure the work wholly or in part, the expense of such re-measurement shall be borne by the party requiring the ,measurement to be re-taken provided that a net error is found by this re-measurement to amount to less than 5% (five percent) of the value as recorded by the first measurement. But, where the net errors amount to 5% and over of the said value, then the cost is to be borne by the other party. In any case, if the net value of errors found exceeds Rs. 500/- the expense of re-measurement is to be borne by the other party.

If the Contractors representative fails to attend when required, the Engineer-in-charge shall have power to proceed by himself to take measurements and in that case these measurements shall be accepted by the Contractor as final.

The contractor shall, once every month submit to the Senior Engineer/Civil/E/C with a copy to the Sr. M/P/details of his claims for the work done by him upto and including the previous months which are not covered by his contract Agreement in any of the following respects.

a) Deviation from the items and Specifications provided in the contract documents.

b) Extra items/New items of work.

c) Quantities in excess of those provided in the contract schedule.

d) Items in respect of which rates have not been settled. He should, in addition, furnish a clear certificate to the effect that the claims submitted by him as aforesaid cover all his claims and that no further claims shall be raised by him in respect of the work done upto and including the period under report.

50. VALUATION OF DEVIATIONS :

Rates for deviated items of work will be fixed as follows:

I. For any item of wok required to be carried out after the contract has been awarded and which is not covered by Contractors Schedule but is covered by K.P.W.D. schedule of rates the rate payable for such a fresh item will be derived from K.P.W.D. Schedule by the method of proportion as follows:

a) In the same proportion to the rate in K.P.W.D. Schedule of Rates as the tendered rate for the nearest analogous items of work in Contractors Schedule bears to the rate for the particular analogous item or work in K.P.W.D. schedule of Rates.

b) If a single appropriate analogous item of work is not available in both Contractor's Schedule and K.P.W.D. Schedule, then the method of proportion will be applied to the nearest analogous group of items available in both the Schedules referred i.e. in the same proportion as the total tendered cost of that particular group of items (the sum of the products of the tendered rates and the quantities for which orders are placed) bears to the total cost of the same items and quantities at the K.P.W.D.Schedule of Rates.

c) If even an appropriate analogous group of items is not available in Contractor's Schedule and K.P.W.D. Schedule, then the methods of proportion will be applied to all those items of the whole work, which are available in both the Schedules and for which orders have been placed on the Contractor, i.e., In the same proportion as the total cost of all these items of work (the sum of the products of the tendered rates and the quantities for which orders are placed) bears to the total cost of the same items and quantities at the K.P.W.D. Schedule of Rates.

II. If any work not covered by any of the foregoing is ordered on the Contractor, the basis of payment shall be decided by the Accepting Officer whose decision shall be final and conclusive and binding on the parties.

The selection of analogous item or analogue group of items referred to above shall be done by the Sr. E/C./E/C. Where the rates for deviated items or new items of work can be derived

by the selection of different analogous items or analogous group of items, the lowest of all such derived rates shall be taken as the correct rate.

In the case of the contracts for which the Sr. E/C.,E/C is the Accepting Officer, all disputes regarding the settlement of rates of deviated or new items of work shall be referred to the Sr. M/P. whose decision shall be final and conclusive.

51. **REIMBURSEMENT/REFUND ON VARIATION IN PRICE, MATERIALS** :

In after submission of the tender and/or during the progress of the works, the price of any materials (not being a material supplied from the BHEL, stores in accordance with the Conditions of the Contract) is increased or decreased by an Act of Legislature (Central or state) and /or any notification thereunder or on account of new duties or levies such as octroi or on account of increase or decrease in such duties affecting the price of materials required for incorporation in the works or the price of any item to be incorporated in the works and made from materials of which the price has increased or decreased as aforesaid and the Contractor has thereupon to pay in respect of such material or item a price which is higher or lower than the price of that material or item as prevailing immediately before the passing of such Act or levying, increasing/decreasing of such duty, the BHEL., shall in case of increase in price or the duty reimburse the Contractor the increase in price or additional increased duty paid by the Contractor and in case of decrease in price, the BHEL shall be entitled to a refund of the reduction in duty. Provided however no reimbursement or refund shall be made if the increase /decrease is not more than plus 10% of the said price, and if so, the reimbursement or refund shall be made only on the excess over 10% provided always that any such increase shall not be payable if, in the opinion of the Sr. M/P whose decision shall be final and conclusive the increase is attributable to the delay in the execution of the contract within the control of the Contract, or that any such increase has become operative after the contracted/or extended date completion of the work or items of works in question.

