

TECHNICAL SPECIFICATIONS

CIVIL WORKS

1.0 GENERAL:-

- 1.01 The specifications and mode of measurements for Civil and Plumbing works shall be in accordance with C.P.W.D. specifications 2009 Volumes I and II with up to date correction slips unless otherwise specified in the nomenclature of individual item or in the specifications. The entire work shall be carried out as per the C.P.W.D. specifications in force with up to date correction slips upto the date of opening of tender.
- 1.02 For the item not covered under CPWD Specifications mentioned above, the work shall be executed as per latest relevant standards/codes published by B.I.S. (formerly ISI) inclusive of all amendments issued thereto or revision thereof, if any, upto the date of opening of tenders.
- 1.03 In case of B.I.S. (formerly I.S.I) codes/specifications are not available, the decision of the Engineer based on acceptable sound engineering practice and local usage shall be final and binding on the contractor.
- 1.04 However, in the event of any discrepancy in the description of any item as given in the schedule of quantities or specifications appended with the tender and the specifications relating to the relevant item as per CPWD specifications mentioned above, or in drawings the former shall prevail.
- 1.05 In general the building floor to floor height is 4.00 mtr unless specified otherwise in the drawing. However, the rates for different items of work shall be for up to 4.5 m floor to floor height at all levels, lifts, leads and depths of the building except where otherwise specified explicitly in the item of work or in special conditions appended with the tender. All works above the top most terraces (main) shall be paid under the level existing below (i.e. machine room, mummy etc)
- 1.06 The work shall be carried out in accordance with the architectural, structural, plumbing and electrical drawings etc. The drawings shall have to be properly co-related before executing the work. In case of any difference noticed between the drawings, final decision, in writing of the Engineer shall be obtained by the contractor. For items, where so required, samples shall be prepared before starting the particular items of work for prior approval of the Engineer and nothing extra shall be payable on this account.
- 1.07 All materials to be used on works shall bear I.S. certification mark unless specifically permitted otherwise in writing. In case I.S. marked materials are not available (not produced),

the materials used shall conform to I.S. Code or CPWD specifications, as applicable in this contract.

In such cases the Engineer shall satisfy himself about the quality of such materials and give his approval in writing. Only articles classified as "First Quality" by the manufacturers shall be used unless otherwise specified. All materials shall be tested as per provisions of the Mandatory Tests in CPWD specifications and the relevant IS specifications. The Engineer may relax the condition regarding testing if the quantity of materials required for the work is small. Proper proof of procurement of materials from authentic manufacturers shall be provided by the contractor to the satisfaction of Engineer. Grade of cement used shall be OPC 43 Grade unless otherwise specified explicitly. The contractor shall get the Design Mix for RCC done by the labs approved by OWNER only. Reinforcement Steel used shall be of TMT Fe-500 unless otherwise specified.

- 1.08 In respect of the work of the sub-agencies deployed for doing work of electrification, air-conditioning, external services, other building work, horticulture work, etc. for this project and any other agencies simultaneously executing other works, the contractor shall afford necessary coordination and facilities for the same. The contractor shall leave such necessary holes, openings, etc. for laying / burrying in the work pipes, cables, conduits, clamps, boxes and hooks for fan clamps, etc. as may be required for the electric, sanitary air-conditioning, fire fighting, PA system, telephone system, C.C.T.V. system, etc. and nothing extra over the agreement rates shall be paid for the same.
- 1.09 Unless otherwise specified in the bill of quantities, the rates for all items of work shall be considered as inclusive of pumping out or bailing out water if required for which no extra payment will be made. This will include water encountered from any source such as rains, floods, or due to any other cause whatsoever.
- 1.10 Any cement slurry added over base surface (or) for continuation of concreting for bond is added its cost is deemed to have in built in the item unless otherwise/explicitly stated and nothing extra shall be payable or extra cement considered with consumption on this account.
- 1.11 The rate for all items in which the use of cement is involved is inclusive of charges for curing.
- 1.12 The contractor shall clear the site thoroughly of all scaffolding materials and rubbish etc. left out of his work and dress the site around the building to the satisfaction of the Engineer before the work is considered as complete.
- 1.13 Rates for plastering work (excluding washed grit finish on external wall surfaces) shall include for making grooves, bands etc. wherever required and nothing extra shall be paid for the same.
- 1.14 The rates quoted for all brick/concrete work shall be deemed to include making openings and making good these with the same specifications as shown in drawings and/or as directed. No extra payment shall be made to the contractor on this account.
- 1.15 Rates for all concrete/plaster work shall include for making drip course moulding, grooves etc. wherever required and nothing extra shall be paid for the same.
- 1.16 Rates for flooring work shall include for laying the flooring in strips/as per sample or as shown in drawings wherever required and nothing extra shall be paid for the same.

- 1.17 The drawing(s) attached with the tender documents are for the purpose of tender only, giving the tenderer a general idea of the nature and the extent of works to be executed. The rates quoted by the tenderer shall be deemed to be for the execution of works taking into account the "Design Aspect" of the items and in accordance with the "Construction Drawings" to be supplied to the Contractor during execution of the works.
- 1.18 The quoted rate shall be for finished items and shall be complete in all respects including the cost of all materials, labour, tools & plants, machinery etc., all taxes, duties, levies, octroi, royalty charges, statutory levies etc. applicable from time to time and any other item required but not mentioned here involved in the operations described above. The client/OWNER/Employer shall not be supplying any material, labour, plant etc. unless explicitly mentioned so.
- 1.19 On account of security consideration, there could be some restrictions on the working hours, movement of vehicles for transportation of materials and location of labour camp. The contractor shall be bound to follow all such restrictions and adjust the programme for execution of work accordingly.
- 1.20 The contractor has to ensure co-ordination with Institute authorities to maintain the smooth functioning / operation of existing Institute without disruption during the execution of work. This may require working rescheduling the normal working hours, working in restricted period etc. Nothing extra shall be payable on this account.

He shall also ensure that all work sites within the Institute complex are properly cordoned off by means of barricades and screens upto a height of 3.0 m above ground level. The contractor shall use painted CGI sheets which are in good condition mounted on steel props.

- 1.21 Stacking of materials and excavated earth including its disposal shall be done as per the directions of the Engineer-in-Charge. Double handling of materials or excavated earth if required shall have to be done by the contractor at his own cost.

2.0 Mix Design, Batching Plant/ Ready mix Concrete

- 2.01 Following parameters shall be adopted for mix design in moderate exposure.

1.	Nominal Maximum size of aggregate	20mm angular as Per CPWD specification
2.	Degree Of quality control	Good
3.	Type of Exposure	Moderate
4.	Maximum water cement/ratio	0.50
5.	Type of cement to be used	OPC 43 grade conforming to IS: 8112
6.	Sand	Coarse Sand as per CPWD specification
7.	Use Of Fly Ash in RMC	Strictly not permitted.

- 2.02 **BATCHING PLANT:** Batching Plant of suitable capacity to be installed within a period of 30 days from award of work. The contractor shall install batching plants (within 50 meters distance from the site of work) supplying Concrete at site. The batching plant proposed to be engaged by the contractor shall fulfill the following requirements.

- i) It shall be fully computerized.
- ii) Facility to pump concrete upto the highest point of the building.
- iii) It should have facility for providing printed advice showing ingredients of concrete carried by each mixer.
- iv) Should have sufficient capacity to meet the requirement as per schedule.

In case of failure of Batching Plant, RMC may be allowed with a written permission of Engineer in Charge

2.03 Approved admixtures conforming to IS.9103 shall be permitted to be used. The chloride content in the admixture shall satisfy the requirement of BS 5075. The total amount of chloride content in the admixture mixed Concrete shall satisfy the requirement of IS 456-2000.

2.04 The concrete mix design with and without admixture will be carried out by the contractor through one of the following Laboratories / Test house to be approved by Engineer.

- i) IIT, Delhi
- ii) Shri Ram Institute of Industrial Research, Delhi
- iii) Any other Govt Laboratory as approved by Engineer.

2.05. In the event of all the four laboratories being unable to carry out the requisite design /testing the contractor shall have to get the same done from any other reputed laboratory with prior approval of the Engineer.

2.06. The various ingredients for mix design \laboratory tests shall be sent to the lab test house through the Engineer and the sample of such ingredients sent shall be preserved at site by the department till completion of work or change in Design Mix whichever is earlier. The sample be taken from the approved materials which are proposed to be used in the work.

2.07. The rate for the item of Ready Mixed Concrete shall be inclusive of all the ingredients including admixtures if required, labour, machine T&P etc (except shuttering which will be measured & paid for separately) required for design mix concrete of required strength and workability.

The rate quoted by the agency shall be net & nothing extra shall be payable in account of change in quantities of concrete ingredients like cement and aggregates and admixtures etc. in the approved mix design.

2.08. The contractor shall engage Ready Mix Concrete (RMC) producing plants (Distance of plant from site to be approved by Engineer in Charge) to supply RMC for the work. The RMC plant proposed to be engaged by the contractor shall fulfill the following requirements.

- i) It shall be fully computerised.
- ii) It should have supplied RMC for Govt. projects of similar magnitude.
- iii) It should have facility for providing printed advice showing ingredients of concrete carried by each mixer.

2.09. The contractor shall, within 10 days of award of the work submit list of at least three RMC plant companies from the approved makes along with details of such plants Including details of transit mixer, pumps etc. to be deployed indicating name of owner/company, its location,

capacity , technical establishment, past experience and text of MOU proposed to be entered between purchaser (the contractor) and supplier (RMC Plant) to the Engineer who shall give approval in writing (Subject to drawl of MOU).

2.10. The Engineer reserves the right to exercise over the:-

i) Ingredients, water and admixtures purchased, stored and to be used in the concrete including conducting of tests for checking quality of materials recordings of test results and declaring the material fit or unfit for use in production of mix.

ii) Calibration check of the RMC.

iii) Weight and quality check on the ingredient, water and admixture added for batch mixing.

iv) Time of mixing of concrete.

v) Testing of fresh concrete, recordings of results and declaring the mix fit or unfit for use. This will include continuous control on the workability during production and taking corrective action.

For exercising such control, the Engineer shall periodically depute his authorized representative at the RMC plant. It shall be the responsibility of the contractor to ensure that the necessary equipment manpower & facilities are made available to Engineer and/or his authorized representative at RMC plant

2.11. Ingredients, admixtures & water declared unfit for use in production of mix shall not be used. A batch mix found unfit for use shall not be loaded into the truck for transportation.

2.12. All required relevant records of RMC shall be made available to the Engineer or his authorized representative. Engineer shall, as required, specify guidelines & additional procedures for quality control & other parameters in respect of materials, production and transportation of concrete mix which shall be binding on the contractor & the RMC plant.

2.13. 43 grade OPC (Conforming to IS-8112) of brand/make/source approved by Engineer shall only be used for production of concrete.

2.14. It shall be the responsibility of the Contractor to ensure that the RMC producer provides all necessary testing equipment and takes all necessary measures to ensure Quality control of ready -mixed concrete. In general the required measures shall be:-

i) CONTROL OF PURCHASED MATERIAL QUALITY

RMC producer shall ensure that the materials purchased and used in the production of concrete conform to the stipulation of the relevant agreed standards with the material Supplier and the requirement of the product mix design and quality control producer's. This shall be accomplished by visual checks, sampling and testing, certification from materials suppliers and information /data from material supplier. Necessary equipment for the testing of all material shall be provided and maintained in calibration condition at the plant by the RMC producer.

ii) CONTROL OF MATERIAL STORAGE

Adequate and effective storage arrangement shall be provided by RMC producer at RMC plant for prevention of contamination, reliable transfer and feed system, drainage of aggregates, prevention of freeing or excessive solar heating of Aggregate etc,

iii) **RECORD OF MIX DESIGN AND MIX DESIGN MODIFICATION**

RMC producer shall ensure that record of mix design and mix design modification is available in his computer at RMC plant for inspection of Engineer or his representative at any time.

iv) **COMPUTER PRINT OUTS OF EACH TRUCK LOAD**

Each truckload / transit mixer dispatched to site shall carry computer printout of the ingredients of the concrete it is carrying. The printout shall be produced to Engineer or his representative at site before RMC issued in work.

v) **TRANSFER AND WEIGHING EQUIPMENT RMC**

Producer shall ensure that a documented calibration is in place. Proper calibration records shall be made available indicating date of next calibration due, corrective action taken etc. RMC producer shall ensure additional calibration checks whenever required by the Engineer in writing to contractor. RMC producer shall also maintain a daily production record including details of mixes supplied. Record shall be maintained of what materials were used for that day's production including water and admixtures.

The accuracy of measuring equipment shall be within +2% of quantity of cement +/- 3% of quantity of aggregate, admixture and water being measured.

vi) **MAINTENANCE OF PLANT, TRUCK Mixers AND PUMPS**

Plant, Truck Mixers and Pumps should be well maintained so that it does not hamper any operation of production, transportation and placement.

vii) **PRODUCTION OF CONCRETE**

The following precautions shall be taken during the production of RMC at the plant

i) Weighing (correct reading of batch data and accurate weighing) :- For each load, written, printed or graphical records shall be made of the weights of the materials batched, the estimated slump, the total amount of water added to load the delivery tickets number for that load and the time of loading the concrete into the truck.

ii) Visual observation of concrete during production and delivery or during sampling and testing of fresh concrete assessment of uniformity, cohesion, workability adjustment to water content. The workability of the concrete shall be controlled on a continuous basis during production. The batch mix found unfit shall not be loaded into the truck for transportation. Necessary corrective action shall be taken in the production of mix as required for further batches.

iii) Use of adequate equipment at the plant to measure surface moisture content of aggregates, particularly fine aggregates or the workability of the concrete, cube tests etc. shall also be ensured.

iv) Making corresponding adjustment at the plant automatically or manually to batched quantities to allow for observed, measured or reported changes in materials or concrete qualities.

v) Sampling of concrete, testing monitoring of results.

vi) Diagnosis and correction of faults identified from observations /complaints.

The RMC plant produced concrete shall be accepted by Engineer at site after receipt of the same after fulfilling all the requirements of mix mentioned in the tender documents.

2.15. The rate for the Item of design mix cement concrete shall be inclusive of all the ingredients including admixtures if required, labour, machinery T&P etc. (except shuttering which will be measured & paid for separately) required for a design mix concrete of required strength and workability. The rate quoted by the agency shall be net & nothing extra shall be payable on account of change in quantities of concrete, ingredients like cement and aggregates and admixtures etc. as per the approved mix design.

2.16 Ready mix concrete shall be arranged in quantity as required at site of work. The ready mix concrete shall be supplied as per the pre-agreed schedule approved by Engineer.

2.17. Frequency of sampling and standards of acceptance shall be as per CPWD specifications.

i) No addition of water or other ingredients shall be permitted in the RMC at site or during transit.

ii) The RMC shall be placed by pump of suitable capacity and the contractor shall arrange sufficient length of pipe at site to place the RMC in the minimum required time. The contractor shall co-ordinate with RMC supplier and pumps hirer to have effective concrete placement.

iii) Pre-paid delivery tickets shall be produced with each truck load of RMC.

iv) The representative of RMC supplier shall attend the site meeting as and when decided by the Engineer

2.18 i) The contractor shall assess the quantity of RMC requirement at site well in advance and order accordingly to the RMC supplier. In case excess RMC is received at site, the department shall not be under any obligation to get extra quantities utilized and no payment for such RMC shall be made.

ii) The contractor shall have to employ labour in shifts to ensure continuous casting of raft and other RCC members. No extra payment on this account shall be made.

3.00 PLUMBING & SANITARY INSTALLATIONS

3.01 Special condition for PHE work: The plumbing work shall be carried out by specialized plumbing agency who has licensed plumber and experience of similar works. For supervising the plumbing work at least one engineer who has rich experience in executing plumbing work shall be engaged full time. Approval of specialized agency shall be obtained from HSCC.

3.02 The provision of adequate sanitary and safety facilities as per the norms of NBC and good engineering practice shall be compliance during construction for construction workers and staff.

- 3.03 The water use for construction shall be suitable for the same and should be used efficiently and checks and control valves shall be provided to avoid the wastage and leakage.
- 3.04 To reduce the water consumption of the building, the flushing system of water closet shall be of dual flushing cistern type and plumbing fixture shall be provided which require GRIHA compliance for low flow rate.
- 3.05 Lab service related to plumbing & fire fighting will be executed by specialized agency who has experience of carrying out similar work earlier. All the lab item shall be detailed out & redesign as per requirement of client , WHO, CDC norms, items given in BOQ are indicative but covered the cost as per the latest requirement of client , WHO, CDC and required approval of client before execution.

3.06 Wall Caps

Wall caps shall be provided on all walls, floors, columns etc. wherever supply and disposal pipes pass through them. These wall caps shall be chromium plated brass snugly fittings and shall be large enough to cover the puncture properly and shall conform to IS: 4291.

3.07 Pipes, Hangers, Brackets, etc.

Sturdy hangers, brackets and caddles of approved design shall be installed to support all pipe lengths, which are not embedded over their entire runs. The hangers and brackets shall be of adjustable heights and painted with red oxide primer, and two coats of enamel paint of approved make and shade. Clamps, coils and saddles shall be provided to hold pipes with suitable gaskets of approved quality. The brackets and hangers shall be designed to carry the weights of pipes safely. Wherever required pipes may run along ceiling level in suitable gradient and supported on structural clamps. Spacing for clamps for such pipes shall be as follows:

	Vertical	Horizontal
G.I. Pipes	300 cms	240 cms
H.C.I. Pipes	180 cms	120 cms

3.08 Pipe sleeve

Adequate number of sleeves (pipe inserts) of Cast Iron or Mild Steel shall be provided where pipes cross through concrete, masonry and similar work. The pipe inserts shall be provided with removable timber plugs to keep foreign matter out till installation of the services pipe cross the sleeve. The diameter of sleeve should be one size higher than the proposed dia or as instructed by the Engineer.

3.09 Floor trap inlet

Bath room traps and connections shall ensure free and silent flow of discharging water. Where specified, contractor shall have a special type G.I. / M.S. inlet hopper without or with one, two or three inlet sockets to receive the waste pipe. Joint between waste and hopper inlet socket shall be lead caulked/welded/threaded. Hopper shall connected to a C.I. P or S trap with at

least 50mm water seal. Floor trap inlet hoppers and traps shall be set in cement concrete 1:2:4 blocks without any extra cost.

3.10 C.P. gratings

Floor trap and urinal trap shall be provided with 110mm square or round C.P. /stainless steel grating, with rim of approved design and shape. Minimum thickness shall be 3 mm.

3.11 Hot Water Supply

The chase will be closed in cement mortar 1:2 (1 cement : 2 coarse sand). Pipes shall be clamped to the wall inside the chase.

3.12 Making Connections

Contractor shall connect the new sewer line to the existing manhole by cutting the walls, benching and restoring them to the original condition. A new channel shall be cut in the benching of the existing manholes for the new connection. Contractor shall remove all sewage and water if encountered in making the connection without additional cost.

3.13 Water Heater

Water heater shall be automatic pressure type water heater (with pressure release valve) with heavy gauge copper container duly tinned, thermostats, indicator lamp and glass wool insulator. the water heaters shall be fitted with pressure release valve, non-return valve and inlet and outlet stop valves as required. Water heaters to conform to IS:2082.

3.14 FULLWAY BALL VALVE

The valves shall be of full-bore type and of quality approved by the Engineer. The body and ball shall be of copper alloy and stem seat shall be of Teflon.

3.15 COMPOSITE PIPES: Composite pipes shall be used in the internal water supply if specified in the Bill of Quantities. These may required to be connected to the existing/ new GI pipes.

3.16 SAMPLE AND SHOP DRAWINGS;

All plumbing items shall be provided as per approved sample/data sheet approved by the HSCC. Before placing the order, the contractor shall submit the shop drawings prepared based on tender drawings and BOQ alongwith samples for approval of HSCC. The shop drawings shall have all the details. The contractor has to obtain the approval of external plumbing drawings from DJB/MCD before start of work.

4.00 WATER TREATMENT & PUMPS

1.0 SCOPE OF WORK

Work under this section consists of furnishing all labour, materials, equipment's and appliances necessary and required to supply, install and commission pumping and water filtration as described hereinafter and given in the schedule of quantities and/or shown in the drawings. Tentative raw water characteristics are given in Appendix-1

- 2.0 GENERAL REQUIREMENTS
- 2.1 All materials shall be new and of the best quality conforming to specifications and subject to the approval of Engineer.
- 2.2 All equipment shall be of best available make manufactured by reputed firms.
- 2.3 All equipment shall be installed on suitable foundations, true to level and in a neat work-man-like manner.
- 2.4 Equipment shall be so installed as to provide sufficient clearance between the end walls and between equipment to equipment.
- 2.5 Piping within the pump houses shall be so done as to prevent any obstruction in the movement within the pump house.
- 2.6 Each pumping set shall be provided with a valve and a flap type non-return valve on the delivery side.
- 2.7 The contractor shall submit the following documents :
- a. Process and hydraulic design calculations for all units.
 - b. Civil, Structural arrangement , design calculations if included in the scope of work.
 - c. Plant layout drawings
 - d. Process flow sheet
 - e. Design Philosophy
 - f. All technical brochures,
 - g. Operation and maintenance manuals and other details of the system offered.
 - h. Equipments listing & list of consumables.
- 2.8 The contractor shall supply shop drawings with supporting details for approval from Engineer before procurement of material. The contractor shall also obtain approval from local statutory authority / authorities as applicable at no extra cost.
- Four sets of shop drawings shall be submitted for approval showing:
- a) Any change in layout from the contract drawings.
 - b) Equipment layout, piping, wiring diagram and instrumentation.
 - c) Manufacturer's or contractor's fabrication drawings for any material or equipment.

2.9 COMPLETION DRAWINGS

On completion of the work and before issuance of certificate of virtual completion, the Contractor shall submit to the Engineer. General layout drawings, drawn at approved scale indicating layout of pump house piping and its accessories "As installed ". These drawings shall in particular give the following:

- a. General layout of pump house.
- b. Panels and other equipment location and sizes etc.
- c. Complete Schematic as installed.
- d. Route of all cables and pipes run along with detail sizes and mode of installation.

2.10 The contractor shall also include the cost of supply and execution any other item required for the effective functioning of system but not mentioned in schedule of quantities/ specifications.

2.11 The contractor shall also arrange for the appropriate training for the clients staff.

2.12 PERFORMANCE GUARANTEE

At the close of the work and before issue of final certificate of virtual completion by the Engineer, the Contractor shall furnish a written guarantee indemnifying the Owner against defective materials and workmanship for a period of one year after completion and handing over. The Contractor shall hold himself fully responsible for reinstallation or replace free of cost to the Owner.

- a. Any defective material or equipment supplied by the Contractor.
- b. Any material or equipment supplied by the Owner which is proved to be damaged or destroyed as a result of defective workmanship by the Contractor.

2.13 A tentative treatment scheme is shown in the drawings.

3.0 WATER SUPPLY PUMPS

3.1 Water supply pumps shall be centrifugal types as given in the schedule of quantities.

3.2 Water supply pumps shall be suitable for clean filtered water, pump shall be single stage pumps with cast iron body and gunmetal/bronze/SS impeller and directly coupled motor suitable for 400X440 volts, 3 phase, 50 cycles A.C. power supply and mounted on single base frame.

4.0 WATER FILTER (MULTI-GRADE)

Water filters shall be sand/gravel and anthracite pressure filters downward or upward flow type suitable for a rate of filtration given in schedule of quantities.

Filters shall be vertical types of a required diameter, the shell shall be fabricated from M.S. plates suitable to withstand a working pressure given in schedule of quantities. The thickness of shell and of dished ends shall be as per IS: 2825. The filter shall have two-pressure tight manhole cover one at the top and other at side shell portion. Each filter shall be provided with screwed or flanged connections for inlet, outlet, individual drain connections and all other connections necessary and required. Filters shall be rubber lined with 3mm thick non-toxic, non-leaching rubber. Rubber lining to be tested with Spark Tester for pinholes etc. Primary painting of all exposed surfaces to be done.

5.0 UNDER DRAIN SYSTEM

Each filter shall be provided with an efficient under drain system comprising of collection pipes, polypropylene nozzles of manufacturer's design. The entire under draining system shall be provided on M.S. Plate or cement concrete supports provided by the contractor.

6.0 FACE PIPING

Each filter shall be provided with interconnection face piping comprising of inlet, outlet and backwash complete with diaphragm valves/ball valves. Piping shall be fabricated from mild steel pipes as per IS: 1239.

7.0 ACCESSORIES

Each filter shall be provided with the following accessories:

- a) Air release valve with connecting piping.
- b) 100mm dia Borden type gunmetal pressure gauges with gunmetal isolation cock and siphon on inlet and outlet.
- c) Sampling cocks on raw water inlet and filtered water outlet.
- d) Individual drain connection with ball valves for each filter.
- e) Connections with valve for air scouring.
- f) Rate of Flow Indicators in the raw water inlet line.
- g) Quantity meter in the filter water outlet line

8.0 FILTER MEDIA

8.1 Each filter shall be provided with clean and washed filter media, following is recommended.

Coarse Silex Pebbles	6.0 - 10.0mm size	(150mm deep)
Fine Silex Sand	1.4 - 2.5mm size	(600mm deep)
Anthracite	0.80 - 1.6mm dia	(600mm)

8.2 The above filter media arrangement may be altered to suit contractor's own design for the most efficient performance and also keeping the low height available for the installation of these Vessels.

9.0 TEST KITS

9.1 Provide one test kit with initial requirement of reagents for the following:

Residual Chlorine Indicator

Valve

9.2 Details of equipment with literature shall be supplied with the tender.

10.0 VALVES

10.1 Valves 50mm dia and above shall be of cast iron butterfly valves.

10.2 Non-return valves 80mm dia and above shall be cast iron double flanged conforming to IS: 5312, 65mm and below shall be of gunmetal.

10.3 Valves 50mm dia and below shall be cast iron ball valves with stainless steel SS-304, stem and ball (S.S.304 or brass with hard chrome plating) with Teflon seat.

10.4 Suction strainer shall be of cast iron with S.S. Perforated sheet.

11.0 PAINTING AND CLEAN UP

a) On completion of the installation Contract shall be scrub clean all pumps, piping, filters and equipment and apply one coat of primer.

b) Apply two or more coats of synthetic enamel paint of approved make and shade.

c) Provide painted identification legend and direction arrows on all equipment's and piping as directed by Engineer.

d) All M.S. fabricated items M.S. pipe lines structural, vessels for water treatment plant shall be painted with zinc/chromate primer after through cleaning. On completion of the installation Contractor shall scrub clean all pumps, piping, filters and equipment and again apply one coat of zinc chromate primer.

e) On final completion of the work, contractor shall clean up the site and the pump room, pump room of all surplus material, rubbish and leave the place in a broom clean condition.

12.0 MOTOR CONTROL CENTERS

12.1 Switchboard cubicles of approved type shall be fabricated from 2mm thick CRC sheet with dust and vermin proof construction. It shall be painted with powder coating of approved make and shade. It shall be fitted with suitable etched plastic identification plates for each motor. The cubicle shall comprise of the following (Switchgear as given in the schedule of quantities):

a) Incoming MPCB of required capacity

b) Isolation MPCB/MCCB, one for each motor

c) Fully automatic DOL/Star Delta starters suitable for motor DOL upto 7.5 H.P.; Star/Delta for 10 H.P. and above H.P. with push buttons one for each motor and On/Off indicating neon lamps.

d) Single phasing preventor of appropriate rating for each motor

e) Rotary duty selector switch

f) Panel type ampere meters one for each motor shall be with rotary selector switch to read line currents.

- g) Panel type voltmeter on incoming main with rotary selector switch to read voltage between phase to neutral and phase to phase
- h) Neon phase indicating lamps and indicating lamp for each motor and on incoming mains.
- i) Rotary switch for manual or auto operation for each pump
- j) Fully taped separate aluminium bus bar of required capacity for normal and emergency supply where specified.
- k) Space for liquid level controllers and other equipment specified separately in the contract/given in the schedule of quantities
- l) The panel shall be pre-wired with colour coded wiring. All interconnecting wiring from incoming main to switchgear, meters and accessories within the switchboard panel. Wiring shall have suitable copper or aluminium ferrules.

12.2 Switchboard cubicle shall be floor or wall mounted type as directed by the Engineer.

13.0 WATER SOFTENING PLANT

Mild steel pressure / FRP vessel complete with dished ends, supporting legs and facing pad for pipe connection, internally rubber lined and externally two coats of red oxide primer and two coats of synthetic enamel paint complete with manhole, cover, frontal pipe work fitted with valves provided with inlet, outlet pressure gauges and sample valves and with frontal pipe work complete with manually. Ball Diaphragm for normal operation and regeneration and hydraulically operated erector, initial charge of resin and internals consisting of distributor, collector and regeneration tank to store and measure chemicals for regeneration.

13.1 Hardness Test Kit

Details of test kit with literature shall be supplied by the contractor at appropriate stage.

14.0 TREATED WATER QUALITY

The out put from Softener shall conform to commercial hardness. Similarly the resultant TDS from RO system shall be less than 100 PPM. Other output parameters from the system shall with in the Desirable limits specified in IS :10500 standards.

APPENDIX - I

Tentative Raw Water Characteristics :

S.NO	PARAMETER	VALUE
1.	Hardness	800 mg/l
2.	Colour	Less than 5
3.	Odour	Unobjectionable
4.	Turbidity	4 NTU
5.	PH	6.5 to 8.5

6.	Total iron	0.1 mg/l
7.	Chlorides	250 mg/l
8.	Total Dissolved solids	1200 mg/l
9.	Coliform organisms at 37o C (MPN)	221 per 100 ml
10.	E-Coli	79/100 ml

Note : The parameters and characteristics of raw water given are tentative only. The contractor shall on his own collect and assess the nature of water available at the site and has to design the system according to that.

5.00 LIST OF APPROVED MAKES : CIVIL WORKS

Sl.No.	MATERIALS	MANUFACTURERS
1.	Doors & Windows fixtures/ Fittings:	Everite, Hardima, Global, Crown, Ozone, Dorset
2.	Door Closer / Floor spring :	Doorking, Everite, Hardwyn, Amar Darmy, Hardima, Ozone
3.	Aluminium Sections. :	Hindalco, Jindal, Indal , Bhoruka,
4.	Clear Glass/ Clear Float Glass / Toughened Glass :	Saint Gobain(SG),Modi,Gujrat Guardian, Tata , AIG
5.	Laminates :	Formica, Decolam, Century, Marino, Green Ply
6.	Synthetic Enamel Paints :	Berger (Luxol gold), Asian(Apcolite), ICI Dulux (Gloss), Nerolac (Full gloss hard drying)
7.	Oil Bound Distemper :	Asian (Tractor), Berger (Bison), Nerolac (Super Acrylic).
8.	Cement Paint :	Snowcem Plus, Berger (Durocem Extra), Nerolac (Nerocem with titanium),.
9.	Plastic Emulsion Paint :	ICI, Asian, Nerolac
10.	Other Paints/Primers :	ICI Dulux, Asian, Berger, Nerolac
11.	Cement :	OPC 43 grade conforming to BIS-8112 and approval of source by Engineer

12.	Reinforcement Steel	:	TMT steel conforming to BIS-1786 and approval of source by Engineer
13.	Glass Mosaic Tiles	:	Italica, Bizzaza. Pallidio
14.	Back-up Rod.	:	Supreme Industries or equivalent
15.	M.S. Pipe	:	Jindal Hisar, Prakash-Surya, BST, Kalinga, Tata
16.	Polycarbonate Sheets	:	GE Plastics or approved equivalent
17.	Wooden/Metal Fire Check Doors	:	Navair, Shakti-met, Godrej, Pacific Fire Control, Promat
18.	Gypsum Board System	:	India Gypsum, Laffarge, Boral

Sl.No.	MATERIALS		MANUFACTURERS
19.	Sunken Portion Treatment	:	Choksey, Roffe, Krytone, Sika, CICO
20.	Admixtures for concrete.	:	Cico, Vam Organics, Roffe, Pidilite, FOSROC
21.	Ceramic Tiles	:	Johnson, Somany, Kajaria, Nitco
22.	Pre-Laminated Particle Board	:	Novopan, Greenlam, Kitlam, Marino
23.	Flush Door Shutters.	:	Century, Kitply, Novapan, Green Ply, Marino
24.	Glazed Tiles	:	Bell, Somany, Johnson, Kajaria, Cera,
25.	PVC Water Stops	:	Supreme, Fixopan or approved equivalent
26.	White Cement.	:	Birla White, J.K.
27.	Powder Coating Material Pure Polyester.	:	Jotun, Berger, Goodlass Nerolac
28.	Masking Tapes	:	Suncontrol, Wonder Polymer.
29.	Stainless Steel Screws For Fabrication and fixing of Windows.:		Kundan, Puja, Atul.
30.	Dash Fasteners./Anchor bolts	:	Hilti, Fischer, Bosch.
31.	Stainless Steel Bolts, Washers and		

	Nuts.	:	Kundan, Puja, Atul.
32.	Stainless Steel Pressure Plate Screws.	:	Kundan, Puja, Atul.
33.	Stainless Steel Friction Stay.	:	Securistyle, Earl Bihari.
34.	E.P.D.M. Gaskets.	:	Anand Reddiplex, Enviro Seals
35.	Weather Silicon.	:	Dow Corning, Wacker, GE
36.	Structural Silicon at butt joints	:	- Do -
37.	PVC continous fillet for periphery packing of Glazings /Structural glazings.:		Roop, Anand, Forex Plastic.
38.	Floor Springs.	:	Doorking, Opel or equivalent
39.	Water proofing / Injection Grouting	:	Specilized agency as approved by engineer
40.	6mm thick Reflective Glass	:	Glaverbel, Glavermas, Saint Gobain.

Sl.No.	MATERIALS		MANUFACTURERS
41.	Door Locks.	:	ACME, Godrej, Harrison, Hardima, Mobel, Ozone
42.	Door Seal – Woolpile Weather Strip	:	Anand -Reddiplex.
43.	Aluminium Grill	:	Hindalco, Decogrille or approved Equivalent
44.	Vitrified Tiles	:	Restile, Naveen, Bell-Ceramics, Kajaria, Somani,
45.	Carpets	:	Hollitex, Standard, Mohawk,Birla Transasia
46.	Aluminium Cladding sheets	:	Alstrong , Alpolic, Alucobond, Alucomat Alu Decor
47.	Aluminium Die-cast handles & two point locking kit	:	Giesse, Securistyle, Alu-alpha
48.	Stainless steel D-handles	:	D-line, Giesse, Dorma,Hardima
49.	Fabric for Auditorium	:	ESSMA, Raymonds or equivalent
50.	Stainless Steel Pipes/Flats	:	304 Grade (as approved by Engineer)
51.	Structural Steel	:	Conforming to BIS 2062 and approval of source by Engineer
52.	Ready Mix Concrete	:	ACC,BIRLA, Ahlcon or approvedequivalent
53.	Epoxy Flooring/ wall coating	:	Fosrock, Beck, Famaflor,

54. SBS bitumen based Self adhesive membrane Material : Grace-Bituthene CP1.5, Texsa-Texself 1.5
55. Acoustic Mineral Fibre : USG-Radar, Armstrong, 21st Century, Acostyle
56. Curtain wall/Structure Glazing/Hermatic seal Sliding Doors : Specialised Agency to be approved by Engineer
57. Fire Panic bar : Briton, Monarch, Von-Duprin, Dorma, Mobel
58. Ply board : Greenply, Kitply, Century, Archid, Marino

Sl.No.	MATERIALS	MANUFACTURERS
59	PVC Doors (Solid Profile)	: Rajshri or approved equivalent
60	PVC Doors (Hollow Profile)	: Syntex, Plasopan or approved equivalent
61	PVC Flooring	: LG, Tarkett, Responsive or approved equivalent
62	SS Railing	: Specialised Agency to be approved by Engineer
63	Interlocking Paver Tiles	: Ultra, Shree or Approved Equival
64	Wall Clading Tiles	: Ultra, Shree or Approved Equivalent
65	Acoustic Seals	: Anand Reddiplex , Enviroseal or equivalent
66	Smoke Seals	: Pemko or Equivalent
67	Fire rated door closer/Mortice Lock/ Door Co-ordinator	Dorma, Becker F.S. Australian, Dorset or approved equivalent

Note : Wherever makes have not been specified for certain items, the same shall be as per BIS and as per approval of Engineer

6.00 LIST OF APPROVED MAKES : PLUMBING WORKS

S.No.	Materials	Relevant IS Code	Manufacturers
1.	Vitreous China Sanitary ware	2556	Hindustan Sanitary ware, Cera, Kohler, American standard
2.	White Glazed Fire Clay Sink	771	Sanfire, Cera, Neycer, Hindware.
3.	Stainless Steel Sink		Jayna, Jaguar, Commander, Nirali
4.	Plastic seat cover of W.C	2548	Commander, Cera, Kohler Jaquar, American standard
5.	Geysers		Racold, Venus, Voltas, Usha Lexus
6.	C.P. Fittings Mixer/Pillar taps Washers, C.P. brass accessories	1795 4291/4827	Aquabaths, Othello, Jaquar, Kohler, Marc
7.	Centrifugally /Sand cast iron pipes & fittings	3989/1729	Neco, Hepco
8.	G.I. Pipes	1239 Part I	Jindal-Hissar, Tata, Prakash-Surya B.S.T., SAIL,
9.	G.I. Fittings	1239 Part I	Unik, K.S., Zoloto Zenith
10.	Gunmetal Valves	778	Zoloto, Leader,
11.	Brass stop & Bib Cock	781	Zoloto, Sant, L&K, Jaquar
12.	Ball valve with floats	1703	Zoloto, Leader, Sant, Jayco
13.	Stoneware pipes & Gully Traps	651	IS Marked pipes
14.	R.C.C. pipes	458	IS Marked pipes
15.	D.I. Manhole Covers	1726	RIF, NECO,
16.	Water Tank		Sintex, Polycon, Uniplast
17.	Mirror		Golden, Atul, Modi guard Gujrat Guardian
18.	Hand drier		Kopal, Automat, Euronics
19.	PVC flusing cistern		Commander, Parryware, Duralite
20.	Insulation of Hot water pipes		Vidoflex insulation, Superlon insulation or equivalent

S.No.	Materials	Relevant ISI Code	Manufacturers OR EQUIVALENT
21.	PVC Rain Water Pipes.		Supreme, Prince, Finolex. Oriplast
22.	D.I pipes		Jindal, Tata, Electrosteel.
23.	Sluice valve / NRV		Kirloskar, Kilburn, Zoloto Castle,
24.	Water supply pumps	:	KIRLOSKAR, WILO, GRUNDFOS
25.	Submersible pumps	:	KIRLOSKAR, GRUNDFOS, KSB, Mather & Platt
26	UPVC pipes & fittings	;	Finolex , Prince, Supreme, Oriplast
27.	Chlorinator	:	ALFA, USA, Ion exchange, Sigma DH Combine Inc.
28.	HDPE Solution tank	:	WATCON, ION EXCHANGE, Water Supply Specialist P (Ltd)
29.	C.P Flush Valves	:	Jaquar, DOCOL(Germany) marketed by GEM, Ideal
30	C.P Angle Valves, bib cock	:	Othello, Jaquar, Marc, Kholer, Aquabaths
31.	Infrared Sensor operated Faucets	:	Jaquar, AOS-Robo , Euronics, U-tec Kholer
32.	Gratings, Strainers, Cleanouts etc	:	Neer Brand (Sage Metals) or Equivalent
33.	Level controller	:	Femac or equivalent
34.	Drainage Pumps	:	Grundfos, KSB, Kirloskar
35.	Water / Effluent Treatment Plant	:	Thermax, Geo Miler & Co, Fontos Ion-Exchange, Aquaprocess, Akar- Impex, Polycon Technologies, Indwa
36	Decorative bath room fittings	:	Jaquar (Florentine range), Marc (equivalent) Aquabaths (equivalent)
37.	R.O System	:	Thermax, Aqua Process, Ion-Exchange, Paintir, Polycon Technologies, Fontos, Indwa

38.	PE-AL-PE	:	Kitec, Jindal, NEXGEN
39	HDPE pipes and fittings	:	Oriplast, So-Soon, Finolex
40.	Infrared Sensor operated Urinals	:	Jaquar, Euronics,U-tec
41.	Grab Bars	:	Marino or equivalent
42.	CPVC pipe	:	Ajay, Flowguard, Astral
43.	Solar Panel	:	Tata BP, BHEL, EMMVEE
44.	Copper Pipe	:	Raj Co., Maxflo
45.	Copper Fittings	:	Viega, IBP
46.	Lab drainage	:	Viega or Equivalent as approved.
47.	Lab Fittings	:	Vijay, Viega, or equivalent approved

Note : **Wherever makes have not been specified for certain items, the same shall be as per BIS and as per approval of Engineer**

TECHNICAL SPECIFICATIONS

1.00 GENERAL SCOPE OF WORK

The scope of work shall cover internal electrical works for **the construction of AC plant room at Animal house, NIMR, Dwarka, New Delhi** The scope of work covers the following main items/systems:

- i. MCB Distribution Boards.
- ii. Internal electrification through concealed MS conduit and provide light points, fan points, socket outlets etc. including supplying, installation, testing and commissioning of light fixtures, fans etc.
- iii. Conduiting and wiring for telephone points including Main Telephone Distribution Boards (Tag Blocks), telephone outlets etc. complete with telephone cabling from tag blocks to telephone outlets including EPABX, telephone instruments etc..
- iv. Conduiting for computer networking
- v. LT Cabling.
- vi. Earthing, safety equipments and misc items required for electrical installation complete in all respect.
- vii. Out door lighting
- viii. Testing and commissioning of all electrical installations
- ix. Any other items/ works required for the completion of electrical works.
- x. Enhancement/Sanctioning Electrical Load from State Electricity Board.
- xi. Submission of GA drawings of electrical equipments and getting approvals from Client/ Owner before manufacturing/fabrication.
- xii. Obtaining approvals from Chief Electrical Inspectors, Local Electricity Supply Authority, Telecom Department, and any other statutory authorities for the complete scope.
- xiii. Approval from CCE Nagpur for Diesel tank and pollution control for DG set.
- . Contractor shall submit equipment drawing from manufacturer along with the layout etc. and working drawings for approval from HSCC Electrical Engineer before manufacture / commencement of work at site.

- xiv Contractor has to submit the working drawing of internal as well as external electrification based on our tender drawings for the approval of HSCC Electrical Engineer before commencement of work.
- xv Contractor has to take the approval of DB schedule/drawing of each DB from HSCC.
- xvi In case, details of any electrical item/ system are left out, then kindly refer the CPWD specifications & approval from Engineer.

2.0 REGULATIONS AND STANDARDS

2.1 **All equipments their installation, testing and commissioning shall conform latest CPWD/ IS specifications in all respects.** Indian Standard Code of Practice for Electrical Wiring Installation IS:732-1989. It shall also be in conformity with Indian electricity Rules and the Regulations, National Electric Code, National Building Code, latest CPWD specifications amended up to date and requirements of the Local Electric Supply Authority. In general, all materials equipment and workmanship shall conform to the Indian Standards specifications and code. Mode of all measurement will be as per latest CPWD norms/ specifications Some of the applicable codes/standards are as under:

- | | | |
|----|---|------------------------------------|
| a) | CPWD General specifications for electrical works | Part-I (Internal)- 2005 |
| b) | CPWD General specifications for electrical works | Part-II (External)-1995 |
| c) | CPWD General specifications for electrical works | Part-III (Lifts & Escalators)-2003 |
| d) | CPWD General specifications for electrical works | Part-IV (Substation)-2007 |
| e) | CPWD General specifications for electrical works | Part VII (DG Sets) 2006 |
| f) | CPWD Specification/norms for measurement | Latest revision |
| g) | Guide for marking of insulated conductors | IS 5578 |
| h) | Guide for uniform system of marking and identification of conductor and apparatus terminals. | IS 11353 |
| i) | Low voltage switchgear and control gear assemblies | S 8623 Part-1 to 3 |
| j) | Specification for low voltage switchgear and control gear | IS 13947 |
| k) | Enclosed distribution fuse boards and cutouts for voltages not exceeding 1000V AC and 1200 V DC | IS 2675 |
| l) | Code of practice for selection, Installation and maintenance of switchgear and control gear. | ISI 10118 Part – 1 - 4 |
| m) | Low-voltage fuses for voltages not exceeding 1000V AC or 1500V DC | ISI13703 Part-1&2 |
| n) | PVC insulated (heavy duty) electric cables | IS 1554 |

o)	PVC insulated cables for working voltages upto and including 1100V.	IS 694
p)	Conduit for electrical installations	IS 9537
q)	Accessories for rigid steel conduits for electrical wiring	IS 3837
r)	Boxes for the enclosure of electrical accessories	IS 14772
s)	General and safety requirements for luminaries	IS 1913
t)	Code of practice for earthing	IS 3043
u)	Electrical accessories – circuit breakers for over current protection for household and similar installations.	IS 8828
v)	Low voltage switchgear and control gear	IS 13947 part 1 – 5
w)	Residual current operated circuit breakers	IS 12640
x)	Current Transformers	IS 2705
y)	Voltage Transformers	IS 3156
z)	Direct acting indicating analogue electrical measuring instruments and their accessories	IS 1248 part – 1 to 9
A1)	Control Switches (switching device for control and auxiliary circuits including contactor relays) for voltages upto and including 1000V ac and 1200V DC.	IS 13947 & IS 1336
B1)	Dry type power transformer	IS 11171

In case of contradiction in specification the priority of the documents shall be as follows:

CPWD/ IS specification, BOQ, drawings, Technical specifications.