The Contractor shall , for the propose of this condition, keep such books of account and other document as are necessary to show the amount of any increase claimed or any reduction available and shall allow inspection of the same by any duly authorised representative of the BHEL and further shall at the request of the Sr, E/C/E/C. furnish for verification such other information as the Sr. E/C/E/C may require.

The contractor shall within a reasonable time of his becoming aware of any alteration in the prices of any such materials, give notice thereof in writing to the Sr. E/C.E/C stating that the rate is submitted in pursuance to this condition together with all information relating there to which he may be in a position to supply.

52. **ADVANCES ON ACCOUNT** :

No payment shall be made for work estimated to cost less than Rupees One Thousand till after the whole of the work shall have been completed and a certificate of completion given by the Competent authority.

In the case of work estimated to cost more than Rupees One Thousand the contractor may at intervals of not less than one month or as otherwise provided for in the Contract documents, counting from the date on which order to commence work given by Sr. E/C.E/C submit

claims on BHEL forms for payment of advance on account of work done and of materials delivered in connection with the Contract.

The Contractor shall be paid in respect of such claims to the extent approved and passed by the Sr. E/C.E/C subject to a maximum of 90% of the value of the work actually executed in site provided the work has been executed to the satisfaction of the Engineer-in-charge. The certificate of the Sr. E/C. E/C regarding such approval and passing of the sums so payable shall be final and conclusive against the Contractor.

"After the full amount of Security Deposit is made up through the 10% deductions from 'On Account' bills, 100% of all subsequent bills may be made to the Contractor".

The Contractor may also be paid during the progress of the work 75% of the value of any materials which are in the opinion of the Engineer-in-charge in accordance with contract, and are actually required for incorporation in the work and which have reasonably been brought to the site in-connection therewith and are adequately stored and/or protected against damage by weather or other causes, but which have not at the time of payment of the advance been incorporated in the work. Payment of such advances however shall be purely at the discretion of the Sr. M/P/Sr.E/C.,/E/C provided always that payments shall not be made under these periodical certificates in respect of perishable materials like lime, cement, timber,sand kankar etc.

Any sums/due from the Contractor on account of tools and plant, stores or any other items provided by BHEL shall be deducted from the respective advances.

The Senior Engineer/Civil/E/C shall from time to time certify the sums payable to the Contractor after retaining the reserves.

Any certificate relating to work done or materials delivered may be modified or corrected by any subsequent interim certificate or by the final certificate and no certificate of the Sr. E/C/E/C supporting an advance payment shall itself be conclusive evidence that any work or materials to which it relates are in accordance with the contract. All such intermediate payments shall be regarded as advances against the final payment only and shall not be considered as an admission of the due performance of the contract or any part thereof in respect or the accruing of any claim whatsoever. Such intermediate payments shall not conclude, determine or effect in any way the powers of the Sr. E/C/E/C as to the final settlement and adjustment of the account or otherwise, or in any way vary or affect the Contract.

53. FINAL BILL :

As soon as possible after the completion of the work to the satisfaction of the Engineer-in-charge, the contractor shall forward a certified final account on BHEL forms, in duplicate. It shall be accompanied by all abstracts, vouchers etc., in support thereof and shall be prepared in the manner prescribed by the Senior Engineer /Civil/E/C. No claim will be entertained after the receipt of the final bill.

The contractor shall be entitled to be paid the final sum less the value of payments already made on account, subject to certification of the final bill by the Sr. E/C/E/C any sums due

from the contractor on account of Tools and plant, Stores or any other items provided by BHEL not yet recovered from the contractor shall be deducted from the final sum aforesaid.

No charge shall be allowed to the contractor on account of the preparation of the final bill.

54. PAYMENT OF BILLS :

All payments to be made to the Contractor under this contract shall be by "Crossed Cheque" marked
"A/C payee only" (within a reasonable time after the certification by the Sr. E/C/E/C at the……
……..located in the station where either the work is executed or service rendered or at their branch nearest to the station where the Office of the Senior Engineer/Civil/E/C is located.)