3.01 MOULDED CASE CIRCUIT BREAKERS.

3.01.01 GENERAL

Moulded Case Circuit Breaker shall be incorporated in the Main/Sub Distribution Boards wherever specified. MCCBs shall conform to IS 13947 (Part 2) & IEC 947 (2) in all respects. MCCBs shall be suitable either for single-phase AC 230 volts or three phase 415 volts. All MCCBs shall have microprocessor based over current and short circuit releases with adjustable current setting from $0.4I_n$ to $1.0 I_n$.

3.01.02 Technical Specifications

The MCCB should be current limiting type with trip time of less than 10 milli sec under short circuit conditions. The MCCB should be either 3 or 4 poles as specified in BOQ.

MCCB shall comply with the requirements of the relevant standards IS13947 – Part 2 /IEC 60947-2 and should have test certificates for breaking capacities from independent test authorities CPRI / ERDA

MCCB shall comprise of Quick Make -break switching mechanism, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses.

The breaking capacity of MCCB shall be minimum 35KA / 50 KA or as specified in BOQ. The rated service breaking capacity should be equal to rated ultimate breaking capacities ($I_{cs}=I_{cu}$).

All MCCBs upto 200A ratings should be provided with Thermal Magnetic type release with adjustable Overload and fixed short circuit protections. MCCBs of ratings 250A & above shall be provided with Microprocessor based having inbuilt adjustable protections against Over Load (L), Short Circuit (S) and Ground Faults (G)] with time delay.

All MCCBs should be provided with the Rotary Operating Mechanism. The ROM should be with door interlock (with defeat feature) & padlock facility

MCCB should have Spreader links & Phase barriers as standard feature. Superior quality of engineering grade plastics conforming to glow wire Tests as Per IEC 60695-2-1 should be used for insulation purpose.

The handle position shall give positive indication of 'ON', 'OFF' or 'Tripped' thus qualifying to disconnection as per the IS/IEC indicating the true position of all the contacts.

3.01.03 FRAME SIZES

The MCCBs shall have the following frame sizes subject to meeting the fault level.

- a. Upto 100A rating 100A frame.
- b. Above 100A upto 200A 200A frame.
- c. Above 200A up to 250A 250A frame.
- d. Above 250A up to 400A 400A frame.
- e. Above 400A up to 630Aq 630A frame.
- f. Above 630A to 800A 800A frame.

3.01.04 CONSTRUCTIONS

The MCCB's cover and case shall be made of high strength heat treatment and flame retardant thermo-setting insulating material. Operating handle shall be quick make/quick break, trip-free type. The operating handle shall have suitable "ON", "OFF" "and" "tripped" indicators. Three phase MCCBs shall have common operating handle for simultaneous operation and tripping of all the three phases. MCCBS shall be provided with rotary handle.

Suitable extinguishing device shall be provided for each contact. Tripping unit shall be of thermal magnetic or static release type provided in each pole & connected by a common trip bar such that tripping of any pole operates all three poles to open simultaneously. MCCB shall be current limiting type.

Contact trips shall be made of suitable air resistant, silver alloy for long electrical life. Terminals shall be of liberal design with adequate clearance.

3.01.05 BREAKING CAPACITY

Unless otherwise specified, rated service breaking capacity of the Moulded Case Circuit Breakers shall be minimum 25kA or as mentioned in the BOQ

3.01.06 TESTING

- a. Original test certificate of the MCCB as per Indian Standards (IS) 315-C-8370 shall be furnished.
- b. Pre-commissioning tests on the Main Distribution/Sub Distribution Board incorporating the MCCB shall be done as per standard.

3.02 SWITCH DISCONNECTOR FUSE UNITS

The Switch Disconnecter Fuse Units shall be double break type suitable for load break duty (AC 23) quick make and break action. Hinged doors shall be duly interlocked with operating mechanism so as to prevent opening of the door when the switch is in 'ON' position and also prevent closing of the switch when the door is not properly secured. All contacts incoming and outgoing terminals of switch shall be adequately sized to receive proper size of cables. High rupturing capacity (HRC) fuse links shall be provided with switch fuse units and shall be in accordance with IS 13703-1&2-1993 and having rupturing capacity of not less than 31 MVA at 415 volts. HRC fuse links shall be provided with visible indicators to so that they have operated. The switch disconnecter fuse units shall be manufactured in accordance with IS 13947-3-1993.

FUSE

Fuse shall be of the high rupturing capacity (HRC) fuses links and shall be in accordance with IS 13703-1&2-1993 and having rupturing capacity of not less than 31 MVA at 415 volts. The backup fuse rating for each motor/equipment shall be chosen as the fuse does not operate on starting of motors/equipments.

3.03 MEASURING INSTRUMENTS, METERING & PROTECTION

3.03.01 GENERAL

Direct reading electrical instruments shall be in conformity with IS 1248. The accuracy of direct reading shall be 1.0 for voltmeter and 1.5 for ammeters. Other type of instruments shall have accuracy of 1.5. The errors due to variations in temperature shall be limited to a minimum. The meter shall be suitable for continuous operation between -10 degree Centigrade to + 50 degree Centigrade. All meters shall be of flush mounting type of 96mm square or circular pattern. The meter shall be enclosed in a dust tight housing. The housing shall be of steel or phenolic mould. The design and manufacture of the meters shall ensure the prevention of fogging of instrument glass. Instruments meters shall be sealed in such a way that access to the measuring element and to the accessories within the case shall not be possible without removal of the seal. The meters shall be provided with white dials and black scale markings.

The pointer shall be black in colour and shall have zero position adjustment device which could be operated from outside. The direction of deflection shall be from left to right.

Suitable selector switches shall be provided for all ammeters and voltmeters intended to be used on three-phase supply.

The specifications herein after laid down shall also cover all the meters, instrument and protective devices required for the electrical work. The ratings type and

quantity of meters, instruments and protective devices shall be as per the schedule of quantities.

3.03.02 AMMETERS

Ammeters shall be moving iron or moving coil type. The moving part assembly shall be with jewel bearing. The jewel bearing shall be mounted on a spring to prevent damage to pivot due to vibrations and shocks, the ammeters shall be manufactured and calibrated as per the latest edition of IS:1248. Ammeters shall be instrument transformer operated, and shall be suitable for 5A secondary of instrument transformer. The scales shall be calibrated to indicate primary current, unless otherwise specified. The ammeters shall be capable of carrying sustained overloads during fault conditions without damage or loss of accuracy.

3.03.03 VOLTMETERS

Voltmeter shall be of moving iron or moving coil type. The range for 415 volts, 3 phase voltmeters shall be 0 to 500 volts. Suitable selector switch shall be provided for each voltmeter to read voltage between any two lines of the system. The voltmeter shall be provided with protection fuse of suitable capacity.

3.03.04 CURRENT TRANSFORMERS

Current transformers shall be in conformity with IS: 2705 (Part I, II & III) in all respects. All current transformers used for medium voltage applications shall be rated for 1kV. Current transformers shall have rated primary current, rated burden and class of accuracy as required. However, the rated acceptable minimum class of various applications shall be as given below:

Measuring : Class 0.5 to 1

Protection : Class 5P10.

Current transformers shall be capable of withstanding without damage, magnetic and thermal stresses due to short circuit fault of 50KA on medium voltage system. Terminals of the current transformers shall be marked permanently for easy identification of poles. Separate CT shall be provided for measuring instruments and protection relays. Each C.T. shall be provided with rating plate.

Current transformers shall be mounted such that they are easily accessible for inspection, maintenance and replacement. The wiring for CT's shall be copper conductor, PVC insulated wires with proper termination lugs and wiring shall be bunched with cable straps and fixed to the panel structure in a neat manner.

All Current Transformer shall be Cast resin type.

3.04 MISCELLANEOUS

Control switches shall be of the heavy-duty rotary type with escutcheon plates clearly marked to show the operating position. They shall be semi-flush mounting with only the front plate and operating handle projecting.

Indicating lamps shall be of the filament type of low watt consumption, provided with series resistor where necessary, and with translucent lamp covers, bulbs & lenses shall be easily replaced from the front.

Push buttons shall be of the momentary contact, push to actuate type fitted with self-reset contacts & provided with integral escutcheon plates marked with its functions.

4.0 INTERNAL ELECTRIFICATION OF BUILDING

4.1 SCOPE

As specified in subhead 1.00

4.2 GENERAL

The electrical Installation work shall be carried out in accordance with Indian Standard Code of Practice for Electrical Wiring Installation IS: 732-1989 and IS: 2274-1963. It shall also be in conformity with the current Indian Electricity rules and regulations and requirements of the Local Electricity Supply Authority and Fire Insurance regulations, so far as these become applicable to the installation. Electrical work in general shall be carried out as per following CPWD Specifications with up to date amendment.

- Specifications for Electrical Works Part-I (Internal) by CPWD – 2005 or latest revision
- Specifications for Electrical Works Part-II (External) by CPWD – 1994 or latest revision

Wherever these specifications calls for a higher standard of material and or workmanship than those required by any of the above mentions regulations and specification then the specification here under shall take precedence over the said regulations and standards.

4.3 DISTRIBUTION BOARDS.

As a general practice only pre-wired MCB type double door DB shall be used. Pre-wired DB shall have following features:

- i) Recess/ surface type with integral loose wire box.
- ii) Phase/neutral/ earth terminal blocks for termination of incoming & outgoing wires.
- iii) DIN channel for mounting MCBs.
- iv) Arrangement for mounting incomer MCB/RCCB/RCBO/MCCB as required.
- v) Copper bus bar.
- vi) Earthing terminals.
- vii) Wiring from MCBs to terminal block.
- viii) Interconnection between terminal block/ incoming switch/ bus bar/ neutral/ terminal block/ earth terminal connector with specified size of FRLS pre insulated copper conductor cable duly fitted with copper lugs/ thimbles.
- ix) Termination block should be suitable for termination of conductor/ cable of required size but minimum rated cross section of the terminal blocks should be 6 sq. mm.
- x) Terminal block shall be made of flame retardant polyimide material.
- xi) Coloured terminal blocks and FRLS wires for easy identification of RYB phases, Neutral and Earth.
- xii) Pre-wired DB shall be provided with a detachable cassette for safe removal of MCBs, RCCBs. Terminal connectors from the DB without loosening the internal cable connections of phase and neutral circuits.
- xiii) The pre-wired DB shall have peel able poly layer on the cover for protection from cement, plaster, paints etc during the construction period.
- xiv) Detachable plate with knock out holes shall be provided at the top/ bottom of board. Complete board shall be factory fabricated and pre-wired in factory, ready for installation at site. The box and cover shall be fabricated from MS sheet steel, properly pretreated, phosphotized with powder coated finish.
- xv) DB shall be of double door construction provided with hinged cover in the front.

Distribution Board shall be standard type. Distribution boards shall contain miniature circuit breakers of rating specified in BOQ/DB Schedule.

Miniature circuit breakers shall be quick make and quick break type with trip free mechanism. MCB shall have thermal and magnetic short circuit protection. All miniature circuit breakers shall be of 9 KA rated rupturing capacity unless otherwise specified.

Neutral busbars shall be provided with the same number of terminals, as there are single ways on the board, in addition to the terminals for incoming mains. An earth bar of similar size as the neutral bar shall also be provided. All live parts shall be screened from the front. Ample clearance shall be provided between all live metal and the earth case and adequate space for all incoming and outgoing cables. A circuit identification card in clear plastic cover shall be provided for each distribution board.

MCB's shall be provided on the phase of each circuit. The individual banks of MCB's shall be detachable. There shall be ample space behind the banks of MCB's to

accommodate all the wiring. All the distribution boards shall be completely factory wired, ready for connections. All the terminals shall have adequate current rating and size to suit individual feeder requirements. Each circuit shall be clearly numbered from left to right to correspond with wiring diagram. All the switches and circuits shall be distinctly marked with a small description of the service installed.

Earth Leakage Circuit Breaker shall be current operated type and of 30mA sensitivity unless otherwise specified. It shall also provide over-current and short circuit protection i.e. it shall be MCB-cum-RCCB (Residual Current Circuit Breaker). In case ELCB doesn't have inbuilt short circuit protection, same rating MCB have to be provided for short circuit protection along with ELCB. Cost of this MCB is deemed to be included in the cost of ELCB. ELCB shall be housed within the Distribution Board.

Distribution Boards shall be ready for connections and shall be inspected in the factory by HSCC Electrical Engineer before dispatch.

Before procurement of Distribution Boards, MCB's, ELCB's (incomer and outgoing) etc., the contractor has to take approval of the DB Schedule/Drawings of each DB from the HSCC Electrical Engineer. The whole unit i.e. Distribution Board, MCB's, ELCB's etc. shall come from the manufactures premises/workshop. After inspection and clearance from the HSCC Electrical Engineer the same may be dispatched to site for installation. However if a single component (such as ELCB or MCB or DB) is required for any reason such as replacement, increase in no. of circuits in the DB, change in the load of existing circuit, change in the total load on a particular DB etc., the same may be ordered separately but after the approval of HSCC Electrical Engineer.

4.4 METALLIC CONDUIT WIRING SYSTEM.

4.4.1 TYPE AND SIZE OF CONDUIT.

All conduit pipes shall be of approved gauge (not less than 16 SWG for conduits of sizes up to 32 mm diameter and not less than 14 SWG for conduit of size above 32mm diameter) solid drawn or reamed by welding finished with black stove enameled surface. All conduit accessories shall be of threaded type and under no circumstances pin grip type accessories shall be used. The maximum number of PVC insulated 650/1100 volts grade copper conductor cable that can be drawn in conduit of various sizes shall be as per IS Code. No steel conduit less than 20mm in diameter shall be used.

4.4.2 CONDUIT JOINTS.

Conduit pipes shall be joined by means of threaded couplers, and threaded accessories only. In long distance straight run of conduits, inspection type couplers at reasonable intervals shall be provided or running threads with couplers and jam nuts shall be provided. In the later case the bare threaded portion shall be treated with anti-corrosive preservative. Threads on conduit pipes in all cases shall be between 13 mm to 19 mm long sufficient to accommodate pipes to full threaded portion of couplers or accessories.

Cut ends of conduit pipe shall have neither sharp edges nor any burrs left to avoid damage to the insulation of conductor while pulling them through such pipes.

4.4.3 PROTECTION AGAINST CONDENSATION.

The layout of conduit should be such that any condensation or sweating inside the conduit is drained out. Suitable precaution should also be taken to prevent entry of insects inside the conduit.

4.4.4 PROTECTION OF CONDUIT AGAINST RUST.

The outer surface of conduit including all bends, unions, tees, junction boxes etc. forming part of conduit system shall be adequately protected against rust when such system is exposed to weather by being painted with two coats of oxide paint applied before they are fixed. In all cases, no bare threaded portion of conduit pipe shall be allowed. Unless such bare thread portion of conduit is treated with anticorrosive preservative or covered with approved plastic compound.

4.4.5 PAINTING OF CONDUIT AND ACCESSORIES.

After installation, all accessible surface (if any) of conduit pipes, fittings etc. shall be painted with two coats of approved enameled paint or aluminium paint as required to match the finish of surrounding wall, trusses etc.

4.4.6 RECESS CONDUIT.

The chase in the wall shall be neatly made and of ample dimensions to permit the conduit to be fixed in the manner desired. In the case of building under construction, conduit shall be buried in the wall before plastering and shall be finished neatly after erection of conduit. In case of exposed brick/rubble masonry work, special care shall be taken to fix the conduit and accessories in position along with the building work. Entire work of chasing the wall, fixing the conduit in chases, and burring the conduit in mortar before plastering shall form part of point wiring work.

The conduit pipe shall be fixed by means of staples or by means of saddles not more than 60cm apart or by any other approved means of fixing. Fixing of standard bends and elbows shall be avoided as far as practicable and all curves maintained by bending the conduit pipe itself with the long radius, which shall permit easy drawing

in of conductors. All threaded joints of conduit pipe shall be treated with some approved preservative compound to secure protection against rust. Suitable inspection boxes to the barest minimum requirements shall be provided to permit periodical inspection and of facilitate replacement of wires, if necessary. These shall be mounted flush with the wall. Suitable ventilating holes shall be provided in the inspection box covers. Wherever the length of conduit run is more than 10 meters, then circular junction box shall be provided.

4.4.7 METAL OUTLET BOXES & COVERS.

The switch box shall be made of modular metal boxes with suitable size modular cover plates. Modular metal box shall be made of mild steel on all sides except on the front.

The metal box (other than modular type) shall be made of metal on all sides except on the front. Boxes shall be hot dip galvanized mild steel. Metal boxes upto 20 x 30 cm size M.S. box shall have wall thickness of 18 SWG and MS boxes above 20 x 30 cm size shall be of 16 SWG. The metallic boxes shall be painted with anticorrosive paint before erection. Clear depth of the box shall not be less than 60mm. All boxes shall be covered from top with Phenolic laminated sheet of approved shade. These shall be of 3 mm thick synthetic phenolic resin bonded laminated sheet as base material and conform to grade P-I of IS: 2036-1994.

4.4.8 ERECTION AND EARTHING OF CONDUITS.

The conduit of each circuit or section shall be completed before conductors are drawn in. The entire system of conduit after erection shall be tested in presence of HSCC Electrical Engineer for mechanical and electrical continuity throughout and permanently connected to earth conforming to the requirement by means of special approved type of earthing clamp effectively fastened to conduit pipe in a workmen like manner for a perfect continuity between the earth and conduit.

4.4.9 SWITCHES.

All 5 and 15 Amp switches shall be modular type of 240 volts A.C. grade. All switches shall be fixed on modular metal boxes. All 5 Amp socket shall be 5 pin type and 15 Amp socket shall be 6 pin type (unless otherwise specified) suitable for 15/5 Amp. All modular switches, sockets, telephone outlets, TV outlet etc. shall be in off white finish unless otherwise specified. The switches controlling the lights or fans shall be connected to the phase wire of the circuit. Switch boards shall be located at 1200 mm above finished floor level unless otherwise indicated on drawings or directed by Engineer-In-Charge.

In case of computer power points, power points, telephone points etc. to be fixed on laminated partition board (furniture), same shall be fixed on laminated board (portion

of laminated board meant for fixing power points) with base plate/cover plate as applicable, duly fixed with screws.

4.4.10 COVER PLATE.

All modular switches, sockets, telephone outlets etc. shall be fixed modular metal boxes with modular base plates and modular cover plates on top.

4.4.11 WALL SOCKET PLATE.

Each outlet shall have a switch located beside the socket preferably on the same cover plate/modular base. The earth terminal of the socket shall be connected to the earth wire.

4.5 WIRING.

All PVC insulated copper conductor wires shall conform to relevant IS Codes. All wires/cables shall be stranded type irrespective of its size. Cable conductor size and material shall be specified in BOQ.

All internal wiring shall be carried out with PVC insulated wires of 650/1100 volts grade. The circuit wiring for points shall be carried out in looping in system and no joint shall be allowed in the length of the conductors. Circuit wiring shall be laid in separate conduit originating from distribution board to switch board for light/fan. A light/fan switchboard may have more than one circuit but shall have to be of same phase. Looping circuit wiring shall be drawn in same conduit as for point wiring. Each circuit shall have a separate neutral wire. Neutral looping shall be carried out from point to point or in light/fan switchboards. A separate earth wire shall be provided along with circuit wiring for each circuit. For point wiring red/yellow/blue colour wire shall be used for phase and black colour wire for neutral. Circuit wiring shall be carried out with red, yellow or blue colour PVC insulated wire for RYB phase wire respectively and black colour PVC insulated wire for the neutral wires. Bare copper wire shall be used as earth continuity conductor and shall be drawn along with other wires. No wire shall be drawn into any conduit until all work of any nature, that may cause injury to wire is completed. Care shall be taken in pulling the wires so that no damage occurs to the insulation of the wire.

Before the wires are drawn into the conduit, the conduits shall be thoroughly cleaned of moisture, dust and dirt. Drawing and jointing of copper conductor wires and cables shall be as per CPWD specifications.

Maximum number of PVC insulated 650/1100 V grade aluminium/copper conductor cable conforming to IS : 694 - 1990

Nominal	25mm	32mm	38mm	51mm	64mm
Cross-Sectional					

area of conductor in Sq.mm.	S	B	S	B	S	B	S	B	S	B
1	4	5	6	7	8	9	10	11	12	13
1.5	10	8	18	12	-	-	-	-	-	-
2.5	8	6	12	10	-	-	-	-	-	-
4	6	5	10	8	-	-	-	-	-	-
6	5	4	8	7	-	-	-	-	-	-
10	4	3	6	5	8	6	-	-	-	-
16	2	2	3	3	6	5	10	7	12	8
25	-	-	3	2	5	3	8	6	9	7
35	-	-	-	-	3	2	6	5	8	6
50	-	-	-	-	-	-	5	3	6	5
70	-	-	-	-	-	-	4	3	5	4

NOTE :

1. The above table shows the maximum capacity of conduits for a simultaneous drawing in of cables.
2. The columns headed 'S' apply to runs of conduits which have distance not exceeding 4.25m between draw in boxes and which do not deflect from the straight by an angle of more than 15 degrees. The columns headed 'B' apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.
3. Conduit sizes are the nominal external diameters.

4.5.1 JOINTS.

All joints shall be made at main switches, distribution board socket and switch boxes only. No joint shall be made in conduits and junction boxes. Conductors shall be continuous from outlet to outlet.

4.5.2 LOAD BALANCING

Balancing of circuits in three-phase installation shall be planned before the commencement of wiring and shall be strictly adhered to.

4.5.3 COLOUR CODE FOR CIRCUIT WIRING.

Colour code for circuit and sub main wiring installation shall be Red, Yellow, and Blue for three phases. Black for neutral and yellow/green or green only for earth incase of insulated earth wire.

4.5.4 CLASSIFICATION OF POINTS.

4.5.4.1 General

Classification and measurement of Point wiring shall be as per CPWD specification for Electrical Works (Part-I-Internal) 1994.

4.5.4.2 Point Wiring (Modular)

Definition of point wiring

A point (other than socket outlet point) shall include all work necessary in complete wiring to the light points/fan/exhaust fan/call bell point from the controlling switch/MCB. The scope of wiring for a point shall, however, include the wiring work necessary in tapping from another point in the same distribution circuit i.e. from first switch board (wiring from distribution board to first switch box is covered in the circuit wiring and is not in the scope of point wiring) to subsequent switch board(s) in the same distribution circuit. The point wiring includes all materials specified below including chasing the wall (in case of recessed wiring in wall), fixing the conduit and making the wall good as it originally was. It also includes supply, drawing, testing and commissioning of wires.

Scope of point wiring

Following shall be deemed to be included in point wiring.

- (a) Supply & fixing conduit & conduit accessories for the same and wiring cables (including supplying and drawing wires) between the switch box and the point outlet. [See also (i) below]
- (b) All fixing accessories such as clips, nails, screws, phil plug, rawl plug etc. as required.
- (c) Modular Metal boxes for control switches, regulators, sockets etc. recessed or surface type, modular base plates and modular cover plates over the same.
- (d) Outlet boxes, junction boxes, pull-through boxes etc. but excluding modular metal boxes if any, provided the switchboards for loose wires/conduit terminations.
- (e) In case of recessed wiring in wall the scope includes chasing of wall, fixing the conduit and making the wall good as it originally was.
- (f) Control modular switch (5/6A) as specified.

- (g) Ceiling rose or connector (in case of points for ceiling/exhaust fan point, prewired light fittings and call bells).
- (h) Connections to ceiling rose, connector, socket outlet, lamp holder, switch etc.
- (i) Interconnecting wiring between points on the same circuit, in the same switch box or from another. Interconnecting wiring from first switchboard to subsequent switch board(s).
- (j) Protective (loop earthing) conductor (as specified in the BOQ) from one metallic switch box to another in the distribution circuits, and from switchboard to each point (light/fan/exhaust fan/call bell etc).
- (k) Bushed conduit where wiring cables pass through wall etc.
- (l) Ceiling rose (in the case of pendants except stiff pendants).
- b) Lamp holder (in the case of goose neck type wall bracket, batten holder and fittings which are not pre-wired).
- c) Back Plate (in the case of stiff pendants).
- d) MS Fan Boxes with MS hook (as per CPWD specifications) for the erection of Ceiling Fans

Note :- In the case of call bell points the words “from the controlling switch or MCB” shall be read as “from the ceiling rose meant for connection to bell push”.

Measurement of Point Wiring (other than socket outlet points)

- i) There shall be no linear measurement for point wiring for light points, fan points, exhaust fan points and call bell points. These shall be measured on unit basis by counting,
- ii) No separate measurement shall be made for interconnections between points in the same distribution circuit and for the circuit protective (loop earthing) conductors between metallic switch boxes.

4.5.5. Circuit and Submain Wiring

Circuit Wiring

Circuit wiring shall mean the wiring from the distribution board upto the tapping point for the nearest first point of that distribution circuit i.e. up to the nearest first switch box.

Submain Wiring

Submain wiring shall mean the wiring from one main/distribution switchboard to another.

Measurement of circuit wiring and submain wiring

- (i) Circuit and submain wiring shall be measured on linear basis along the run of the wiring. The measurement shall include all lengths from end to end of conduit, exclusive of interconnections inside the switchboard etc. The increase on account of diversion or slackness shall not be included in the measurement.
- (ii) The length of circuit wiring with two wires shall be measured from the distribution board to the first nearest switch box in the circuit irrespective of whether neutral conductor is taken to switch box or not.
- (iii) When wires of different circuits are grouped in a single conduit, the same shall be measured on linear basis depending on the actual number and size of wires run.
- (iv) When circuit wires and wires of point wiring are run in the same conduit, circuit wiring shall be measured on linear basis depending on the actual number and sizes of wires run in the existing conduit.
- (v) Protective (loop earthing) conductors, which are run along the circuit wiring and submain wiring, shall be measured on linear basis and paid separately. This is not applicable if protective conductor is clubbed with the BOQ item of circuit and submain wiring.

4.5.6 Power Plug Wiring

5A Plug Wiring

Wiring for all 5 A Socket Outlets shall be done with 2X1.5 sqmm PVC insulated copper wire in suitable size MS Conduit (including supplying and fixing MS Conduit) along with the earth wire as specified in the BOQ/Drawings, from the switchboard or 15A power point as the case may be.

Measurement of 5A point wiring shall be done on number basis from switchboard/15A power point to 5A point. Conduit of point wiring/power point wiring can also be used for 5A point wiring, butt both phase and neutral wires shall come directly from switchboard/power point. Looping of neutral shall not be done.

15A Power Plug Wiring

Wiring for all 15 A Socket Outlets/Gyser point shall be done with 2X4 sqmm PVC insulated copper wire in suitable size MS Conduit (including supplying and fixing MS Conduit) along with the earth wire as specified in the BOQ/Drawings, directly from the MCB-Distribution Board or from one power point to another in case of computer power points. Looping shall not be done in general 15A power points (other than computer power points).

Measurement of power point wiring shall be done on number basis under following two subheads:

- i) Directly from MCB-Distribution Board to the Socket Outlets

- ii) From One power point/computer power point to another (looping)

Wiring for 20A Metal Clad Socket Outlets

Wiring for all 20A Metal Clad Socket Outlets shall be done with 2X6 sqmm PVC insulated copper wire in suitable size MS Conduit (including supplying and fixing MS Conduit) along with the earth wire as specified in the BOQ/Drawings, directly from the MCB-Distribution Board. Measurement of wiring for 20A Metal Clad Socket outlet shall be done on number basis i.e. complete wiring directly from MCB-Distribution Board to the socket outlet.

No extra payment shall be made on account of minor changes in location of power points (15A or 20A or computer power points) due to change in the architectural layout or change due to any other reason. Height of the power socket outlets shall be 300mm from the finished floor level unless otherwise specified.

4.5.7 CONDUCTOR SIZE.

Wiring shall be carried out with following sizes of PVC insulated stranded single core copper conductor wire/cable.

- i. Light point. - 1.5Sq.mm
- ii. Ceiling /Cabin/Exhaust Fan Point - 1.5Sq.mm
- iii. Call Bell Point - 1.5Sq.mm
- iv. Plug Point (5 A Outlet) - 1.5Sq.mm
- v. Circuit Wiring - 1.5Sq.mm
- vi. General Power Point - 4Sq.mm
- vii. 20A Industrial Socket Outlet – 6 Sqmm
- viii. Special Power Point – 6 Sqmm
- ix. A/C Box with 32A MCB- 6 Sqmm

4.5.8 LIGHTING FIXTURE AND FANS

4.5.8.1 GENERAL

- a. The Contractor shall supply and install lighting fixtures including but not limited to lamps, ballasts, accessories fixing hardware necessary for installations, as shown on the Drawings, as required, and as herein specified.
- b. All fixtures shall be delivered to the building complete with suspension accessories, canopies, hanging devices, sockets, holders, reflectors, ballasts, diffusing material, louvers, plaster frames, recessing boxes, etc. all wired and assembled as indicated.
- c. Full size shop detail drawings of special fixture or lighting equipment, where called for in the fixtures schedule, shall be submitted to the HSCC Electrical Engineer for approval.
- d. Fixtures, housing, frame or canopy, shall provide a suitable cover for fixture outlet box or fixture opening.
- e. Fixtures shall comply with all applicable requirements as herein outlined unless otherwise specified or shown on the Drawings.
- f. Manufacturer's name and catalogue number of light fixtures, fans, switchgears etc. shall be strictly adhered.
- g. Fixtures shall bear manufacturer's name and the factory inspection label.
- h. Fixtures shall be completely wired and constructed to comply with the IEE wiring regulations requirements for lighting fixtures, unless otherwise specified.
- i. Revamping the fixture shall be possible without having to remove the fixture from its place.
- j. Lamps of the proper type, wattage and voltage rating shall be furnished and installed in each fixture.

4.5.9 INSTALLATION

Fixtures shall be installed at mounting heights as detailed on the Drawings or as instructed on site by the Engineer-In-charge.

Pendent fixtures within the same room or area shall be installed plumb and at a uniform height from the finished floor. Adjustment of height shall be made during installation.

Flush mounted recessed fixtures, shall be installed so as to completely eliminate leakage of light within the fixture and between the fixture and adjacent finish.

Fixtures mounted outlet boxes shall be rigidly secured to a fixture stud in the outlet box. Hickeys or extension pieces shall be installed where required to facilitate proper installation.

Fixtures located on the exterior of the building shall be installed with non-ferrous metal screws finished to match the fixtures.

4.5.10 LAMPS-GENERAL

Lamp shall be supplied and installed in all lighting fixtures listed in the BOQ.

Lamp shall be the part of Fitting no extra Payment will be made

Lamps used for temporary lighting service shall not be used in the final fixture units.

Lamps shall be of wattage and type as shown in the BOQ.

Lamps for permanent installation shall not be placed in the fixtures, until so directed by the Engineer In-charge.

4.5.11 BALLASTS-FLUORESCENT

Ballasts shall be electronic type and having high power factor type.

Ballasts shall have manufacturer's lowest sound level and case temperature rise rating.

Ballasts shall be special cool operated type.

Ballasts for indoor fixtures shall be protected by an integral thermal automatic resetting protective unit, which shall disconnect the ballast in the event of overheating.

Ballasts shall be of the same manufacture as the lamps/fixture.

4.5.12 FIXTURE SAMPLES

Detailed catalogue for all fixtures or if so required by the HSCC Electrical Engineer sample fixtures shall be submitted for prior approval of the HSCC Electrical Engineer before orders for the fixtures are placed.

4.5.13 TESTING

After all lighting fixtures are installed and are connected their respective switches, test all fixtures to ensure operation on their correct switch in the presence of the engineer.

All non-operating fixtures or ones connected to the wrong or inconveniently located switch shall be correctly connected as directed by the Engineer In-charge.

4.5.14 CEILING FANS

All ceiling fans shall be provided with suspension arrangement in the concrete/slab/roof members. Contractor to ensure that provision are kept at appropriate stage at locations shown on the drawing. Fan box with MS hook shall be as per CPWD specification. Ceiling fan shall be double ball bearing type, copper wound motor complete with canopy, down rod, blades etc. and shall conform to relevant IS standards ceiling fan shall be white in colour. Ceiling fan shall be provided with electronic regulator. Electronic Regulator shall be suitable for 240 volts A.C supply 50 Hz and shall be of continuous duty type

4.5.15 EXHAUST FANS

Exhaust fans shall be heavy-duty type with double ball bearing and conforming to IS 2312 (latest revision). Exhaust fan shall be complete with copper wound motor, capacitor, Louver/shutter, frame and mounting bracket. Exhaust fan shall be suitable fan operation on 240 volts single phase A.C supply.

5.00 TELEPHONE SYSTEM

5.01 Telephone point wiring

- (a) The point wiring shall be carried out with Double pair telephone wire/cable, unarmoured, PVC insulated, 0.61 mm dia annealed tinned copper conductor (IS: 2532-1965) in suitable size conduit (one pair always remaining spare for one point)

Minimum Dia of Conduit for Internal/External Telephone Wiring - 20mm.

If more than one telephone point has to be provided at one point, multicore, unarmoured telephone cable shall be used (pairs required are equal to 2 No. of points) in suitable size of conduit.

- (b) The point shall commence from the main telephone tag box/sub tag box and would terminate at outlet box of point. Connection at both ends included in point wiring.
- (c) Fixing of conduit, conduit accessories draw out boxes and outlet box etc. in concealed/surface conduit works as that of wiring for light fixtures shall be applicable for telephone wiring conduit system also.
- (d) Joint in telephone wiring (between main tag box/sub tag box and outlet box of point) shall not be allowed and the contractor should bear the wastages of wire if resulted due to this special requirement of telephone system.
- (e) External/Internal telephone and intercom wiring can be drawn in the same conduit, provided after drawing wires, 50% of conduit cross sectional area is free. However, independent PVC insulated telephone wire of suitable pairs shall be used for external, internal and intercom.
- (f) To identify each pair of multipair telephone wire/cable, PVC indication numbers shall be put on both ends of pair just before termination.

5.02 Telephone Tag Boxes

These shall be of MS sheet 2 mm thick with connector suitable for telephone connection (as approved by ITI). It shall have hinged MS sheet cover.

6.00 LT CABLES

6.1 GENERAL

L.T. Cables shall be supplied, inspected, laid tested and commissioned in accordance with drawings, specifications, relevant Indian Standards specifications and cable manufacturer's instructions. The cable shall be delivered at site in original drums with manufacturer's name clearly written on the drums. The recommendations of the cable manufacturer with regard to jointing and sealing shall be strictly followed.

6.2 MATERIAL

The L.T. power cable shall be PVC insulated PVC sheathed type aluminium conductor armoured cable and L.T. control cable shall be PVC insulated PVC sheathed type copper conductor unarmoured cable conforming to IS: 1554: 1988 (Part-I) with up to date amendments.

6.3 INSTALLATION OF CABLES

Cables shall be laid directly in ground, pipes, masonry ducts, on cable tray, surface of wall/ceiling etc. as indicated on drawings and/or as per the direction of HSCC Electrical Engineer. Cable laying shall be carried out as per CPWD specifications.

6.4 INSPECTION

All cables shall be inspected at site and checked for any damage during transit.

6.5 JOINTS IN CABLES

The Contractor shall take care to see that the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilisation and avoiding of cable joints. This apportioning shall be got approved from Engineer-in-Charge before the cables are cut to lengths.

6.6 LAYING CABLES IN GROUND

Cables shall be laid by skilled experienced workmen, using adequate rollers to minimize stretching of the cables. The cable drums shall be placed on jacks before unwinding the cable. With great care it shall be unrolled on over wooden rollers placed in trenches at intervals not exceeding 2 metre. Cables shall be laid at depth of 0.75 metres below ground level for LT Cables and 1 metre below ground level for HT cable. A cushion of sand total of 250mm shall be provided both above and below the cable, joint boxes and other accessories. Cable shall not be laid in the same trench or along side a water main.

The cable shall be laid in excavated trench over 80mm layer of sand cushion. The relative position of the cables, laid in the same trench shall preserved. At all changes in direction in horizontal and vertical planes, the cables shall be bent smooth with a

radius of bent not less than 12 times the diameter of cables. Minimum 3 metre long loop shall be provided at both end of cable.

Distinguishing marks may be made on the cable ends for identifications of phases. Insulation, tapes of appropriate voltage and in red, yellow and blue colours shall be wrapped just below the sockets for phase identifications.

Cable route marker shall be provided as per CPWD specifications. Cost of cable route markers is deemed to be included in the cost of cables/cable laying.

PROTECTION OF CABLES

The cables shall be protected by bricks laid on the top layer of the sand for the full length of underground cable. Where more than one cable is laid in the same trench, the bricks shall cover all the cables and shall project a minimum of approximately 80mm on either side of the cables. Cable under road crossings and any other places subject to heavy traffic shall be protected by running them through Hume Pipes of suitable size. Pipes for cable crossing the road shall be laid at a depth of 1000 mm.

EXCAVATION & BACK FILL

All excavation and back fill required for the installation of the cables shall be carried out by the Contractor in accordance with the drawings and requirements laid down elsewhere. Trenches shall be dug true to line and grades. Back fill for trenches shall be filled in layer not exceeding 150mm. Each layer shall be properly rammed and consolidated before laying the next layer.

The Contractor shall restore all surfaces, road ways, side walks, curbs, wall or the works cut by excavation to their original condition to the satisfaction of the Engineer-in -Charge.

LAYING OF CABLES ON CABLE TRAY/SURFACE OF WALL/ CEILING

Cable shall be laid on perforated M.S. Cable tray/ladders. Cables shall be properly dressed before cable ties/clamps are fixed. Wherever cable tray is not proposed, cables shall be fixed on surface of wall or ceiling slab by suitable MS clamps/saddles. Care shall be taken to avoid crossing of cable.

CABLES ON HANGERS OR RACKS

The Contractor shall provide and install all iron hangers racks or racks with die cast cleats with all fixings, rag bolts or girder clamps or other specialist fixing as required.

Where hangers or racks are to be fixed to wall sides, ceiling and other concrete structures, the Contractor shall be responsible for cutting away, fixing and grouting in rag bolts and making good.

The hangers or racks shall be designed to leave at least 25mm clearance between the cables and the face to which it is fixed. Multiple hangers shall have two or more fixing holes. All cables shall be saddled at not more than 150mm centres. These shall be designed to keep provision of some spare capacity for future development.

CABLES TAGS

Cable tags shall be made out of 2mm thick aluminium sheets, each tag 1-1/2 inch in dia with one hole of 2.5mm dia, 6mm below the periphery. Cable designations are to be punched with letter/number punches and the tags are to be tied inside the panels beyond the glanding as well as below the glands at cable entries. Tray tags are to be tied at all bends. On straight lengths, tags shall be provided at every 5 metres.

6.7 TESTING OF CABLES

Prior to installation burying of cables, following tests shall be carried out. Insulation test between phases, phase & neutral, phase & earth for each length of cable.

- a. Before laying.
- b. After laying.
- c. After jointing.

Along with the test as prescribed in IS Code, cross sectional area shall also be checked.

On completion of cable laying work, the following tests shall be conducted in the presence of the Engineer in Charge.

- a. Insulation Resistance Test (Sectional and overall).
- b. Continuity Resistance Test.
- c. Earth Test.

All tests shall be carried out in accordance with relevant Indian Standard code of practice and Indian Electricity Rules. The Contractor shall provide necessary instruments, equipments and labour for conducting the above tests & shall bear all expenses of conducting such tests.

7.00 CABLE TRAY

7.1 Ladder Type Cable Tray

Ladder type cable tray shall be fabricated out of double bended channel section longitudinal members with single bended channel section rungs of cross members welded to the base of the longitudinal members at a centre to centre spacing of 250 mm. The channel sections shall be supplied in convenient lengths and assembled at site to the desired lengths. These may be galvanised or painted to the desired lengths.

7.2 Perforated Type Cable Tray

The cable tray shall be fabricated out of slotted/perforated M.S. Sheet as channel section single or double bended. The channel section shall be supplied in convenient length and assembled at site to the desired lengths. These shall be galvanised or painted as specified. Alternatively, where specified, the cable tray may be fabricated by two angle irons of 50mm x 50mm x 6mm as two longitudinal members, with cross-bracings between them by 50mm x 5mm flats welded/bolted to the angles at 1 m spacing. 2mm thick MS perforated sheet shall be suitably welded/bolted to the base as well as on the two sides.

7.3 Typically, the dimensions, fabrication details etc. are shown in CPWD General Specification for Electrical Works - Part II -External, 1994.

7.4 The jointing between the sections shall be made with coupler plates of the same material and thickness as the channel section. Two coupler plates, each of minimum 200mm length, shall be bolted on each of the two sides of the channel section with 8mm dia round headed bolts, nuts and washers. In order to maintain proper earth continuity bond, the paint on the contact surfaces between the coupler plates and cable tray shall be scraped and removed before the installation.

7.5 The maximum permissible uniformly distributed load for various sizes of cables trays and for different supported span are as per CPWD General Specification of Electrical Work Part II -1994. The sizes shall be specified considering the same.

7.6 The width of the cable tray shall be chosen so as to accommodate all the cable in one tier, plus 30 to 50% additional width for future expansion. This additional width shall be minimum 100mm. The overall width of one cable tray shall be limited to 800mm.

7.7 Factory fabricated bends, reducers, tee/cross junctions, etc. shall be provided as per good engineering practice. (Details are typically shown in figure 3 of CPWD General Specification of Electrical Work Part II -1994). The radius of bend,

junctions etc. shall not be less than the minimum permissible radius of bending of the largest size of cable to be carried by the cable tray.

- 7.8** The cable tray shall be suspended from the ceiling slab with the help of 10mm dia MS rounds or 25mm x 5mm flats at specified spacing as per CPWD General Specification of Electrical Work Part II -1994. Flat type suspenders may be used for channels upto 450mm width bolted to cable trays. Round suspenders shall be threaded and bolted to the cable trays or to independent support angles 50mm x 50mm x 5mm at the bottom end as specified. These shall be grouted to the ceiling slab at the other end through an effective means, as approved by the PMC/Consultant to take the weight of the cable tray with the cables.
- 7.9** The entire tray (except in the case of galvanised type) and the suspenders shall be painted with two coats of red oxide primer paint after removing the dirt and rust, and finished with two coats of spray paint of approved make synthetic enamel paint.
- 7.10** The cable tray shall be bonded to the earth Terminal of the switch bonds at both ends.
- 7.11** The cable trays shall be measured on unit length basis, along the center line of the cable tray, including bends, reducers, tees, cross-joints, etc, and paid for accordingly.

8.00 EARTHING

8.01 GENERAL

All the non-current metal parts of electrical installation shall be earthed properly. All metal conduits trunking, switchgear, distribution boards, switch boxes, outlet boxes, and all other parts made of metal shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. Earthing work shall conform to CPWD General Specifications for Earthing work shall conform to Internal) -1994 and Indian Electricity Rules 1956 amended up to date and in the regulations of the local Electricity Supply Authority.