55. **RECOVERY FROM CONTRACTOR** :

Whenever under the contract any sum of money shall be recoverable from or payable by the contractor the same may be deducted from any sum then due or which at any time thereafter may become due to the contractor under the contract or under any other contract with BHEL or from his Security Deposit or he shall pay the claim on demand.

56. POST TECHNICAL AUDIT OF WORK AND BILLS :

BHEL reserves the right to carry out a post-payment audit and technical examination of the work and final bill including all supporting vouchers, abstract etc., and to enforce recovery of any sums becoming due as a result thereof in the manner provided in the preceeding sub-paragraph's provided however that no such recovery shall be enforced after three years of passing the final bill.

57. REFUND OF SECURITY DEPOSIT :

50% of the Security Deposit mentioned in condition 16 above, may be refunded to the contractor in respect of all contracts on completion of work and after payment of final bill and the balance 50% on expiry of the maintenance period, (Described under clause 23) provided the contractor shall have rendered a " No Demand Certificate." In case of works where maintenance period is not involved 100% of the security deposit may be refunded after payment of final bill provided that the contractor shall have rendered a " No Demand Certificate."

58. ARBITRATION :

Except where otherwise provided for in the contract all question and disputes relating to the meaning of the specifications, design, drawings and instructions herein before mentioned and as to the quality of workmanship or materials used on the work or as been other questions, claim, right, matter or things whatsoever in any way arising out of or relating to the contract, design, drawing, specification, estimates, instructions, orders or these conditions or otherwise concerning the works or the execution or failure to execute the same

whether arising during the program of the work or after the completion or abandonment thereof shall be refereed to the sole arbitration of the Managing Director/Chief Engineer of BHEL and if the Managing Director/Chief Engineer is unable or unwilling to Act, to the sole arbitration of some other person appointed by the Managing Director/General Manager/Chief Engineer, willing to Act as such arbitrator. The cases referred to arbitration shall be other than those for which the decision of the Sr. M/P./D.C.E/Sr.E/C. is expressed in the contract to be final and conclusive. There will be no objection if the arbitrator so appointed is an employee of BHEL and that he had to deal with the matters to which the contract relates and that in the course of his duties as such he had expressed views on all or any of the matters in dispute or difference. The arbitrator to whom the matter is originally referred being transferred by vacating his office or being unable to act for any reason, such Managing Director/ General Manager/Chief Engineer as aforesaid at the time of such transfer, vacation of office or inability to act, shall appoint another person to act as arbitrator in accordance with the terms of the contract, such person shall be entitled to proceed with the reference from the state at which it was left by his predecessor.

Subject as aforesaid the provision of the Arbitration Act, 1940 or any statutory modification or re-enactment thereof and the rules made thereunder and for the time being in force shall apply to the arbitration proceedings under this clause.

It is a term of contract that the party involving arbitration shall specify the dispute or disputes to be referred to arbitration under this clause together with the amount or amounts claimed in respect of each such dispute.

The arbitrator (s) may from time to time with consent of the parties enlarge the time, for making and publishing the awards.

The work under the contract shall, if reasonably possible, continue during the arbitration proceedings and no payment due to payable to the contractor shall be withheld on account of such proceedings.

The Arbitrator shall be deemed to have entered on the reference on the date he issues notice to both the parties fixing the date of the first hearing.

The Arbitrator shall give a separate award in respect of each dispute or difference referred to him.

The venue of arbitration shall be such place as may be fixed by the arbitrator in his sole discretion.

The award of the arbitrator shall be final, conclusive and binding all parties to this contract.

ANNEXURE- 'A'

BHEL CONTRACTOR'S LABOUR REGULATIONS.
(See condition 20)

1. **DEFINITION:**
   In these regulations, unless otherwise expressed or indicated, the following words and expressions shall have the meaning hereby assigned to them.

   a) " Labour " means workers employed by a contractor directly or indirectly through a sub-contractor, or by an agent on his behalf on a payment not exceeding Rs. 500/- per month.
   b) " Fair Wage " means wages, which shall include wages for weekly day of rest and other allowances, whether for time or piece work, after taking into consideration prevailing market rates for similar employment in the neighborhood but shall not be less than the minimum rates of wages fixed under the Minimum wages Act.
   c) " Contractor " for the purpose of these Regulations shall include an agent or sub-contractor employing labour on the wok taken on contract.
   d) " Inspecting Officer " means any Labour Enforcement Officer or Assistant Labour Commissioner of the Chief Labour Commissioner's organisation.
   e) " Form" means a form appended to these Regulations.