8.02 EARTHING CONDUCTOR

Earth continuity conductor along with submain wiring from Main/Sub Distribution boards to various distribution boards shall be of copper. Earth continuity conductor from distribution board onward up to outlet point shall also be of bare copper. Earth continuity conductor connecting Main & Sub Distribution boards to earth electrode shall be with galvanised MS strip.

8.03 SIZING OF EARTHING CONDUCTOR

Single phase distribution board shall have one earth continuity conductor while three phase distribution board shall be provided with two earth continuity conductors. Earthing of main switch board and sub switch boards shall be earthed with two independent earth electrodes or as indicated elsewhere. Earth conductor laid in ground shall be protected for mechanical injury & corrosion by providing GI pipe.

8.04 GI pipe shall be of medium class 40mm dia and 4.5 metre in length. Galvanising of the pipe shall conform to relevant Indian Standards. GI pipe electrode shall be cut tapered at the bottom and provided with holes of 12mm dia drilled not less than 7.5cm from each other upto 2 metre of length from bottom. The electrode shall be buried in the ground vertical with its top not less than 20cm below ground level as per detail enclosed. Earth electrode shall not be situated less than 2metres from the building. The location of the earth electrode will be such that the soil has reasonable chance of remaining moist as far as possible. Masonry chamber of size 300 x 300 x 300mm shall be provided with water funnel arrangement a cast iron or MS frame & cover having locking arrangement at the top.

8.05 PLATE EARTH ELECTRODE

Earthing shall be provided with either GI plate electrode or copper plate electrode of following minimum dimensions.

- i. GI Plate Electrode : 600mm x 600mm x 6mm thick

- ii. Copper Plate Electrode : 600mm x 600mm x 3mm thick

The electrode shall be buried in ground with its faces vertical and not less than 3 metres below ground level. 20mm dia medium class GI pipe shall be provided and attached to the electrode. A funnel with mesh shall be provided on the top of this pipe for watering and earth electrode. Earth electrode the watering funnel attachment shall be housed in masonry enclosure of not less than 300 x 300 x 300mm deep. A cash iron or MS frame with cover having locking arrangement shall be provided at top of metres from the building. Care shall be taken that the excavation for earth electrode may not affect the column footing or foundation of the building. In such cases electrode may be further away from the building.

8.06 ARTIFICIAL TREATMENT OF SOIL

If the earth resistance is too high and the multiple electrode earthing does not give adequate low resistance to earth, then the soil resistivity immediately surrounding the earth electrodes shall be reduced by addition of sodium chloride calcium chloride, sodium carbonates copper sulphate, salt and soft coke or charcoal in suitable proportions.

8.07 RESISTANCE TO EARTH

The resistance of earthing system shall not exceed 5 ohm.

9.00 SAFETY EQUIPMENTS

9.01 DANGER NOTICES

Danger notices shall be affixed permanently in a conspicuous position in Hindi or English and the local language of the district with sign of skull and bones at every overhead lines, transformer, electrical equipments motors, etc.

9.02 FIRST AID BOX

Standard first aid box with all standard contents shall be supplied.

9.03 FIRE BUCKETS

The fire bucket unit shall consist of our galvanised iron baskets, which shall be with round bottom, and of 13 liters capacity. They shall be filled with dry sand. Arrangement shall be made to hang them on GI pipe stand comprising of at least 2

vertical and one horizontal members of 50 mm GI pipe. The stands shall have hooks and locking chain arrangement. The buckets and stand shall be painted with epoxy red paint.

9.04 FIRE EXTINGUISHER

Foam type Fire extinguishers of 9 Kg. capacity and Dry Chemical type Fire Extinguishers of 10 Kg capacity shall be of approved make. It shall be filled with carbon tetrachloride. It shall have horns. Extinguishers shall be fixed on walls/columns with necessary clamps made out of 50 mm x 6mm MS flat and coated bolts and nuts grouted in wall/column.

9.05 RUBBER MAT

Corrugated rubber insulating matting shall be provided in front of all power & motor control centers, push button station and distribution board in the electrical rooms. The width of matting shall be one meter. It shall be as ISI mark.

9.06 INSTRUCTION CHART

Printed instruction chart both in English and Hindi and duly framed with front glass, prescribing treatment to be given to persons having Electric shock, shall be supplied.

10.00 PROCUREMENT, INSPECTION OF EQUIPMENT & APPROVALS

Approved list of makes and vendors are given in the end of technical specifications. The makes of equipment/materials supplied shall be strictly as mentioned therein. For items not specially mentioned, prior approval shall be taken before procurement of the same. All equipments/material supplied shall be brand new and shall be procured directly from the manufacturers, dealers or authorised agents.

HSCC Electrical Engineer shall have access to the manufacturer's premises for stage inspection/final inspection of any item during its design, manufacturing, and assembly and testing. After carrying out the necessary factory tests and routine tests as per IS Standards, a copy of the routine test certificate shall be forwarded along with the call for carrying out the inspection at the manufacturer's works.

Based on the inspection certificate, HSCC Electrical Engineer reserves the right to carry out the inspection at a mutually agreed date and/or give inspection waiver. A minimum of two weeks will be needed after receipt of complete shop inspection report and other details to depute our inspector for inspection.

It is the responsibility of the contractor to ensure that all electrical works are carried out as per the IE Rules & regulations, National Building Code and IS Codes & Standards. All necessary drawings and details as required by Electricity Board, Electrical Inspector, Fire Department and other Local Statutory agencies, shall be prepared by the contractor. **The contractor is responsible to submit the drawings and other details as required to the Local Authorities (refer above) and obtain necessary approvals including sanction of load/enhancement of electrical load from SEB before energizing and commissioning.** All official fee required for getting the approval will be reimbursed on account of Client on submission of original documents.

11.00 LIST OF APPROVED MANUFACTURERS:

1. L.T. Cables - Universal/ICC/ NICCO/INCAB/Rallison Cables
- National/ Skytone / KEI/ Cab Com India
2. PVC insulated Wires/
Telephone wires & cables - Finolex/ Havells/ Ploycab/ KEI/ Rallison/
Co-axial cables National/ Cab Com/ Skytone/ L&T/ Batra
Henlay/ Bonton
3. Telephone Tag Blocks - Krone Type
4. Modular Range of Switches, - Anchor- Roma/ North West-wraparound/
Sockets etc Toyama-Wallart/MK-Standard/MDS-Mosaic/
Havell,s-Crab tree
5. Industrial Sockets & Plugs. - Siemens/Schneider/Crompton/MDS/ BCH/
Havell's
6. M.S. Conduit - BEC/ AKG/ Steel craft/M Kay/ NIC/Atul
7. Light fixtures. - Philips/ GE/ Crompton
(Flourescent, CFL, HPMV etc)
- Light Fixture - Decon/ Ankur/ May Fair/Philips
(Down, Fancy & other fixtures)
8. Ceiling Fan/ Exhaust fan - Crompton Greaves/ Alstom/ Usha/ Bajaj.
9. MCCB - L&T/ Siemens/ ABB/ Schneider
10. MCB-DB's, MCB, ELCB - L&T/ Siemens/ MDS/ Schneider/Havells
RCCB/ MCB-Isolator etc.
11. SDFU - L&T/ Siemens/ Schneider/ABB
12. Power Contactors - L&T/ Siemens/ Schneider/ ABB
13. Cable joint kit - Raychem, 3M, Cabseal

12.00 LIST OF TENDER DRAWINGS

<u>S.No.</u>	<u>Drawing Number</u>	<u>Description</u>
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As per list

DETAILED SPECIFICATIONS

SYSTEM DESIGN DATA

1.0 GENERAL

An animal House is proposed at National Institute of Malaria Research, Dwarka, New Delhi.

The system design, basis of design, estimated requirements and other relevant data are outlined in this section.

2.0 LOCATION

The proposed animal house is coming up within the campus of National Institute of Malaria Research, Dwarka.

3.0 SCOPE OF WORK

3.1 The work proposed under this tender includes supply, installation, testing & commissioning of independent central air-conditioning systems for the proposed animal house and labs as detailed in the technical specifications and schedule of prices.

4.0 BASIS OF DESIGN

4.1 Assumptions

Following assumptions have been made for calculation of air-conditioning cooling load:

- | | | | |
|----|--------------------------|---|--|
| a) | Fresh air | : | 100% Fresh air for animal house |
| b) | Window glazing | : | Single pane glass |
| c) | Lighting load | : | 2W/ Sq. ft |
| d) | Occupancy | : | As per standards for animal house. |
| e) | Equipment load | : | As per attached Table |
| f) | Roof Insulation | : | The exposed roof of air-conditioned areas shall be insulated with 50 mm thick expanded polystyrene or equivalent insulation by other agencies. |
| g) | Electrical power supply: | : | 415v/3ph/50Hz, AC power supply |

- h) Humidity control : To control high humidity, heating coil for reheating shall be considered in AHU's .

4.2 Design Considerations :

- All the equipments etc. shall be suitable for 415 V, three phases or 220 V, Single phase, 50 Hz A.C. supply.
- Energy efficient chillers, Insulation of roof for reducing heat ingress & reducing load on AC, Double glazing of windows on sun facing side, Air tight windows and doors for reducing leakage of air and dust.
- All HVAC equipments and systems shall comply with the mandatory provisions of ECBC, 2007.
- Natural ventilation shall comply with the design guidelines provided for natural ventilation in the National Building Code of India 2005.
- Cooling equipments shall meet or exceed the minimum efficiency requirements laid down in ECBC, 2007.
- Where ever used, the Unitary Air conditioners will meet IS 1391 (part-I), split air conditioner shall meet IS 1391 (Part –II), Packaged air conditioner shall meet IS 8148.
- All cooling towers will have two speed motors controlling the fans as prescribed in ECBC, 2007.

4.3 OUTSIDE AMBIENT CONDITIONS

Season	Dry Bulb temp	Wet Bulb temp.
SUMMER:	110 deg F DB	75 deg F WB
MONSOON:	95 deg F DB	83 deg F WB
WINTER:	45 deg F DB	41 deg F WB

4.4 INSIDE CONDITIONS

A.	For Animal areas	SUMMER MONSOON	1)	70 +/- 2 deg F DB & 50 +/- 5% RH
		WINTER	2)	70 +/- 2 deg F DB 60 +/- 5% RH
B.	For other areas	SUMMER & MONSOON	1)	75 +/- 2 deg F DB 55 +/- 5% RH
		WINTER	2)	70 +/- 2 deg F DB 55 +/- 5% RH

5.0 ESTIMATED LOAD

On the basis of data given above, the estimated load for the air conditioning system is summarised in Table-1:-

(Tenderers shall work out the heat loads on their own and satisfy themselves that the plant specified in this tender shall be able to maintain the inside conditions as per specification)

Description of room with animals									
Sr. No	Room Name	Area (Sqft)	Occupancy (Animal / People)	Equip. Load	ACPH	Total CFM	TR(max)	Return (CFM)	Pressure balance
Basement Area									
1	Quarantine 1	181	36	0.0	15	850	7.56	935	negative
2	Quarantine 2	135	400	0.2	15	800	7.12	880	negative
3	Small Surgery & Treatment	155	4	0.5	15	840	7.52	925	negative
4	Recirculation	152	240	1.5	15	560	5.17	615	negative
5	Insectory 1	153	38	0.0	15	510	4.63	560	negative
6	Insectory 2	155	40	0.0	15	725	6.47	800	negative
7	Experimental Animal-1	147	200	0.0	15	620	6.22	680	negative
8	Air lock	90	0	0.0	5	200	1.12		
9	Clean Corridor -1	270	5	0.0	6	800	2.76		
10	Clean Corridor -3	195	5	0.0	6	425			
11	Dirty Corridor - 1	350	5	0.0	4			440	
12	Dirty Corridor - 3	90	5	0.0	4			150	
13	Recirculation -1	232	36	1.5	15	930	8.53	1025	negative

14	Recirculation -2	235	36	0.0	15	900	8.07	990	negative
15	Lab -1	141	4	1.0	15	560	5.11	615	negative
16	Lab -2	141	4	1.0	15	670	6.11	735	negative
17	Experimental Animal-2	239	44	0.5	15	910	8.22	1000	negative
18	Experimental Animal-3	239	900	0.6	15	1000	9.03	1100	negative
	F/A REQUIREMENT								
1	Dirty Corridor - 1	350	5	0.0	2	150			
	Total=					11450	94	11450	
19	Clean Bedding Store	138	3	0.2	15	600	5.25	540	Positive
20	Experimental Animal -4	125	30	0.5	15	475	4.40	520	negative
21	Experimental Animal -5	149	300	0.0	15	850	7.63	935	negative
22	Clean Corridor -2	577	10	0.0	6	1050	7.58		
23	Dirty Corridor - 2	680	10	0.0	4			800	
24	Stock -1	251	40	0.0	15	975	8.64	1070	negative
25	Breeding -1	300	44	0.0	15	1125	9.77	1235	negative
26	Breeding -2	208	600	0.2	15	790	8.77	865	negative
27	Stock -2	278	800	0.0	15	1485	13.28	1635	negative
	F/A REQUIREMENT								
2	Dirty Corridor - 2	680	10	0.0	2	250			
	Total=					7600	65	7600	
Ground Floor									
1	Clean Cage Store	80	4	0	20	440	3.98	380	Positive
2	Change Room	41	2	0	2	100	0.29		
3	Cage Wash Tank	443	4	1.3	20	1650	14.72		
4	Bedding Store	109	3	0.0	10	350	3.25	310	Positive
5	Clean Bed Store	67	2	0.1	10	180	1.62	150	Positive
6	Feed Store	102	3	0.0	10	330	3.03	290	Positive
7	Lift Lobby	116	3	0.0	2	200	0.76	200	
	Separate exhaust requirement								
1	Cage Wash Tank	443	4	1.3	25			1820	
	Total=	958				3250	28	3150	
1	Workers Rest Room	159	5	0.2	2	600	1.5	600	
2	Entrance	160	2	0.2	2	250		250	
3	Tech Office	82	2	0.2	15	210	0.7	210	
4	Vetinary officer	116	2	0.0	2	150	0.66	150	
5	Staff Room	191	8	0.5	2	380	1.42	380	
6	Record	207	2	0.2	2	250	1.17	250	
7	Change Room Ladies	65	3	0.0	2	180	0.52		
8	Change Room Male	143	5	0.0	2	420	1.05		
9	Free Space -1	30	0	0.0	2	70	0.18		
10	Free Space -2	63	0	0.0	2	240	0.54	240	
	Total=					2150	8	1480	
	Grand Total=					25050	196	24280	

To cater to the above load, the air conditioning system proposed is as follows:

6.0 System Design

The total peak load comes out to 196 TR. Since the animal house is to run on continuous basis with all facility running, no diversity should be taken on actual load computation. For this requirement 2 Nos. screw type water chilling machines each of 200 TR capacity with water cooled condensers are proposed. Out of these one Chiller shall be working and one shall be standby.

System Design Description

6.1 It is proposed to provide a central air conditioning system to maintain the specified inside design conditions during summer, monsoon and winter for the proposed building. The system should be BMS compatible.

6.2 Water chilling machines shall work in conjunction with 2 Nos. chilled water pumps .02 nos secondary water pumps. The plant shall be located in AC plant room.

6.3 Chilled water produced shall be pumped to various air handling units. Chilled water shall be pumped through insulated chilled water pipes installed in ceiling spaces and in vertical risers installed in pipe shafts. At each air handling units balancing valves are provided for balancing.

6.4 Electric type hot water generators shall be used for winter heating (2 Nos.180 kw).This is after taking partial credit for the high equipment load inside.

- The exhaust from animal holding areas shall be exhausted through fan section provided with pre and fine and charcoal filters on terrace.
- Both supply and return air shall be ducted.
- Three level filtration shall be adopted with prefilters, fine filters and hepa filters of following filtration efficiency :
- The AHUs shall be double skin type to prevent any microbial growth inside the AHUs and outside skin shall be pre-coated sheet.
- Filters shall be as per following:-

HEPA filter	99.97% down to 0.3 micron
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Fine Filters	99% down to 5 μ
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Pre Filters	90% down to 10 μ
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- AHU's with hepa filters shall be designed for high static pressure to over come high pressure drops with 50 mm insulation.

- All these filters shall be with aluminium frame to prevent formation of bacterial colonies. Epoxy resin shall be used to seal filter media with the framework.
 - AHU's shall have heating coils for winter heating monsoon reheat and pan humidifiers to maintain humidity in winter.
 - Also there will be a static pressure sensor to control for blower speed through a VFD as per requirements.
 - Exhaust from all AHUs shall be connected to two common exhausters on terrace for redundancy.
- 6.5 Fire dampers shall be provided in accordance with ASHRAE/NFPA/ within supply ducts and return air ducts/spaces to prevent spread of smoke / fire to adjacent area
- 6.6 The main electrical panel, chillers, Condenser & chilled water pumps, hot water pump will be located in the plant room.
- 6.7 The distribution panel, AHU panels and starters shall be placed in AHU room.
- 6.8 All the AHU's on respective floors shall be connected with chilled water pipes coming from the water chilling machines.
- 6.9 For fire safety motorised fire dampers with electrical actuators interlocked with the air blowers shall be provided in supply and return air paths. All materials used for insulation shall be fire proof type. The air handling unit's motors shall also be interlocked with the central fire alarm system such that in case of detection of smoke or fire by the fire alarm system, the air handling units shall automatically shut off.
- 6.10 For monsoon reheating, it is proposed to provide Heating Coil in Floor Mounted AHU's.
- 6.11 Two separate central control consoles shall be provided, one in the AC plant room and the other in AHU room in animal house with indication lamps and push buttons for remote start/stop of the equipment.

7. GENERAL DESIGN GUIDELINES

Design parameters for selection of air handling units and its components shall be: -

Maximum face velocity across prefilters	150M/MIN
Maximum face velocity across Microvee	100M/MIN
Maximum face velocity across cooling coil	150 M/MIN
Maximum face velocity across Heating coil	200 M/MIN
Maximum fan outlet velocity	550 M/MIN
Maximum fan motor speed	1450 RPM

CHW piping shall be sized for following design parameters

Maximum flow velocity	2.5 M/SEC
Design parameters for duct design shall be	
Maximum flow velocity	450M/MIN
Maximum friction	1CM WG/100M
Maximum velocity at supply air outlet	150 M/MIN

8.0 Items to be provided by other Agencies to AC contractor:

- 8.1 Civil works such as trenches for piping, cables and making foundations of equipments.
- 8.2 Construction of AC plant rooms, AHU rooms etc.
- 8.3 Main 3 ph, 415 v, 50 hz, A.C. supply power supply upto main Electrical Distribution Panel in A/C plant room.
- 8.4 Soft filtered water supply upto each cooling tower and expansion tank etc.
- 8.5 Make up water tanks for soft water.
- 8.6 Drain trap in plant room and AHU rooms.
- 8.7 Any kind of false ceiling, boxing etc.
- 8.8 Making frames for fixing grilles & diffusers in false ceiling, boxing or in walls.

9.0 Drawings:

The drawings forming part of these specifications provide a feasible scheme for locating the equipment. The contractor may re-arrange the equipment for improving the layout and meeting the site conditions. All such changes shall however be subject to the architect's approval. These drawings are not meant to be working drawings which shall be prepared by the contractor or as required.

10.0 Test Data:

The complete HVAC system shall be tested as per the specifications given elsewhere and complete test data shall be furnished on prescribed data sheets:

11.0 Technical Data:

The contractor shall furnish complete technical data, on the equipment offered as required under the heading 'Technical data'. In this specification every effort has been taken to put forth only general specifications of various equipments/ material. If inadvertently, any of the specification drawn happens to match with the

specifications of any one particular firm's product only, in respect of critical parameters, than it will not automatically mean that this particular firm's offer is only technically suitable. In general, the specifications offered by other firms will be assessed in their own entirety to ascertain whether or not the broad functions in general expected of the requirements are available with reasonable tolerance on the desired requirements of the client and accordingly the offers would be considered based on prudent assessment and sole discretion of the Engineer.

12.0 Performance Guarantee:

- 12.1 The contractor shall guarantee that the air-conditioning plant and system shall maintain the desired inside temperature within +/- 2 % tolerance.
- 12.2 The contractor shall guarantee that the capacity of various components as well as the whole system shall not be less than specified.
- 12.3 The contractor shall ensure that the system shall be free of vibrations and disturbing sounds.

13.0 Foreign Exchange

The contractor shall make his own arrangements to procure the necessary, specified equipments, controls for which no foreign exchange shall be made available

SCREW TYPE WATER COOLED WATER CHILLING MACHINE

1.0 General

The Screw Type water chilling units (ARI Certified) shall be packaged factory assembled including evaporator, water-cooled condenser, compressor, sub-cooler, oil separator, lubrication system, micro computer control centre and all interconnecting unit piping and wiring and tested and complete in all respects and shall generally comply with specifications as given in subsequent paragraphs. Testing of the chillers shall be done on ARI certified bed.

Each water chilling unit shall comprise:

Screw type multiple compressor with motor, base plate/frame, drive, guard etc.

Condenser with accessories and supports etc.

Chiller with accessories, supports, insulation etc.

Steel frame for mounting the above components.

Control panel box with controls, starter for motor as specified.

Refrigerant piping controls and accessories etc. as specified/required

Full charge of refrigerant gas (R-134 a) and oil.

2.0 Compressor

The compressor shall be semi-hermetic/ hermetic, single / multistage rotary screw type. The compressor housing shall be of cast iron, precision machined to provide minimal clearance for the rotors. The rotors shall be manufactured from forged steel and use asymmetric profiles operating at a maximum speed of 3000 RPM. The compressor should incorporate a complete anti-friction bearing design to reduce power and increase reliability; four separate cylindrical roller bearings to handle radial loads and two 4- point angular contact ball bearings to handle axial loads. The compressor shall have an internal oil reservoir to assure a constant supply of oil to the bearings at all times. A spring actuated positive seating check valve should be incorporated in the compressor housing to prevent rotor backspin during shutdown. The shaft seal should be spring loaded, carbon ring type with precision lapped collar cooled by low pressure oil.

Capacity control shall be achieved by use of a slide valve to provide fully modulating control from 100% to 10% of full load. The slide valve should be actuated by oil pressure, controlled by external solenoid valves through the micro computer controlled centre. The unit should be capable of

operating with lower temperature cooling water during part load operation

3.0 Motor Driveline

The motor shall be 2-pole, continuous duty, induction type and shall be refrigerant cooled for semi hermetic / hermetic compressor.