2. **NOTICE OF COMMENCEMENT:**
   The contractor shall, within seven days of commencement of the work, furnish in writing to the Inspecting Officer of the area concerned the following information, with copy to the Engineer- in-charge.
   a) Name and situation of the work.
   b) Contractor's name and address.
   c) Particulars of the Department for which the work is undertaken.
   d) Name and address of the sub-contractors as and when they are appointed.
   e) Commencement and probable duration of the work.
   f) Number of workers employed and likely to be employed.
   g) 'Fair Wages' for different categories of workers.

3. I) Number of hours, which shall constitute a normal working day. The number of hours which shall constitute a normal working day for an adult shall be NINE hours. The working day of an adult worker shall be so arranged that of intervals, if any for rest it shall not spread over more than 12 hours on any day, when an adult worker is made to work for more than NINE hours on any day or for more than 48 hours in any week he shall in respect of over time work, be paid wages at double the ordinary rate of wages.

   II) Weekly day of rest: Every worker shall be given a weekly day of rest, which shall be fixed and notified at least 10 days in advance. A worker shall not be required or allowed to work on the weekly rest day unless he has or will have a substitution rest day, on one of the five days immediately before or after the rest day, provided that no substitution shall be made which will result in the worker working for more than 10 days consecutively without a rest day for a whole day.
   Where in accordance with the foregoing provisions a worker works on the rest day and has been given a substituted rest day he shall be paid wages for the work done on the weekly rest day at the overtime rate of wages.

NOTE: The expression ‘ Ordinary rate of wages ’ means the fair wage the worker is entitled to.

4. **DISPLAY OF NOTICE REGARDING WAGES, WEEKLY DAY OF REST ETC**.

The Contractor shall before he commences his work on contract display and correctly maintain and continue to display and correctly maintain in a clean legible condition in conspicuous places on the works, notice in English and in the local Indian languages, spoken by majority of workers, giving the rate of fair wages, the hours of work for which such wages are payable, the weekly rest days workers are entitled to and name and address of the Inspecting Officer. The Contractor shall send a copy of each of such notice to the Inspecting Officers and the Engineer- in- charge.

5**. FIXATION OF WAGE PEIODS:**

The contractor shall fix wage periods in respect of which wages shall be payable. No wage period shall normally exceed one work.

6**. PAYMENT OF WAGES:**

i) Wages due to every worker shall be paid to him direct. All wages shall be paid in current coins or currency or in both.

ii) Wages of every worker employed on the contract shall be paid where the wage period is one week ,within three days from the end of the wage period, and in any other case before the expiry of the 7^{th} day or 10^{th} day from the end of the wage period according as the number of workers does not exceeds 1000.

iii) When employment of any worker is terminated by or on behalf of the contractor, the wages earned by him shall be paid before expiry of the day succeeding the one on which his employment is terminated.

iv) Payment of wages shall be made at the work site on a working day except when the work is completed before expiry of the wage period, in which case final payment shall be made at the work site with in 48 hours of the last working day and during normal working time.

Note:

The term “working day” means a day on which the work, on which labour is employed, is in progress .

7. REGISTER OF WORKMEN:

A register of workmen shall be maintained in the form appended to these regulations and kept at the work site or as near to it as possible, and the relevant particulars of every workmen shall be entered therein within 3 days of his employment.

8. **EMPLOYMENT CARD:**

The contractor shall issue an employment card in the form appended to these regulations to each worker on the day of work or entry into his employment. If a worker has already any such card with him issued by the previous employer the contractor shall merely endorse that employment card with relevant entries. On termination of employment the employment card shall again be endorsed by the contractor and returned to the worker.

9**. REGISTER OF WAGES ETC :**

i) A register of wages- cum-muster roll in the form appended to these regulations shall be maintained and kept at the work site or as near to it as possible.

ii) A wage slip in the form appended to these regulations shall be issued to every worker employed by the contractor atleast a day prior to disbursement of wages.

10. **FINES AND DEDUCTIONS WHICH MAY BE MADE FROM WAGES:**

i) Wages of worker shall be paid to him without any deductions of any kind except the following:

a) Fines.
b) Deductions for absence from duty, i.e. from the place or the places where by the terms office employment is required to work. The amount of deduction shall be in proportion to the period for which he was absent.
c) Deduction for damage to or loss of goods expressly entrusted to the employed person for custody, or for less of money which he is required to account for, where such damage or loss is directly attributable to his neglect or default ;
d) Deductions for recovery of advances or for adjustment of over payment of wages. Advances granted shall be entered in a register ; and
e) Any other deduction which the BHEL may from time to time allow.

ii) No fines shall be imposed on a worker save in respect of such acts and omissions on his part as have been approved by the chief Labour Commissioner.

iii) No fines shall be imposed on a worker and no deductions for damage for loss shall be made from his wages until the worker has been given an opportunity of showing – cause against such fines or deductions.

iv) The total amount of fines which may be imposed in any one wage period on a worker shall not exceed an amount equal to three paise in a rupee of the wages payable to him in respect of that wage period.

v) No fine imposed on a worker shall be recovered from him in instalments, or after expiry of sixty days from the date on which it was imposed. Every fine shall be deemed to have been imposed on the day of the act or omission in respect which it was imposed.

vi) The contractor shall maintain both in English and the local Indian language a list, approved by the Chief Labour Commissioner, clearly stating the acts and omissions for which penalty or fine may be imposed on a workman and display it in good condition in a conspicuous place on the work site.

vii) The contractor shall maintain a register of fines and the register of deductions for damage or loss in the forms appended to these regulations which should be kept at the place of work.

11. REGISTER OF ACCIDENTS:

The contractor shall maintain a register of accidents in such form as may be convenient at the work place but the same shall include the following particulars :-

a) Full particulars of the labourers who met with the accident.
b) Rates of wages
c) Sex.
d) Age.
e) Nature of accident and cause of accident.
f) Time and date of accident.
g) Date and time when admitted in hospital.
h) Date of discharge from the hospital.
i) Period of treatment and result of treatment.

j) Percentage of loss of earning capacity and disability as assessed by Medical officer.
k) Claim required to be paid under workmen's composition Act.
l) Date of payment of compensation.
m) Amount paid with details of the person to whom the same was paid.
n) Authority by whom the compensation was assessed.
o) Remarks.

12. **PRESERVATION OF REGISTERS**:
The register of workmen and the Register of wages-Cum-Muster Roll required to be maintained under these Regulations shall be preserved for 3 years after the date on which the last entry is made therein.

13. **ENFORCEMENT:**
The Inspecting Officer shall either on his own motion or on a complaint received by him carry out investigations and send a report to the Engineer-in-charge specifying the amount representing / workers dues and amount of penalty to be imposed on the contractor for breach of these regulations, that have to be recovered from the contractor, indicating full details of the recoveries proposed and the reasons, therefor. It shall be obligatory on the part of the Engineer-in-charge on receipt of such a report to deduct such amounts from payments due to the contractor.

14. **DISPOSAL OF AMOUNTS RECOVERED FROM THE CONTRACTORS**:
The engineer- in -charge shall arrange payment to workers concerned within 45 days from receipt of a report from the Inspecting Officer except in cases where the contractor had made an appeal under regulation. 16. Of these regulations. In cases where there is an appeal, payment of worker dues would be arranged by the Engineer -in -charge, wherever such payments arise, with in 30 days from the date of receipt of the decision of the Regional Labour Commissioner (RLC).

15. **WELFARE FUND :**
All moneys that are recovered by the Engineer-in-charge by way of workers due which could not be disbursed to workers with in the time-limit prescribed above, due to reasons such as where about or workers not being known, death of a worker, etc., and also amounts recovered as penalty, shall be credited to a fund to be kept under the custody or BHEL for such benefits and welfare of workmen employed by the contractors.

16. **APPEAL AGAINST DECISION OF INSPECTING OFFICER**:
Any person aggrieved by a decision of the Inspecting Officer may appeal against such decision to the Regional Labour Commissioner concerned within 30 days from the date of decision, forwarding simultaneously a copy of his appeal to the Engineer-in-charge. The decision of the Regional Labour Commissioner Shall be final and binding upon the contractor and the work men.

17. **REPRESENTATION OF PARTIES :**
i) A workman shall be entitled to be represented in any investigation or enquiry under these Regulations by an officer of a registered trade union of which the said trade union is affiliated or where the work man is not a member of any registered trade union, by an officer of a registered trade union, connected with, or any other workmen employed in, the industry in which the worker is employed.

ii) A contractor shall be entitled to be represented in any investigation or enquiry under these Regulations by an officer of an association of contractors of which he is member or by an officer of a Federation of associations of contractors to which the said association is affiliated or where the contractor is not a member of any association of employers, connected with, or by any other employer engaged in the industry in which the contractor is engaged.

iii) No party shall be entitled to be represented by a legal practitioner in any investigation or enquiry under these Regulations.