Motor full load amperes at design conditions should not exceed the indicated amperes. Motor shall be factory mounted and directly connected to the compressor to provide compressor/motor alignment. The complete motor/compressor assembly should be statically and dynamically balanced.

4.0 Lubrication System

An adequate supply of oil should be available to the compressor at all times. During start up and coast down, this should be achieved by oil reservoirs in the compressor or by pre-lube and post lube oil pump operation. During operation, oil should be delivered by positive system pressure differential or full time operation of an oil pump. An oil reservoir should be located in the compressor to lubricate bearings in case of a power failure.

An immersion oil heater shall be provided (temperature actuated), to effectively remove refrigerant from the oil. An external replaceable cartridge, oil filter shall be provided along with manual isolation stop valves for ease of servicing. An oil eductor shall be provided to automatically remove oil which may have migrated to the evaporator, and return it to the compressor. The oil separator shall be of horizontal design with no moving parts and shall provide effective oil separation before the refrigerant enters the heat exchangers. The oil separator shall be manufactured and tested in accordance with ASME standards (Boiler and pressure vessel) code, section VIII - Division 1. A refrigerant cooled oil cooler shall be provided to allow operation of the chiller over the full range of operating conditions.

5.0 Evaporator

The evaporator shall be shell and tube type, flooded type designed for 300 psig working pressure on the refrigerant side and tested at 450 psig. Shell shall be fabricated from rolled carbon steel plate with fusion welded seams having carbon steel tube sheets, drilled and reamed to accommodate the tubes and with intermediate tube supports spaced not more than four feet apart. The refrigerant side shall be designed in accordance with ASME standards (Boiler and pressure vessel) code, Section VIII - Division 1. Tubes shall be of high efficiency, internally and externally enhanced type having plain copper lands at all intermediate tube supports to provide maximum tube wall thickness at the support area. Each tube shall be expanded into the tube sheets to provide a leak proof seal and be individually replaceable. Water velocity through the tubes shall not exceed 12 fps. Liquid level sight glasses shall be located on the side of the shell to aid in determining proper refrigerant charge. The evaporator shall have a refrigerant relief device to meet the requirements of the ASHRAE 15 safety

code for mechanical refrigeration.

Water boxes shall be removable to permit tube cleaning and replacement. Stub out connections having vactaulic grooves shall be provided. Vent and drain connections with plugs shall be provided on each water box.

6.0 Condenser (Water Cooled Type)

Each Condenser will be of the shell-and-tube type, designed for 235 psig working pressure on the refrigerant side. Shell will be fabricated from rolled carbon steel plate with fusion welded seams; have carbon steel tube sheets, drilled and reamed to accommodate the tubes; and intermediate tube supports spaced no more than four feet apart. The refrigerant side will be designed, tested and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section VIII- Division 1. Tubes shall be high-efficiency, internally and externally enhanced type having plain copper lands at all intermediate tube supports to provide maximum tube wall thickness at the support area. Each tube will be roller expanded into the tube sheets providing a leak-proof seal, and be individually replaceable. Water velocity through the tubes will not exceed 12 fps.

Water boxes will be removable to permit tube cleaning and replacement. Stub out water connections having Victaulic grooves will be provided. Vent and drain connections with plugs will be provided on each water box.

7.0 Refrigerant System

Refrigerant flow to the evaporator shall be metres by single /multiple fixed orifices with no moving parts. The condenser shell shall be capable of storing the entire system refrigerant charge during servicing. Isolation from the rest of the system shall be manually operated. Isolation valves shall be located at the inlet and outlet of the condenser. Additional valves shall be provided to facilitate removal of refrigerant charge from the system.

8.0 Micro - Computer Control Centre

Each water chilling machine shall be complete with compressor motor starter and a micro computer control centre. The micro control centre shall be factory mounted , wired and tested. The control centre shall indicate all system parameters. The control centre should be programmable to program chilled water leaving temperature, percent current limit, pull down demand limiting, at least seven day time clock for starting and stopping the chiller, pumps etc. and remote reset temperature range. All safety and cycling shutdowns shall be annunciating through display and consists of day, time, cause of shutdown, restart required. Safeties shall include high condenser pressure, low oil pressure at compressor, clogged oil filter, high oil temperature, high oil pressure , high compressor discharge temperature, low evaporator pressure, motor controller fault and sensor malfunction. Cycling

shutdowns shall include low water temperature, cooled condenser water flow interruption, power fault, internal time clock and anti-recycle.

System information shall include (but not limited to) return/leaving chilled water temperature, return/leaving condenser water temperature, evaporator/condenser refrigerant pressure, oil pressure at compressor, oil filter differential, percent motor current, evaporator/condenser saturation temperatures, compressor discharge temperature, oil temperature, percent slide valve position, operating hours and number of compressor starts.

Security access shall be provided to prevent unauthorized changing of set points and to select local or remote control of the chiller.

9.0 Insulation

Insulation shall be applied to the cooler shell, flow chamber, tube sheets, suction connection and all the necessary tubings (wherever required). The insulation shall be minimum 3/4" thick

10.0 Accessories

Each unit shall include:

Water flow switches at the outlet of the condenser and the chiller (included in chilling machine).

Ribbed rubber isolation pads to eliminate transmission of vibrations upto 90%.

Full charge of refrigerant gas and required quantity of lubrication oil.

Stem type thermometers and dial type water pressure gauges at the inlet and outlet of the condenser and the chiller (included in chilling machine).

Suitable size butterfly valves at the inlet and outlet of the condenser and chiller. (Priced separately)

Suitable size balancing valve at outlet of condenser & chiller (Priced separately)

Other valves as required for cleaning of condenser and draining of water. (included in chilling machine)

Each unit shall include, but not be limited to, all the items listed in the foregoing paragraphs or in the Schedule of Equipment and drawings for this project. In addition all such items, as may be required, shall be included whether specifically mentioned or not, if considered or found necessary to fulfil the intent and meaning for the purpose of maintaining design operations under all extreme weather conditions.

11.0 **Starter for Compressor Motor**

The starter for the motor shall be as per the standard of the manufacturer. The starting current shall be within 2 times the full load current.

The starter should include all necessary safety devices, i.e. overload relays, under voltage release and single phase preventing device.

12.0 **Installation and Testing**

The complete water chilling unit shall be mounted on a R.C.C. foundation. Necessary foundation bolts, nuts, levelling shims etc., required for mounting of the unit shall be provided by the contractor.

All controls and switchgear shall be tested for proper functioning and set of design values.

On completion of installation and tests the water chilling unit shall be tested for performance. The capacity in cal/hr (tons) shall be calculated from measurements of temperature difference and flow rate of water, in condenser and chiller. The power consumption shall be checked from current measurement of the motor. All calculated and checked results shall match the specified data. All instruments and personnel for tests shall be provided by the contractor.

COOLING EQUIPMENT SHALL MEET OR EXCEED THE MINIMUM EFFICIENCY REQUIREMENTS (COP, IPLV AND IKW/TR) AS PER ECBC AND ASHRAE 90.1-2007.

AIR HANDLING UNITS

1.0 General:

The air handling system shall be complete in all respects and shall generally comply with the specifications as given in the following paragraphs.

2.0 Air Handling Units (Double skin & Two Tier Type)

The air handling units shall be double skin fully enclosed construction, draw-thru type and shall include flat filter section, fan section, coil section, Microvee & Hepa Filter section, and humidifier section etc with necessary vapour arrangement. The AHU shall be two tier type with the Microvee and HEPA filter sections (as applicable) in the upper tier.

2.1 Fan Section

Fan shall be centrifugal with forward or backward inclined blades. Fan casing shall be made of galvanised steel sheet. Fan wheels shall be made of galvanised steel. Fan shaft shall be ground C40 carbon steel and supported in pre-greased ball bearings operating less than 75% of first critical speed. Fan wheels and pulleys shall be individually tested and precision balanced dynamically. The fan shall be selected for a fan speed not exceeding 1000 rpm for fan dia of more than 350 mm. The fan outlet shall be connected with casing with the help of fire retardant canvas.

2.2 Coil Section

The cooling coil shall be of seamless copper tubes, not less than 0.41 mm thick and 12 mm dia 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 the air velocity across the coil shall not exceed 500FPM. The coil shall be pitched in the unit casing for proper drainage. The fins shall be spaced by collars forming integral part of the fins. The tubes shall be staggered in the direction of air flow.

The fins shall be uniformly bonded to the tubes by hydraulic mechanical expansion of the tubes. Fin spacing shall not exceed 5 fins per cm. The coiling coil assembly shall be on aluminium rails and nylon rollers for easy withdrawal from either side.

The coils shall be tested against leaks at 21 kg/sq. cm air pressure under water. This pressure shall be maintained for a period of at least 2 hours. No drop should be observed indicating any leaks.

The water headers shall be of heavy class pipes, to connect all the tubes. The headers shall be complete with water in/out connections, vent plug on top and drain at the bottom

and designed to provide water velocity between 0.6 to 1.8 m/s (2 to 6 fps).

Automatic control valves serving the unit-mounted preheat and reheat coils and the terminal reheat coils are selected to close in fail-safe position, that is, assume normally closed position.

2.3 Prefilter

Each unit shall be provided with a factory assembled filter sections containing washable synthetic type air filters. Filter framework shall be duly sealed and constructed from aluminium alloy. The media shall be supported with hdp mesh on one side and aluminium frame mesh on other side. Filters face velocity shall not exceed 500 FPM. Filters shall fit so as to prevent by pass. Holding frames shall be provided for installing a number of filters cells in bank. These cells shall be held within the frames by sliding the cells between guiding channels.

2.4 Humidifier Section

A separate humidifier section shall be provided in the AHU's in the lower tier. Pan humidifier shall be placed outside the AHU & within the AHU room & steam shall be supplied in the humidifier section.

2.5 Housing/ Casing

The housing /casing of the air handling unit shall be of double skin panels, sandwiched type with polyurethane foam insulation of 50 mm thickness (overall). The housing shall be so made that it can be delivered at site in the total/ semi knock down conditions depending upon the location. The frame work shall be of extruded aluminium hollow section duly powder coat painted/ anodized. All the frame shall be assembled using mechanical joints to make a sturdy & strong frame work for various sections.

The outer sheet of panel shall be of made of galvanised pre-plasticised sheet/powder coated CRC sheet of 0.80 mm thickness, and inner sheet of 0.63 mm thick GSS. These panels shall be bolted from inside on the frame with soft rubber gasket in between to make the joints air tight.

Frame work for each section shall be bolted together with soft rubber gasket in between to make the joints air tight, suitable doors with chrome plated hinges and latches shall be provided for access to various panels for maintenance. The entire housing shall be mounted on steel channel frame work. Units shall have hinged, quick operating access door in the fan section etc. The access doors shall also be double skin type similar to the casing.

The special (Microvee & HEPA) filters shall be housed in a separate AHU upper tier casing of suitable size & length.

The enclosure shall be sized to accommodate the standard HEPA & high efficiency microvee filters. The inspection doors shall have double synthetic rubber seals doors & locking arrangements. The gaps between filter frames & housing shall have synthetic rubber packing to eliminate any air leakage. All filter frames & metallic parts shall be made of Aluminium. The HEPA filter & microvee filter sections shall have provision for fixing a portable inclined manometer for taking filter pressure drop readings.

Drain pan shall be constructed of 18 gauge aluminium sheet with necessary slope to facilitate fast removal of condensate. It shall be isolated from the bottom floor panels through 12 mm thick kinny foam insulation or equivalent.

2.6 Fan Motor and Starter

The totally enclosed fan cooled squirrel cage fan motor shall have a minimum rating as given under "Schedule of Equipments and the starter rating shall match the motor rating and both control panel shall conform to the specifications under "Motors and Switchgears". Drive to fan shall be provided through belt-drive arrangement. Belts shall be of oil resistant type.

2.7 Controls

Each air handling unit shall be provided with a modulating valve motor and modulating thermostat, conforming to specifications under "Controls".

2.8 Fresh Air Controls

An adjustable manual damper of aluminium along with bird screen air inlet louvers shall be provided for fresh air entry.

2.9 Accessories

Each air handling unit shall be complete with: -

Stem type thermometer at coil inlet and outlet.(Included in AHU's)

Pressure gauges with cocks at inlet and outlet of the coil. (Included in AHU's)

Balancing valve at coil outlet and butterfly valves at coil inlet & outlet. (priced seperately)

Drain line from unit to drain trap. (priced separately)

Flexible connection between fan outlet and duct.

Vibration isolators of high efficiency.

2.10 **Testing**

Air handling units shall be tested to measure air quantity and coil performance by measuring temperature difference and then calculating capacity by using the above measurements.

2.11 **Limitations**

The air velocity across the cooling coil shall not exceed 500 FPM.

The fan outlet velocity shall not exceed 1800 FPM

The air velocity across the filters shall not exceed 500 FPM..

The air velocity across the electrical strip heater shall be minimum 1000 FPM

3. **Air Handling Units: (Double skin type)**

The air handling units shall be double skin fully enclosed construction draw-thru type and shall include fan section, coil section. Filter section with filters, coil section etc.

3.1 **Fan Section**

Fan shall be centrifugal with backward inclined blades. Fan casing shall be made of galvanised steel sheet. Fan wheels shall be made of galvanised steel. Fan shaft shall be ground C 40 carbon steel and supported in pre-greased ball bearings operating less than 75% of first critical speed. Fan wheels and pulleys shall be individually tested and precision balanced dynamically. The fan shall be selected for a fan speed not exceeding 1000 rpm for fan dia of more than 350 mm and fan outlet velocity shall not exceed 1800 fpm. The fan outlet shall be connected with casing with the help of fire retardant canvas.

3.2 **Coil Section**

The cooling coil shall be of seamless copper tubes, not less than 0.41 mm thick and 12 mm dia 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 the air velocity across the coil shall not exceed 150 MPM. The coil shall be pitched in the unit casing for proper drainage. The fins shall be spaced by collars forming integral part of the fins. The tubes shall be staggered in

the direction of air flow. The fins shall be uniformly bonded to the tubes by hydraulic mechanical expansion of the tubes. Fin spacing shall not exceed 5 fins per cm. The coiling coil assembly shall be on aluminium rails and nylon rollers for easy withdrawal from either side.

The coils shall be tested against leaks at 21 kg/sq.cm air pressure under water.. This pressure shall be maintained for a period of at least 2 hours. No drop should be observed indicating any leaks.

The water headers shall be of heavy class pipes, to connect all the tubes. The headers shall be complete with water in/out connections, vent plug on top and drain at the bottom, and designed to provide water velocity between 0.6 to 1.8 m/s (2 to 6 fps).

Automatic control valves serving the unit-mounted preheat and reheat coils and the terminal reheat coils are selected to close in fail-safe position, that is, assume normally closed position.

3.3 **Filter**

Each unit shall be provided with a factory assembled filter sections containing washable synthetic type air filters. Filter framework shall be duly sealed and constructed from aluminium alloy. The media shall be supported with hdp mesh on one side and aluminium frame mesh on other side. Filters face velocity shall not exceed 500 fpm. Filters shall fit so as to prevent by pass. Holding frames shall be provided for installing a number of filters cells in bank. These cells shall be held within the frames by sliding the cells between guiding channels.

3.4 **Housing/ Casing**

The housing /casing of the air handling unit shall be of double skin panels, sandwiched type with polyurethane foam insulation of 25 mm thickness (over all). The housing shall be so made that it can be delivered at site in the total/ semi knock down conditions depending upon the location. The frame work shall be of extruded aluminium hollow section duly powder coat painted/ anodized. The entire frame shall be assembled using mechanical joints to make a sturdy & strong frame work for various sections.

The outer sheet of panel shall be of made of galvanised pre-plasticised sheet/powder coated CRC sheet of 0.80 mm thickness, and inner sheet of 0.63 mm thick GSS. These panels shall be bolted from inside on the frame with soft rubber gasket in between to make the joints air tight.

Frame work for each section shall be bolted together with soft rubber gasket in between to make the joints air tight, suitable doors with chrome plated hinges and

latches shall be provided for access to various panels for maintenance. The entire housing shall be mounted on steel channel frame work.

Units shall have hinged, quick operating access door in the fan section etc. The access doors shall also be double skin type similar to the casing.

Drain pan shall be constructed of 18 gauge aluminium sheet with necessary slope to facilitate fast removal of condensate. It shall be isolated from the bottom floor panels through 12 mm thick kinny foam insulation or equivalent.

3.5 **Fan Motor and Starter**

The totally enclosed fan cooled squirrel cage fan motor shall have a minimum rating as given under "Schedule of Equipments and the starter rating shall match the motor rating and both control panel shall conform to the specifications under "Motors and Switchgears". Drive to fan shall be provided through belt-drive arrangement. Belts shall be of oil resistant type.

3.6 **Controls**

Each air handling unit shall be provided with a modulating valve motor and modulating thermostat, conforming to specifications under "Controls".

Automatic control valves serving the unit-mounted preheat and reheat coils and the terminal reheat coils are selected to close in fail-safe position, that is, assume normally closed position.

3.7 **Fresh Air Controls**

An adjustable manual damper of aluminium sheet along with bird screen air inlet louvers shall be provided for fresh air entry.

3.8 **Accessories**

Each air handling unit shall be complete with :-

Stem type thermometer at coil inlet and outlet. (Included in AHU's)

Pressure gauges with cocks at inlet and outlet of the coil. (Included in AHU's)

Balancing valve at coil outlet and butterfly valves at coil inlet & outlet. (priced separately)

Drain line from unit to drain trap. (priced separately)

Flexible connection between fan outlet and duct.

Vibration isolators of high efficiency.

3.9 **Testing**

Air handling units shall be tested to measure air quantity and coil performance by measuring temperature difference and then calculating capacity by using the above measurements.

3.10 **Limitations**

The air velocity across the cooling coil shall not exceed 500 fpm.

The fan outlet velocity shall not exceed 1800 fpm

The air velocity across the filters shall not exceed 500 fpm.

4. **Air Handling Units : (Ductable /Unitary Type)**

The unitary type air handling unit shall be compact, Double Skin, self contained and shall consist of blower assembly, cooling coil, air filter, drive and motor all enclosed in an attractive sheet steel housing

The blower assembly shall consist of forward curved, double inlet, double width impeller, blower housing of mild steel with smooth air inlet volutes, self aligning bearing block and supports for mounting the bearing on the blower housing.

The cooling or heating coil shall be of seamless copper tubes not less than 12 mm o.d. and 0.41 mm thickness. The coil shall have continuous aluminium plate fins. The fins shall be spaced by collars forming an integral part of the fins. The tube shall be staggered in the direction of air flow. The coil circuit should be sized for adequate water velocity but not exceeding 1.8 m/s (6 F.P.S.). The fins shall be uniformly bonded to the tubes by hydraulic expansion of the tubes. The water headers shall be of copper pipers to connect all the tubes. The header shall be complete with water in/out connection vent plug on top and drain at the bottom.

The air filter shall be of metallic viscous type with a minimum depth of 50 mm. The air filter shall consist of 24 gauge wire mesh in at least five layers with outer casing of 20 ga m.s. sheet formed into channels. Both side of filter shall have expanded metal screens.

The fan motor shall be squirrel cage totally enclosed fan cooled type with suitable starter conforming to specification under "Motor and Switchgears".

The fan drive shall consist of grooved motor pulley, blower pulley and v belt, along with adjustable mounting for the motor.

All the above components shall be housed in a G.I. sheet steel housing made of 1.2 mm (20 ga) sheets, suitably reinforced to provide rigidity. Access panel to coil and fan areas shall be hinged for ease of maintenance.

4.1 **Controls**

Each unitary unit shall be provided with a heating/cooling snap acting thermostat and a 3 way water solenoid valve, conforming to specifications (wherever given in schedule of prices).

4.2 **Fresh Air Control**

An adjustable manual damper of aluminium sheet along with a bird screen on the outside wall shall be fixed in the opening provided for this purpose in the air handling unit room.

4.3 **Accessories:**

Each air handling unit shall be complete with

One stem type thermometer for coil inlet and outlets, with tubing and gauge cocks. (Included in AHU's)

One pressure gauge with cock for inlets and outlets of the coil, with tubing and gauge cocks. (Included in AHU's)

Balancing valve at coil outlet and butterfly valves at coil inlet & outlet (priced separately)

Drain line from unit to drain trap (priced separately)

Flexible connection between fan outlet and duct.

Vibration isolators of atleast high efficiency.

4.4 **Testing:**

The air handling unit shall be tested to measure air quantity and coil performance by measuring temperature difference, water pressure drop across coil and then calculating the capacity by using the above measurements.

4.5. **Limitations:**

The air velocity across the cooling coil shall not exceed 500 FPM.

The fan outlet velocity shall not exceed 1800 FPM.

The air velocity across the filters shall not exceed 500 fpm.

FILTERS

1.0 General

This section covers the general requirements for special type of filters to be installed in air moving equipment or air ducts.

2.0 Prefilters (fabric type)

Synthetic fibre Pre-filters shall be in light weight aluminium framed with non woven synthetic fibre replaceable media. The filter shall have an efficiency of 90 percent down to 10 microns particles size when tested as per B.S.2831 standards. The filter frame shall be of aluminium and shall be suitable for mounting in Air handling units or ducts as required at site. The velocity across the face of the filter shall not exceed 500 FPM and the pressure drop across the filter shall not exceed 4mm. The filters shall be suitable for operation under 100 percent relative humidity and 120 deg.C temperature conditions.

3.0 Microvee filters (fine filters)

Microvee filters shall be of dry type. Filters media shall be made from washable nonwoven synthetic fibre replaceable media reinforced with HDPE cloth & Aluminum mesh, specially treated with antifungal and bactericidal agents to prevent growth of micro organisms. The filter media shall be treated to permit washing with water several times before discharged. The media shall be properly supported and spaced so that air flow through the filter is uniform. The filter shall be housed in aluminium frame work. Filters shall be designed to remove particle down to 5 micron size and with efficiency of 98.0 percent tested as per BS 2831 using Test Dust II. The filters shall be installed in the air handling units after the chilled water coils. They shall be capable of being replaced or removed for servicing without the use of special tools.