18. **INSPECTION OF BOOKS AND OTHER DOCUMENTS:**

The contractor shall allow Inspection of the registers and other documents prescribed under these regulations by inspecting officers and the Engineer-in-charge or his authorised representative at any time and by the worker or his agent on receipt of due notice at a convenient time.

19. **INTERPRETATION ETC. :**

On any question as to the application, interpretation or effect of these Regulations, the decision of the Chief Labour Commissioner or Deputy Chief Labour Commissioner (Central) shall be final and binding.

20. **AMENDMENTS :**

Central Government may, from time to time, add to or amend the Contractors Labour Regulations and issue such directions as it may consider necessary for the proper implementation of the Contractors Labour Regulations for the purpose of removing any difficulty which may arise in the administration thereof, based on which the BHEL Contractors Labour Regulation here in contained shall be subject to revision.

BHEL SAFETY CODE

(See condition 20)

1. Suitable scaffolds shall be provided for workmen for all work that cannot safely be done from the ground, or from solid construction except such short period work as can be done safely from ladders. When a ladder is used one extra mazdoor shall be engaged for holding the ladder and if the ladder is used for carrying materials as well, suitable footholds and handholds shall be provided on the ladder and the ladder shall be given an inclination not steeper than ¼ to 1 (1/4 horizontal and 1 vertical).
2. Scaffolding or staging more than 3.25 meters above the ground or floor, swing or suspended from an overhead support or erected with stationery support, shall have a guard rail properly attached, bolted, braced and otherwise secured atleast 1 meter high above the floor or platform of such scaffolding or staging and extending along with the entire length of the outside and ends thereof with only such openings as may be necessary for the delivery or materials, such scaffolding or staging shall be so fastened as to prevent it from swaying from the building or structure.
3. Working platform, gangways and stairways shall be so constructed that they do not sag unduly or unequally, and if height of a platform or gangway or stairway is more than 3.25 meters above ground level or floor level it shall be closely boarded, have adequate width and be suitably fenced, as described in 2 above.
4. Every opening in floor of a building or in a working platform shall be provided with suitable means to prevent fall of persons or materials by providing suitable fencing or failing with a minimum height of 1 meter.
5. Safe means of access shall be provided to all working platform and other working places, Every ladder shall be securely fixed. No portable single ladder shall be over 9 meters in length. Width between side rails in a rung ladder shall in no case be less than 30cm. For ladders upto and including 3 meters in length. For longer ladders this width shall be increased by atleast 6mm for each additional 30 cms of length. Uniform step spacing shall not exceed 30 cm.

   Adequate precautions shall be taken to prevent danger from electrical equipment. No materials on any of the sites shall be so stacked or placed as to cause danger or inconvenience to any person or the public. The contractor shall provide all necessary fencing and lights to protect public from accidents and shall be bound to bear expenses of defence of every suit action or other proceedings at law that may be brought by any person for injury sustaining owing to neglect of the above precautions, and pay any damages and costs which may be awarded in any such suit, action or proceedings to any such person or which may with the consent of the contractor be paid to compromise any claim by any such person.

6. **EXCAVATION AND TRENCHING :**

   All trenches, 1.5 meters or more in depth, shall at all times be supplied with atleast one ladder for each 30 m length or fraction thereof. Ladder shall to be extended from bottom of trench to atleast, 1 meter above surface of the ground. Sides of a trench 1.5 meters or more in depth shall be stepped back to give suitable slope, or securely held by timber bracing, so as to avoid the danger of sides collapsing. Excavated materials shall not be placed within 1.5 meters of the edge of trench or half the depth of trench, whichever is more. Cutting shall be done from top to bottom. Under no circumstances shall undermining or undercutting be done.

7. **DEMOLITION :**
Before any demolition work is commenced and also during the process of the work.

a) All roads and open areas adjacent to the work site shall either be enclosed or suitably protected;
b) No electric cable or apparatus which is liable to be source of danger over a cable or apparatus used by operator shall remain electrically charged.
c) All present steps shall be taken to prevent danger to persons employed, from risk or fire or explosion or No floor, roof or other part of a building shall be so overloaded with debris or materials as to render it unsafe.

8. All necessary personal safety equipment as considered adequate by the Engineer-in-charge shall be available for use of persons employed on the site and maintained in a condition suitable for immediate use and the contractor shall take adequate steps to ensure proper use of equipment by those concerned.

a) Workers employed on mixing asphaltic materials cement and lime mortars/concrete shall be provided with protective footwear and protective goggles.
b) Those engaged in handling any materials which is injurious to the eye shall be provided with protective goggles.
c) Those engaged in welding works shall be provided with welder's protective eye shelds.
d) Stone breaker shall be provided with protective goggles and protective clothing and seated at sufficiently safe intervals.
e) When workers are employed in sewer and manholes which are in use, the contractor shall ensure that manholes covers are opened and manholes are ventilated atleast for an hour before workers are allowed to get in to them. Manholes so opened shall be cordoned off with suitable railing and provided with warning signals or boards to prevent accident to public.
f) The contractor shall not employ men below the age of 18 and women on the work of painting with products containing lead in any form. Wherever men above the age of 18 are employed on the work of lead painting the following precautions shall be taken.
i) No paint containing lead or lead products shall be used except in the form of paste or readymade paint.
ii) Suitable face masks shall be supplied by the contractor for use by workers when paint is applied in the form of spray or a surface having lead paint is dry rubbed and scrapped.
iii) Overalls shall be supplied by the Contractor to workmen and adequate facilities shall be provided to enable working painters to wash during and cessation of work.

9. When work is done near any where there is risk of drowning, all necessary equipment shall be provided and kept ready for use and all necessary steps taken for prompt rescue of any person in danger and adequate provision made for prompt first aid treatment of all injuries likely to be sustained during the course of the work.

10. Use of hoisting machine and tackles including their attachments, anchorage and supports shall conform to the following:

a) i) These shall be of good mechanical construction, sound material and adequate strength and free from defects.
ii) Every rope used in hoisting or lowering materials or as a means of suspension shall be durable quality and adequate strength, and free from defects.

b) Every crane driver or hoisting appliance operator shall be properly qualified and no person under the age of 21 years shall be in-charge of any hoisting machine including any scaffolding winch or give signals to operator.

c) In case of every hoisting machine and of every chain, ring, hook, shackle, swivel and pulley block used in hoisting, or lowering or as means of suspension safe working load shall be ascertained by adequate means. Every hoisting machine and all gear referred to above shall have the safe working load plainly marked thereon. In case of a hoisting machine having a variable safe working load, each safe working load, and the conditions under which it is applicable shall be clearly indicated. No part of any machine or any gear referred to above in this paragraph shall be loaded beyond the safe working load except for the purpose of testing.

10.d) In case of departmental machine, safe working load shall be notified by the Engineer-in-charge. As regards contractor's machines the contractor shall notify safe working load of each machine to the Engineer-in-charge whenever he brings it to site of work and get it verified by the Engineer-in-charge.

11. Motors gearing, transmission, electric wiring and other dangerous parts of hoisting appliances shall be provided with efficient safeguards, hoisting appliances shall be provided with such means as will reduce to the minimum risk of accidental descent of load. Adequate precautions shall be taken to reduce to the minimum risk of any part of a suspended load becoming accidentally displaced. When workers are employed on electrical installations which are already energised, insulating mats, working apparel such as gloves, sleeves, and boots, as may be necessary shall be provided. Workers shall not wear any rings, watches carry keys or other materials which are good conductors of electricity.

12. All scaffolding, ladders and other safety devices mentioned or described herein shall be maintained in a safe condition and no scaffold, ladder or equipment shall be altered or removed while it is in use. Adequate washing facilities shall be provided at or near the places of work.

13. These safety provisions shall be brought to the notice of all concerned by display on a notice board at a prominent place at the work spot. Persons responsible for ensuring compliance with the safety code shall be named there on by the contractor.

14. To ensure effective enforcement of the rules and regulations relating to safety precautions, arrangements made by the contractor shall be open to inspection by the Engineer-in-charge or his representative and the inspection officers as defined in the contractor's Labour Regulations.

15. Notwithstanding the above conditions 1 to 14, the Contractor is not exempted from the operation of any other Act or Rule in force.