4.0 High efficiency Particulate Absolute (HEPA) filters

HEPA filters shall be made in extended surface configuration of deep space folds of sub micron glass fibres. The filter media shall be housed in an aluminium sheet frame provided with double turned flanges and closed cell neoprene gasket. The filter media shall not absorb moisture, stretch, swell or undergo chemical change with moisture. The filter shall be resistant to fungus and bacterial growth. Filters shall be free from pin holes and other leaks.

The housing shall be designed to install the HEPA filters in the terminal locations in the false ceiling or in the duct plenum so that it is removed easily without risking the infiltration of dust whatsoever. The arrangement for filters shall be strictly in accordance with the manufacturer's recommendations and shall be approved by the

Engineer prior to fabrication and installation. The filters shall be protected with aluminium slotted protective grille from the bottom in case of installation of filters in false ceiling air terminals. All M.S. parts shall be de rusted and shall be epoxy painted. The Aluminium grilles shall be made from 1.6 mm aluminium sheets with minimum clear area of 60 percent. The grilles shall be anodised stove enamel painted as approved by the Engineer

HEATING AND REHEATING SYSTEM

1. **General:**

The electric heating system and hot water heating/reheating system shall comply with the specifications as laid down.

2. **Electric Heaters:**

- 2.1 The heaters shall be enclosed type with external fins for heat radiation.
- 2.2 The heating element shall be of superior grade Nichrome wire of required resistance for the specified capacity.
- 2.3 The heating element shall be enclosed in aluminium sheet casing with suitable insulator blocks to prevent grounding.
- 2.4 The aluminium casing shall have aluminium fins spaced at least 4 inches. The fins should have a snug tight fit over the casing.
- 2.5 The heater terminals shall be secured at one end through insulated connectors.
- 2.6 The individual heater shall be secured at one end through insulated connectors.
- 2.7 The heater shall be supplied in sets of 3 heaters, for balanced loading of 3 phase and neutral supply.

3. **Heater Frames:**

Each bank of heaters shall be mounted on aluminium angle frame work of suitable size and length to suit the heaters.

4. **Contactors:**

Each bank or banks of heaters shall be controlled through a contactor of ample rating and having a 220 volt holding coil. The contractor shall be indication lamps etc. as specified. The heaters shall be interlocked electrically with the fan so that these are shut off in the event of fans break down.

5. **Heating Thermostats:**

Each group of heaters shall be controlled by one single stage for preheater and one two stage snap acting heating thermostat for reheaters.

6. **Humidistat:**

There shall be one snap acting dehumidifying humidistat in parallel with the single stage heating thermostat. They shall be used for reheaters control in monsoon.

7. **Safety Thermostat:**

Each group of heaters in a unit shall be provided with a heating safety thermostat having manual reset.

8. **Controls:**

The safety thermostat and other controls shall be interlocked with the motor and shall be as specified under controls.

9.0 **Hot Water Generator**

9.1 Hot water generator shall be the electric water heater consisting of a vertical tubular shell, closed to both the ends with bolted end covers. The shell shall be fabricated from M.S. sheet and joints shall be welded. It shall be mounted on a rigid chain iron tripod stand. A drain shall be provided at the lower end and outlet and inlet connections with flanges shall be on upper end lower sided. Connections for safety valve and controls shall be provided on the top. A required no. of sockets for heater elements shall be provided at 120 deg. Angle. The construction shall conform to the Indian standards/international standards. It shall be designed for a working pressure of 21 Kg/cm² and tested accordingly.

9.2 Sheathed tabular electric resistance type heater elements shall be used and connected for equal loading.

9.3 The heater shall be connected in a manner to provide capacity control as under :

Upto 100 KW	- 2 Steps
101 KW to 300 KW	- 3 Steps
301 KW to 600 KW	- 4 Steps

Upto 2 sets, a remote bulb 2 step thermostat shall be used in conjunction with contactors of same size and fire 3 or more steps. A modulating type thermostat, modulation motor and step controller shall be used.

9.4 The electric water heater shall be equipped with a safety thermostat to cut off the power in case the temperature of water exceeds the normal limits. A safety valve

shall be provided on the top of the heater and the outlet of the same be piped out of the plant room. The drain shall be connected to the nearest drain point. Stem type thermometer & pressure gauge at inlet & outlet of the boiler shall be provided.

- 9.5 The electric heater shall be insulated with 50 mm thick resin bonded fibre glass or equivalent material. The thermal conductivity of the insulating material shall not exceed 0.03 Kcal. per m/hr. at 10 deg. C mean temperature and density shall not be less than 24 Kg/Cum for fibre glass and 48 Kg/Cum for mineral wool. The insulation shall be cladded with 1 mm thick aluminium sheet.
- 9.6 The electric hot water heater shall be installed as per the manufacturer's instruction and as shown on drawings.

10 **Pan Type Humidifier**

Type:

The pan type humidifier shall be closed type and connected to the supply air duct for introduction of steam when required.

Construction

The body of the humidifier shall be fabricated out of stainless steel sheet at least 2mm thick with all joints welded with stainless steel welding rods and all edges rounded off. The pan shall be made completely air tight and leak proof. On top of the pan an openable cover shall be provided for maintenance of internal components.

The humidifier shall be externally insulated with Resin bonded fibreglass of density not less than 32 Kg/cub.m and then cladded with 0.8 mm thick aluminium sheet.

The humidifier shall have two chambers with two banks of heaters. One bank of heaters shall always remain ON when the AHU is in operation to maintain the temperature of water between 60 - 70 deg. C and the other bank should come on when there is signal from the humidistat for humidification.

The electric heaters shall be submersible type made out of incloy sheeth and brass/bronze flanges. The heaters shall be of suitable rating to produce instant steam when required.

Electrical panel (For Hot Water Generator/Boiler and Pan Type Humidifier)

The electrical panel box shall be made of 16 GCRC sheet and painted with heat and water resistant paint. All switchgears and internal components of the panel shall be of L&T/ Seimens /EE make only.

Controls and accessories:

The humidifier shall be complete with following controls and accessories:

- a. Water proof light in the tank
- b. Water level indicator
- c. Low water level cut-off switch
- d. Float valve with bronze ball
- e. Make up , quick fill and drain connections
- f. Safety thermostats.
- g. Fault indication lamp.

WATER CIRCULATION EQUIPMENTS

1. GENERAL:

The various items of the water circulating system shall be complete in all respects and comply with the specification given below.

2. COOLING TOWER: (FRP Construction)

The cooling towers shall be of FRP, vertical induced draft, cross/counter flow type complete with FRP basins, FRP body, fan and motor assembly geared speed reducer, fill media, distribution pipes, etc.

2.1 General Construction

2.1.1 The body structural columns shall be made of frp (fibre glass reinforced polyester). The surface on both inside and outside shall be smooth, for minimum air resistance. The fan cylinder shall form an integral part of the body. The structural strength of the body shall be sufficient to withstand wind velocities upto 60 m/sec. vibrations and earthquakes.

2.1.2 The water basin, shall also be of f.r.p. the basin shall be complete with connections for drain, overflow, makeup water, quickfill and float valve, plus hot dipped galvanized suction strainer.

2.1.3 Mechanical equipment supports, all steel components and tower assembly hardware shall be capable of with standing corrosion.

2.1.4 The support structure for the tower shall be of mild steel duly hot dipped galvanized.

2.1.5 The water diffusion deck shall be of rigid pvc fill in honeycomb design, arranged in a suitable pattern for ease of replacement, complete with louvers and drift eliminators.

2.2 The colour of the cooling tower body shall be of the Engineer in charge choice.

2.3 Fan Assembly

2.3.1 The fan shall be propeller type with cast aluminium multiple blades of aerofoil design and adjustable pitch. The fan assembly shall be statically balanced. The fan outlet velocity shall not be less than 10 m/s and the tip speed shall be below 4500 m/minutes.

- 2.3.2 The fan shall be directly mounted on the motor or through speed reduction gears. In the latter case, the housing shall be of heavy cast iron, construction with large oil reservoir.
- 2.3.3 The fan motor shall be totally enclosed fan cooled squirrel cage type conforming to i.p. 55 protection for out door operation.
- 2.3.4 The fan guard shall be hot dipped galvanized with wire mesh screen to prevent bird nesting during idling period.

2.4 **Ladder**

All towers, whose height exceeds 2.5 m shall be provided with a ladder, made out of hot dipped galvanized M.S. tubes.

2.5 **Installation and Tests:**

- 2.5.1 The cooling towers shall be mounted on beams/steel structural members, with all nuts/bolts etc for mounting.
- 2.5.2 On installation the capacity of the cooling tower shall be checked by measuring water flow rate, water in and out temperature and the ambient w.b. temperature and then computing the capacity and efficiency.
- 2.5.3 The pump sets shall be mounted on r.c.c foundation. with grouting nuts, bolts, channels etc.
- 2.5.4 On installation the capacity of the pumps shall be checked by measuring water flow, motor current and pressure difference at inlet and outlet. The readings shall be recorded to compare actual performance with the specified data.
- 2.5.5 Magnetic level switches shall be provided for low level alarm, in each cooling tower.

3.0 **SPLIT CASING PUMPS**

The centrifugal pumps shall be used for chilled water re-circulation in the air conditioning system. The pump shall be back pull out top discharge split casing type as per the requirements given in the schedule of equipments and bill of quantities. The capacity of the driving motor shall be at least 25% in excess of the BHP requirement of the pump.

3.1 Construction.

The split casing pumps shall conform to ISI 1520 and the construction of the pumps shall be as follows.

S.NO.	DESCRIPTION OF COMPONENT	MATERIAL / TYPE OF CONSTRUCTION
1.	Pump Casing	Close grained cast iron of heavy section, end suction back pull out type and machined to close tolerance.
2.	Impeller	Bronze/Gunmetal machined to close tolerance.
3.	Pump Shaft	High quality alloy steel EN8 grade.
4.	Pump Bearings	Heavy duty/ball/roller/ journal bearings.
5.	Shaft sleeves	Gun metal.
6.	Base frame	Cast iron/fabricated out of MS channel in all welded construction.
7.	Flanges	As per ISI standards.
8.	Stuffing box	Mechanical seal.
9.	Pump coupling	Flexible steel pin and rubber bushing type protected by guard.

3.2 CONSTRUCTION DETAILS.

The pump casing shall be end suction vertical back pull out type and the pump shall be installed such that the internal parts of the pump like impeller, mechanical seal and bearing etc can be serviced without disconnecting the pipes or disturbing the motor and pump alignment. The joining faces of the pump casing shall be machined and ground to smooth finish and sealed with leak proof gasket. The suction passages of the pump shall be volute in form thereby allowing smooth entry of water to the impeller. The impeller shall be double suction, enclosed type, statically and dynamically balanced. The impeller water passages shall be smoothly finished to ensure minimum friction loss and maximum efficiency. The pump shall be supported by two precision bearings grease or oil lubricated. The pump casing and the internal components shall be designed to withstand the discharge pressure plus the static water head + additional 50% of the total pressure.

2.3 Pumps for Variable Speed Drive

- 2.3.1 The pumps for variable Speed Drive should be similar to the Vertical Split Casing given above.
- 2.3.2 However, the pump selected for variable speed drive shall be capable of performing satisfactorily over a wide range of speed, allowing a speed variation between 30% to 100%.
- 2.3.3 The pump motor shall be controlled by Variable Frequency Drive (VFD), instead of standard starters.

3 Variable Frequency Drive (VFD)

- 3.1.1 The variable frequency drive shall be micro-processor controlled design complete with a controller suitable for automatic control of operation based on an external signal from sensor or BMS.
- 3.1.2 Each pump shall have an independent VFD.
- 3.1.3 However, the Microprocessor based controller shall be common for each set of pumps in a particular application.
- 3.1.4 The drive shall have a key pad control and a LED display module, along with a manual ON/OFF and bypass switch.
- 3.1.5 The drive shall have a diode bridge rectifier to convert 3-phase AC to fixed DC voltage power factor shall remain above 0.98.
- 3.1.6 The drive shall be capable of displaying the following information, such as, frequency, voltage, current, KWH, percent torque, percent power RPM etc.

3.2 PUMP ACCESSORIES.

The following accessories and fixture will be provided with each pump along with other standard accessories.

- a. Air vent valves.
- b. Drain Plug.
- c. Seal Connections.
- d. Lubrication fixture & mechanical seal.
- e. Suction & delivery shut off valves.

f. Non return valve.

g. Water pressure gauges on inlet and outlet pipes. (Included in pumps)

h. Y-type strainer on suction pipe.

3.3 **PUMP MOTOR & STARTER**

The driving motor shall be totally enclosed fan cooled type with class `F' insulation. The motor shall be designed for quite operation and its speed shall not exceed 1450 RPM. The motor starter shall be star-delta type. The starter shall have thermal overload on all the 3 phases and single phase preventor. The starter shall have spare NO/NC contacts for interlocking and indication lamps.

3.4 **INSTALLATION OF PUMPS.**

The installation of pumps shall be carried out by the contractor as per the manufacturer's - recommendations.

The pumps shall be installed on concrete foundations with at least 25mm thick vibration isolation pads or any other vibrating isolation fittings. The pump and the motor shall be installed on a common steel frame and properly aligned. The alignment of the pump and the motor and the base plate level shall be checked at site and the result submitted to the Engineer in charge. As far as possible the pumps sets shall be factory aligned and if site alignment is necessary it shall be done by experienced and trained personnel. The pumps shall be installed in a manner that the maintenance can be done conveniently. The chilled water circulation pumps shall be insulated in a manner specified under section `Insulation'. The insulation shall be done in such a manner that maintenance can be done on the pumps without causing damage to the insulation.

3.5 **TESTING**

The contractor shall submit the manufacturer's performance curves for the pumps supplied by him. Tests shall be conducted on each pump set after completion of the installation to check and confirm the delivery load, water flow rate and the BHP. The test results shall correspond to the performance curves. The pumps performance shall be computed from the manufacturer's pump curves.

All equipment instruments and labour required for testing shall be furnished by the contractor at no extra cost.

3.6 **PAINTING**

The pumps along with the base, motor and accessories shall be painted with two coats of synthetic enamel paint of approved colour after testing and commissioning.

3.7 EXPANSION TANK

Unless mentioned otherwise, an expansion tank of PVC double layered (Sintex , Uniplas .) , contain twice the maximum expansion likely to place in the system, shall be provided. The bottom of the tank shall be at least 600mm above the highest point of the system. Tank shall be insulated, if required and be complete with float valve, gauge glass, drain, overflow and make up connections, with gate valves and vent piping as required.

CONTROLS

1. SCOPE

This chapter covers the requirements of equipment safety controls, refrigerant flow controls and system controls.

2.0 EQUIPMENT SAFETY CONTROLS

Compressor:

Compressor shall be provided with the following safety controls: -

- i) High discharge pressure (HP) safety (cut out) to stop the compressor automatically, in case discharge pressure exceeds a pre-set safe value. This safety shall operate when discharge head pressure exceeds the set point. Only manual resetting shall be provided for this safety.
- ii) Low suction pressure (LP) safety (cut-out) to stop the compressor automatically, in case suction pressure fails below a pre-set value. This safety shall operate when the suction pressure falls below the set point. Automatic resetting shall be provided for this safety, with adjustable cut-in and cut-out pressures. This safety shall be used for pumping down the system for shutting off the refrigeration plant.
- iii) Oil pressure (O.P) safety (cut-outs) to stop the compressor, in case lubricating oil pressure falls below a safe set value. A time delay mechanism shall also be provided, so as to permit running of the compressor upto a maximum period of 90 seconds, with the oil pressure differential below the set value and allow it to continue normal operation if the pressure differential builds up to the set value within that time, or otherwise shut-down the compressor. Only manual resetting shall be provided for this safety.
- iv) High bearing temperature cut-out (for centrifugal compressor only). This shall be provided with a manual reset only.
- v) High lubricating oil temperature cut-out (for centrifugal compressor only). This shall be provided with a manual reset only.
- vi) Time delay mechanism on the starting gear to limit short cycling regardless of mal-functioning of controls.

The cut-outs (i) to (v) mentioned above shall operate when the respective controlled variable crosses the set point to trip the compressor. Audio visual

alarm shall be provided to indicate such operations. A manual reset shall be provided for them. Safeties mentioned above shall operate when the respective controlled variable crosses the set point to trip the compressor. Audio visual alarm shall also be provided to indicate such operations.

Condenser

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

Chiller

- I) An antifreeze shall be provided with water chiller, set at a few degrees above the freezing point. This shall operate, when the temperature of water in the chiller falls below the set point to trip the compressor motor. The reset provided for the safety shall be manual.
- II) Flooded type of chiller in addition, shall be provided with safety pressure relief valve.

Refrigeration Plant

- i) In addition to the safety controls as above for the individual components of a refrigeration plant, the following safety controls shall also be provided for the plant.
 - a) Compressor motor over current cut-out.
 - b) Condenser water flow switch.
 - c) Chilled water flow switch.
 - d) Condenser air flow switch in the condenser fan discharge (in case of air-cooled condensers).
 - e) Air flow switch in the evaporator fan discharge in case of direct expansion coils
- ii) The above controls, on operation, shall trip the compressor motor, and these shall be provided with manual reset arrangement.
- iii) The compressor motor shall also be interlocked electrically with,
 - a) condenser water pump in case of water cooled condenser, and condenser fan with air cooled condensers,
 - b) Chilled water pumps in case of chilled water system and evaporator

- fan in case of direct expansion system, and
- c) Antifreeze thermostat in case of chillers.
- iv) Indicating lamps shall also be provided on the control panel for indicating operation of the safeties and interlocks.

3.0 REFRIGERANT FLOW CONTROLS

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

Solenoid Valve

- a) For reciprocating, scroll and screw type compressors liquid line solenoid valve shall be provided in the liquid line of the system, ahead of the expansion valve, to allow or to stop the flow of liquid refrigerant to an evaporator, or a section of sectionalized evaporator. This shall be operated by snap-acting thermostat and it shall also be provided with a test switch to enable manual energizing.
- b) Discharge gas valves shall be provided in the following applications as required: -
 - i) Hot gas defrosting: normally this solenoid valve shall remain closed, but it shall open up to feed the evaporator with hot gas for defrosting when required, especially in cold storage applications.
 - ii) Compressor capacity control for reciprocating compressor and for cylinder unloading during starting.
- c) Solenoid valves shall be direct acting in smaller sizes and pilot operated for larger sizes, as required. The size of the valves shall be determined by the desired flow rate of refrigerant through them and the pressure drop across the same (and not by the size of the refrigerant line).

Thermostatic Expansion Valve

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

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

Float Valve

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

4.0 SYSTEM CONTROLS

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

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

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

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

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

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

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

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

- viii) Where more than one bank of heaters is required to be provided for one AHU, thermostat shall be provided in each bank shall suitable for operation in stages.
- ix) A safety thermostat (safety stat) shall be provided as high limit safety for each bank of heaters.
- x) The heater banks intended for reheating during monsoon shall form part of heaters required for winter heating (where winter heating is specified). Necessary change-over switch shall be provided as part of the system wiring to change their control by thermostats or humidistats as required.

5.0 OPERATIONAL CONTROLS AND INTERLOCKS

- i) The operation of refrigeration plant shall be either manual or automatic, as specified. The plant shall be started by an ON/OFF switch.
- ii) The automatic operation shall be effected through the monitoring of return chilled water temperature, or the room conditions, as the case may be. In multi unit installations, one unit shall be arranged to be loaded fully before the next unit is switched on automatically. A similar operation system shall be followed in shutting off of the unit. Change over from one operating unit to another shall be possible through the status switch of the plant to be shut down by change to manual position and thus overriding its anti-cycle timer. It should be possible to introduce the changed unit by running it to speed and changing over the status switch to "auto" position.
- iii) Pump down shut down shall be provided through low pressure (LP) safety irrespective of the status switch position, auto/manual.
- iv) It should be possible to start the compressor motor only after the cooling tower fan motor (where provided), chilled water (where provided) and condenser water pumps are operated.
- v) The compressor motor shall be able to be started or run, only after all the safeties as per para 12.2 are satisfied.
- vi) The blower motor shall be interlocked with strip heaters (where provided) such that power supply to strip heaters will become ON, only after the blower has been started and run to full (designed) speed.
- vii) Where only the blower motor and not heaters is connected to standby generating set in any particular application, a timer shall be provided, such that the heaters may get energised, only after a period of time, after the

blower is run.

- viii) In the event of signal from high limit safety of heaters the power supply to the blower motor and the heater bank shall automatically and instantly be switched off.
- ix) The power supply to AHU shall be cut off on receipt of a signal from the Fire Alarm System.

6.0 REQUIREMENTS OF CONTROL ELEMENTS

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

6.1 Thermostats

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

- I) Proportional control thermostats shall be provided for actuating the three way modulating valve at each air handling unit. Thermostat shall provide manual switching (heat-off-cool-in heating-cooling system).
- II) Snap-acting fixed differential type thermostat for actuating the three-way diverting valve at each fan coil unit.

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

- III) Snap-acting fixed differential heating thermostat for electric winter heating and reheat applications for putting on/off power supply to electric heating or reheat coils in air handling units.
- IV) Safety thermostat shall be provided for electric winter heating and reheat application for cutting off power supply to strip heaters in case air flow across strip heater is not established.
- V) Air-stat shall be provided within air handling unit containing electric heating or reheat coils to prevent heaters from energizing unless the air flow is established.

6.2 Humidistats

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

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

6.3 Three-way modulating valves (for AHUs)

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

6.4 Three-way diverting valves for FCUs

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

6.5 Pan humidifiers where provided shall be complete with necessary heater elements rated for 230 V supply. The pan shall be made of 1.6 mm thick GI sheet, with arrangements for make-up water, inlet and drain.

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

VENTILATION FANS

1.0 Codes and Standards:-

The design, materials, construction, manufacture, inspection, testing and field performance of the centrifugal fans shall comply with all currently applicable international / national codes / safety regulations. In particular the equipment shall conform to latest editions of all applicable codes and standards listed below.

AMCA-201 - Fans and systems - Application guide

AMCA-203 - Field performance measurement of fan systems

AMCA-210 -Laboratory Methods of testing Fans for Aerodynamic performance rating.