Bharat Heavy Electricals Limited
Electronics Division, Mysore Road, Bangalore – 560 026.

FROM OF REGISTER OF WORKMEN
(Regulation 7)

(i) Name and address of the contractor :…….
(ii) Number and date of the contract agreement/work order :…….
(iii) Name and address of the department awarding the contract:……
(iv) Nature of the contract and location of the work:……
(v) Duration of the contract :……..

Sl.No	Name and Surname of the workers	Age & Sex	Father's Husband's Name	Nature of employment designation.	Permanent/ home address of employee (village) Dist. Tana)	Present address.	Date of commencement of employment	Date of termination or leaving of employment	Signature or thumb impression of the employee	Remarks.
1	2	3	4	5	6	7	8	9	10	11

Bharat Heavy Electricals Limited
Electronics Division, Mysore Road, Bangalore – 560 026.

FORM OF EMPLOYMENT CARD
(Regulation 8)

(i) Name and sex of the worker :……
(ii) Father's/Husband's Name :……
(iii) Address :……
(iv) Age or date of birth :……..
(v) Identification marks :……

Particulars of next of kin (wife/husband and children, if any, or/dependant next of kin in case the worker has no wife/husband or child) :
Name :…….
Full address of dependants :……
(Specify village, Dist., and State) :……

Sl.No	Name and address of Employer (specify whether a contractor or a sub- contractor).	Particulars of location of work site and description of work done.	Total period for which the worker is employed (from- to)	Actual Number of days worked	Leave taken (No. of days should be specified	Nature of work done by the worker	Wage rate with particulars of unit in case piece-work	Total wages earned by the worker during the period shown under col.5.	Remarks	Signature of the emplo-yer.
1	2	3	4	5	6	7	8	9	10	11

N.B. for a worker employed at one time one piece-work basis and at another on daily wages, relevant entries in respect of each type of employment should be made separately.

FORM OF WAGE SLIP
(REGULATION 9)

(i) Name of the contractor…….
(ii) Place…….

---

1. Name of the workers with father's/husband's Name :
2. Nature of employment :
3. Wage period :
4. Rate of wages payable :

5. Total attendance/unit of work done :

6. Dates on which overtime Worked. :

7. Overtime wages. :

8. Gross Wages payable :

9. Total deductions (indicating nature of deduction).

10. Net Wages Payable :

CONTRACTOR'S SIGNATURE/ THUMB IMPRESSION.

EMPLOYEES SIGNATURE/ THUMB IMPRESSION.

FORM OF RESISTER OF WAGES-CUM-MUSTER ROLL

(Regulation 9)

(i) Name and address of the contractor:…….
(ii) No. & Date of the contract agreement/work order :……..
(iii) Name and address of the dept. awarding the contract :…….
(iv) Nature of the contract and location of the work :…….
(v) Duration of the contract :…….
(vi) Wage period :…….

							Fair wages payable.		Wages paid .		Overtime worked.				Deduction from wages.								
Serial Number	No. and Surname of the worker.	Father's/husband's Name	Sex	Designation nature of work.	Daily attendance (No. of units worked)	Total attendance units.	Basic	D.A.and other allowances	Basic	D.A.and other allowances	Date	No. of hours.	Over time wages earned .	Total wages paid	Fine	Deduction for damage or loss	House rent.	Revenue of advances.	Other deductions	Net wages payable.	Date of payment	Signature or thumb impression	Remarks.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

FORM OF REGISTER OF
DEDUCTIONS FOR DAMAGE OR LOSS CAUSED TO THE BHEL BY THE NEGLECT OR DEFAULT OF THE EMPLOYED PERSONS.
(Regulation No. 10 (vii).

Sl.No.	Name	Father's/ Husband's Name.	Sex.	Dept.	Damage or loss caused with date.	Whether worker showed cause against deduction if so, enter date.	Date and amount of deduction imposed.	Number of instalment if any.	Date on which total amount realised	Remarks.
1	2	3	4	5	6	7	8	9	10	11

FROM OF REGISTER OF FINES (REGULATIONS No. 10 (VII)

Sl.No.	Name	Father's/ Husband's Name.	Sex.	Dept.	Nature and date of the offence for which fine imposed	Whether workman showed cause against fine or not, enter date.	Rate of wages .	Date and amount of fine imposed.	Date on which fine realised.	Remarks.
1	2	3	4	5	6	7	8	9	10	11