AMCA-2404 - Drive arrangements for centrifugal fans

BS:848, Part-1 - Fans for general purposes - Methods of testing performance

BS:4675, Part-1/ ISO-2372 - Mechanical vibrations in rotating and reciprocating machinery

2.0 Centrifugal Fans:-

2.1 Design Requirements:-

The design parameters for the centrifugal fans shall be as specified in Data Sheet-A (Filled up Data Sheets is enclosed in the Tender package). In the event of conflict between the requirements of this specification and Data Sheet or drawing, the later shall govern

2.2 Design and Constructional Features:-

a. General

a.i Centrifugal fans shall be DIDW / SISW in simply supported arrangement (i.e. Bearings on both the sides) construction complete with access door, squirrel cage induction motor, outlet damper, base frame, canvass connection, V belt drive set, belt guard, foundation bolts, nuts, slide rail and vibration isolators. Direction of discharge / rotation and motor position shall be as per the Good for construction shop drawings. All centrifugal ventilation fans shall be AMCA (Air Movement and Control Associates Incorporation of USA) certified for air & noise performance. Critical speed of the fan shall be minimum 125 % higher than the operating speed. Centrifugal Exhaust fans / motor and other accessories for toilet exhaust system shall be suitable for outdoor applications.

a.ii The Fans shall be AMCA Certified and performance certificate for the particular model of fans being supplied shall be submitted by Contractor.

b. Housing:-

b.i Housing shall be of welded construction, fabricated from carbon steel material with suitable reinforcement for rigidity. It shall be rigidly reinforced and supported by structural angles. Split casings shall be provided for large size fans, however neoprene packing shall be provided through split joints to make it airtight. Cut-off shall be designed to give smooth and quiet airflow from the outlet. Fan housing shall be of welded construction and provided with flanges at outlet for duct connection. Thickness of casing shall be as per manufacturer's standard & factory practices but casing thickness shall not be less than 2.0

mm for side plate and 1.2 mm for back plates.

b.ii The distance between blade tips and cut-off shall be optimally fixed to reduce pressure pulsation. Inlet and outlet shall be flanged.

b.iii Housing shall be provided with standard clean out door with handles and neoprene gasket.

b.iv Inlet cone shall be spun to have deep smooth contour. Close tolerance shall be maintained between inlet edge and the impeller shroud. Inlet cone profile shall ensure a smooth flow of air to blades. Inlet screens shall be provided for open inlet fans. Inlet guards shall be of 18 gauge galvanized wire mesh with 5 mm sieves. Inlet guards shall allow access for lubrication as required.

c. Impeller (Rotor):-

c.i The impeller shall be backward curve or aerofoil sectioned blades of non – over loading type. The Impeller blades shall be welded to back plate/center and shroud all along the length. Shroud shall be spun to have a smooth contour. Shaft sleeves shall be furnished as required. The impeller, pulley, and shaft sleeves shall be positively secured to the shaft. The locking device shall be designed to take the full torque due to momentum of impeller when the shaft suddenly gets arrested while running at operating speed. Air passages shall be free of interference.

c.ii Maximum operating speed of the fans shall be selected to maintain the fan outlet velocity of 2000 FPM (10.15m/s) and Noise level shall not exceed 75 db(A) at 1 mt. Distance from the equipment. The impeller along with driven pulley shall be balanced statically and dynamically after assembly. Balancing shall conform to minimum G 6.3 grade (as per ISO-1940) or Superior grade.

d. Shaft:-

d.i Shaft shall be properly sized for single piece hollow or solid construction of hot rolled steel and it shall be turned, ground and polished. Fan shaft shall not pass through its first critical speed at rated speed.

d.ii Fan shaft shall be of EN8, SAE-1040, SAE-1035 or equivalent .

e. Bearings:-

Fans shall be equipped with amply sized taper roller or ball or spherical roller anti friction or self aligning pillow block type bearings with integral dust and grease seals. Bearings shall be charged with grease. The grease capacity of the bearings shall be such that the fans are suitable for continuous operation for at least 12 months before re-greasing is required. Bearings shall be selected for a life of 50,000 hours and same shall be as per IS-3824. Grease fittings shall be alemite 6mm button head type.

f. Drive Motor:-

The fan motor, suitable for the centrifugal fan drive shall be supplied by the contractor and

the same shall be as per the specification. Motors shall be designed for continuous duty operation and shall have high efficiency. Drive motor shall have minimum 20 % margin over the fan limit load horse power. Motor shall be designed specially for quiet operation and motor speed shall not exceed 1440 rpm. The same shall be capable of accelerating to the rated rpm within safe stall time. The contractor shall submit the motor and fan torque characteristic curves along with other details for fan and motor in support of the selection. The fan and motor combination selected for particular required performance shall be of most efficient and shall be for quiet running characteristics and high efficiency. Fan motor selected shall be in such a way that sound level is lowest (max. 75 db) while running. The power and efficiency factor for all motors shall be submitted along with offer. Motor shall be capable of running continuously with a 5 % drop in rated phase to phase voltage at 15 % increase in design power. Motor of 0.75 KW and over shall be fitted with integral positive temperature coefficient thermistors selected to afford class 1 protection. Motors below 0.75 KW shall be fitted with inherent over heat protection. The Motors shall be TEFC type with IP-55 Protection & Class 'F' Insulation. Motors shall be designed for 415 V + 10% & 50 HZ + 3 %

g. Drives:-

Fans may be direct or belt driven. In case of belt driven fans, there shall be a minimum number of two belts per drive. All belt driven fans shall be equipped with fully enclosed belt guards with speed measurement openings and shall be easily removable. Belts shall be of oil resistant type. Belt guards shall not impede the airflow to the fan inlet. All belts shall be selected based on a service factor of 1.5 as applied to the drive motor kW rating. Should one belt fail the remaining belt(s) should be capable of carrying the full load. All belts shall be sized for 150% rated horsepower. The minimum number of belts to be provided will be as follows:

BHP	NO. OF BELTS
BHP < 5	2 Nos.
BHP >= 5 But < =10	3 Nos.
BHP > 10	4 Nos.

In case of direct drive, a hypoid gear coupling or flexible coupling of standard design shall be used. Pulleys shall be selected to provide the required speed. They shall be multi-groove type, with section and grooves selected to transmit 33% more load than the required power and shall be statically balanced. The belt guards shall be of M.S. sheet with angle iron reinforcements and 18 gauge expanded metal screen

2.3 Accessories:-

a. Common Base Frame:-

Mounting skid of structural steel shall be provided for supporting the fan & motor base frames. Mounting skid shall be bolted / welded with the embedded plates provided on the floor. Fans shall be fixed on mounting skid with vibrations isolators mounted in between.

b. Access Door and Drain Connection:-

Access door shall be provided for periodic inspection or cleaning. The door can be either

toggle clamp fixed or as per manufacturer's standard design. Drain point with plugs or valves shall be provided if specified.

c. Outlet Damper:-

Fan shall be provided with a damper at outlet. Dampers at outlet of centrifugal fan shall be manually operated multi-louvered type with neoprene edging on blades for tight shut off. Each blade shall be provided with bronze/gun metal bearing at each end of spindle. Operating lever along with the necessary linkage shall be provided at an accessible position for operating the dampers. Suitable fixing device for locking the damper at desired position should be provided.

d. Flexible Connection:-

Flexible connections shall be provided on the suction / discharge ends of the fan as specified. The flexible connection shall be of heavy gauge double canvas / Neoprene impregnated glass fiber of length not less than 150mm.

e. Nuts & Bolts:-

All bolts, nuts & locknuts shall conform to IS: 1367. Self-tapping screws shall not be used.

2.4 NOISE & VIBRATION:-

a. The vibrations measured at bearings in both radial and axial direction shall not exceed the specified range in the "Good to very good region" of General machinery vibration chart of VDI-2056. The vendor shall furnish along with their offer the overall fan sound power level for each fan and motor operating at the duty conditions.

b. Vibration isolators of proven design for specified isolation efficiency shall be provided. Double deflection rubber in U shear or cushy foot vibration isolator or spring type isolators shall be provided for each fan. Rubber bushes, washers, wherever needed for the vibration isolators shall be included in the supply. Sufficient number of such isolators shall be provided to ensure isolation of foundation from vibration of the equipment. At the commissioning stage the vibration amplitudes shall be measured to ensure that the vibrations are within the permissible limit of 30 microns. Generally fans / motors shall be selected to run at very minimum vibration level in accordance with the standards and the fans which are to be mounted on the terrace floor should be selected in such a way that it will not transmit any vibration and sound to the office floors below.

2.5 Painting:-

Fans shall be painted on exterior and interior with two coats of red – oxide zinc chrome primer conforming to IS: 2074 or superior, over which 2 coats of synthetic enamel of approved shade shall be applied on all surfaces. Centrifugal fans / accessories which are to be installed on the terrace floor shall be suitably painted on exterior and interior surface to avoid corrosion. If these fans are to be installed on the terrace floor in the open ambient temperature / climate. Hence these fans / accessories are to be specially treated to take care of the adverse weather condition.

2.6 Accessories

All necessary accessories shall be provided for proper operation and shall also include (**As part of Unit Price**).

- a. Dunlop cushy foot vibration isolators for the blowers.
- b. Double canvass connections at the outlet of each fan.
- c. Nuts, bolts, shims etc. as required for the grouting of the equipment.
- d. Slide rails for mounting the motor and belt adjustments.
- e. 18 gauge galvanized wire mesh bird screens in the Inlet.
- f. Outlet damper.

3.0 Axial Flow Fan:-

a. Impeller:

The impeller shall be of die cast aluminium alloy with integrally cast aerofoil sectioned blades and hub. Impeller shall be fixed to motor shaft by a thrust plate and bolt reverse to direction of rotation, in addition to key lock. The critical speed of impeller shall be minimum 1.5 times of the operating speed. The impeller shall be statically and dynamically balanced to G 6.3 grade as per ISO: 1940.

b. Casing:-

Casing shall be of 2mm thick MS for impeller dia up to 600mm and 2.5mm thick MS for impeller dia above 600mm. Casing shall have flanged connection on both ends for ducted application. It shall be provided with suitable supports. Access door shall be provided in the casing for easy access to motor and impeller. Suitable arrangement for mounting of motor shall be provided.

c. Guide Vanes:-

In case of vane axial fans guide vane shall be provided on the discharge side.

d. Guards:-

Suitably designed guards shall be supplied.

e. Drive Motor:-

Motor shall be of totally enclosed fan cooled type squirrel cage induction of IP-55 protection and class-F insulation suitable to run on 415+10% Volts, 50+3% Cycles, 3-phase AC power supply. Motor conduit box shall be mounted on exterior of fan casing, and lead wires from the motor to the conduit box shall be protected from the air stream by enclosing in a flexible metal conduit. Fan motor shall be selected in such a way that sound level is lowest (max. 75 db at 1 m distance) while running. The motor shall be rated for continuous duty. The power and efficiency factor for all motors shall be submitted along with the offer. Motors shall be capable of running continuously with 5 % drop in rated phase to phase voltage at 15 % increase in design power. Motor of 0.75 KW and over shall be fitted with integral positive temperature coefficient thermistors selected to afford class 1 protection. Motors below 0.75 KW shall be fitted with inherent over heat protection.

f. Speed:-

The speed of the fan shall not exceed 960 RPM for fan with impeller diameter above 450mm and 1440 RPM for fan with impeller diameter 450mm and less.

g. Painting:-

Fans and accessories shall be painted with two coats of red-oxide primer zinc chrome primer confirming to IS: 2074 or superior, over which two coats of synthetic enamel of approved shade shall be applied.

4.0 Propeller Fan:-

Propeller fans shall be direct driven, three or four blade type, mounted on a steel mounting plate with orifice ring. The blades shall be of steel and designed such as to give maximum volume at minimum noise level for minimum power consumption. The impellor shall be directly coupled to a purpose designated motor for efficient operation. Fan / motor shall be suitable for continuous duty and shall perform satisfactorily in ambient temperature of above 50 deg. C. The contractor shall furnish along with their offer the overall fan sound power level for each fan and motor operating at the duty conditions.

a. Mounting Plate:

Mounting plate shall be of steel construction, square with stream lined venturi inlet (reversed for supply applications) coated with backed enamel paint. Mounted plate shall be of standard size, constructed of 12 to 16 gauge sheet depending up on the fan size. Orifice ring shall be correctly formed by spinning or stamping to provide easy passage of air with out turbulence and to direct the air stream.

b. Fan Blades:-

Fan blades shall be constructed of mild steel. Fan hub shall be of heavy welded steel construction with blades to the hub. Fan blades and hub assembly shall be statically and dynamically balanced at the manufacturer's works. Impellor hubs and blades, fan supports, wire guards and internal surfaces of fan chambers shall have smooth finish.

c. Shaft:-

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 through the full range of specified fan speeds.

d. Motor:-

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 30 cm dia and smaller. Motor for larger fans shall be suitable for 415 + 10% volts, 50 cycles + 3%, 3 phase power supply and smaller fans shall be suitable for 220V +10%, 50 cycles + 3 % single phase power supply. Motors shall be suitable for either horizontal or vertical services as indicated on drawings / Schedule of quantities. Motor selected shall

fully comply with the specifications mentioned elsewhere. Fan / Motor selection shall be for continuous and quiet operation and the measured noise level shall not exceed 50 db (A) at 1 meter distance from the equipments. Motors shall be TEFC type with IP-55 protection & class 'F' Insulation.

e. Accessories:-

The following accessories may be required and provided with propeller fans, as indicated in Schedule of quantities.

Wire guard on inlet side and bird screen at the outlet.

Fixed louvers built in to a steel frame.

Regulators for controlling fan speed for single phase fan motors.

5.0 Inline Fans:-

a. Inline fans shall be complete with centrifugal impeller, casing, direct driven motor, vibration isolators, direction of discharge and rotation position shall be as per the job requirement and shall be marked on the fan assembly.

b. Housing shall be constructed of hot rolled 16g GSS sheet metal construction. Housing metal parts shall be either spot-welded or screwed or mounted together with rivets. Indication showing rotation arrow and make, model number and duty conditions of the fan shall be available on the housing.

c. Casing shall be with wide hinged doors which open easily inspection doors with handle and neoprene gasket shall also provided. Casing shall have flanged connection on both ends for ducted applications. Casing shall be primed and finish coated with synthetic enamel paint. Extended grease leads for external lubrication shall be provided.

d. Fan wheel shall be forward curved type, statically and dynamically balanced.

e. The fan shall be provided with ball bearings can be used in any mounting position at maximum indicated temperature. The bearing lubricant shall be suitable for a minimum ambient temperature of minus 150C (admissible for a short time without reaching dew point at minus 300C). For applications at maximum indicated ambient temperature life expectancy shall be 40000 hours minimum.

f. Fan motor, fans shall be supplied with built-in-thermal contact (TK) at the critical high temperature point ("B" = 1300C. The thermal contact shall open and break the power supply to the fan, Fan motors have insulation class "F" and protection class IP55.

g. Motor shall be squirrel cage, totally enclosed, fan cooled standard round frame, constant speed, continuous duty, single winding, suitable for single phase supply. (220V+/-10%,50 Hz+/-3%). Motor shall be specially designed for quiet operation and lead wires from the motor to be conduit box shall be protected from the air stream by enclosing in a flexible metal conduit.

h. Fans shall be direct driven type.

i. All fans are hot dipped galvanized.

j. The assembly of fan and motor shall be suspended from the ceiling by spring type vibration isolators.

6.0 Fire Rated Smoke Exhaust Axial Fan:

a. The fire rated smoke exhaust fans shall be axial type suitable for 250oC for minimum 2 hours.

b. The blades shall be of aluminum alloy fixed on an aluminium hub-flange assembly suitable for multiple blades which shall be adjustable when the fan is stationary.

c. The collar shall be constructed of rolled steel and joints welded. The flanges shall have suitable holes for fixing the fans, ducts etc. The collar and flanges shall be galvanized for protection.

d. The collar shall be long to cover fan and motor.

e. The fan shall be supplied with factory mounted TEFC motor suitable for 250oC for minimum 2 hours. The motor shall be foot mounted.

f. The fan shall be approved for 250oC for 2 hours by International / national authorized agency.

g. The speed of the fan shall not exceed 960 RPM for fan with impeller diameter above 450mm and 1440 RPM for fan with impeller diameter 450mm and less.

7.0 Fire Rated Centrifugal Fan:-

a. Fire rated centrifugal fan generally shall be as described above and may have varied construction features as required.

b. The fan shall be supplied with factory mounted TEFC motor suitable for 250oC for minimum 2 hours. The motor shall be foot mounted.

c. The fan shall be approved for 250oC for minimum 2 hours by International / National authorized agency.

8.0 Limitation:-

a. The air velocity limits shall be as per Schedule of Equipment and/or BOQ but in no case exceed.

b. Velocity at blower outlet shall not exceed 10.16 M/s (2000 FPM).

c. Inlet Velocity shall be limited to 5.08 M/S (1000 FPM).

8.1 Life of Ventilation & Smoke Exhaust Fans:-

Ventilation & Smoke Exhaust Fans shall be capable of providing Average Service Life of 25 years.

MOTOR STARTERS CONTROL PANELS

1. General:

The motors and switchgears required for various items shall generally be as per specifications given below. All electric motors shall be suitable for 3 phase, 50 cycles 415 volts a.c. supply.

2. Control Panel:

2.1 These panels should be floor/wall mounted, sheet steel clad, modular construction, cubicle design, compartmentalised. These panels shall comprise of incoming & outgoing feeders (circuit breakers, fuse switch units/switch fuse units, contactor starters with overload relays, single phasing preventor etc. as indicated in the drawings.

2.2 The panels shall be provided wherever necessary with necessary interlocks designed to prevent incorrect operation and to ensure safety of operating personnel and equipment.

2.3 All feeders are to be operated from the front and they shall be interlocked suitably. Padlocking arrangement and interlock defeating device shall also be provided. Each module shall have separate door and partition plate. The feeder incomer switches shall be interlocking with the door so that the door can only be opened when switch is in 'off' position. The doors and covers shall be provided with thick gaskets to make it dust tight. All the door covers shall be provided with synthetic rubber gaskets to make it dust tight. Feeder name tags shall be provided.

2.4 Air Circuit Breaker and Fuse Switch Units

The circuit breaker shall be air break fully draw out type equipped with arc chutes and their face barriers of proper design. The continuous current rating of the circuit breakers shall be as given in the detailed technical specifications. The circuit breakers shall have a breaking capacity of 31 mva at 415 volts, 50 hz ac & they shall be able to withstand full fault current for one second.

2.5 The circuit breaker shall be provided with manually operated spring closing mechanism. The operating mechanism shall be trip-free throughout the breaker travel. The breaker shall be equipped with inside 'on' & 'off' position indicator mechanism and so located that the position of the circuit breaker i.e. whether closed or open, is indicated on the front door of the compartment. The 'on' & 'off' trip indicating lights shall also be provided for each breaker feeder.

2.6 The moving portion of the circuit breaker shall be so interlocked that it is not possible to isolate it and draw out from the service position or to plug it in from the

isolated position when the circuit breaker is closed. The interlock being provided shall be such as to prevent operation of a circuit breaker unless it is fully plugged in or fully isolated and is locked correctly in either of the two positions.

- 2.7 The circuit breaker compartment doors shall be so interlocked as to prevent access to the breaker while in the plugged in position. However special means shall be provided for undoing this interlocked in an emergency.
- 2.8 The draw out feature shall clearly provided three distinct positions of the circuit breaker viz., `service', `test' & isolated. Inadvertent withdrawal of a circuit breaker removable unit too far beyond its supports shall be prevented by a suitably interlock, the design shall provide for the testing of breaker in the test positions i.e. when the breaker's moving unit is in fully disconnected position and the secondary circuit remains connected or energised. The secondary connections between the fixed and removable units shall be provided with means of spring loaded sliding type contacts to make the breaker fully draw out type.
- 2.9 The circuit breaker unit shall be provided with complete range of releases including the overload releases and release for short circuit protection.
- 2.10 The circuit breaker shall be provided with necessary auxiliary contacts with 2 No. spare contacts. All contacts shall be wires upto the terminal board.
- 2.11 The fuse switch unit shall be of load break heavy duty, industrial design and of double break pattern with quick make and quick break mechanism, however, the design shall be such that it shall ensure positive opening even if quick break action is lost due to spring stretching or breaking.
- 2.12 The `on' and `off' position of the switch handle shall be distinctly indicated and inter locks shall be provided to ensure that switch cover can not be opened unless the switch is in the `off' position.
- 2.13 The fuse switch units shall be provided with non-deteriorating type of hrc cartridge fuse link and having rupturing capacity not less than 31 mva at 415 volts.
- 2.14 All alive parts inside switch shall be properly shrouded and interphase barriers shall be provided. Design of the switch handles shall be such that they do not protrude out of the panel in the manner so as to prevent free passage of operating personnel. Design with normal conventional position of switch handle up in `on' position & down in `off' position shall be preferred.
- 2.15 **415 Volts Bus Bars**
 - 2.15.1 The 415 volts main bus-bar shall have continuous current rating as indicated in the specification or equivalent standard rating of at least 50 percent of these of the

phase bus bars. The bar and its connections shall be so arranged and supported as to withstand without any damage or deformation, the specific short circuit current. The bus bars shall be braced and supported on reinforced fibre glass support and shall be of electrolytic grade type E 91e of is:5082. these bus bars shall withstand 43.12 ka for one second during short circuit conditions. The bus bars shall be colour coded with pvc tapes or insulating painting for identification purposes. The bus bars shall be sleeved with special type heat shrinkable pvc sleeving.

2.15.2 Bus supports shall be resistant low absorption type moulded insulation of high impact strength and high creepage surface.

2.15.3 All bus work shall be braced to withstand without damage a short circuit current of 43.12 ka symmetrical for one second.

2.16 Instruments and Meters

2.16.1 Current transformer shall comply with the requirements of is:2705. They shall have ratio outputs and accuracies as specified or required as shown in single line diagram.

2.16.2 All indicating instruments shall be of industrial pattern and should be provided as shown in the single line diagram.

2.16.3 All instruments shall be switch board type flush mounted with proper scale dimensions so as to be clearly visible to the operators standing on the floor. The instruments shall be provided with front of board zero adjuster shall be not preferably be mounted at heights lower than one meter and higher than two meters above the floor level.

2.16.4 The operating handles, meters, instruments etc. shall be mounted at the front of the switch board. Approved means shall be provided for locking the control switch/operating handles in the open position. For fuse switch gear section of the switch board, meters where specifications shall be mounted in such a manner that it is possible to readily identify the meters for individual units and the arrangements does not create hinderance to maintenance of individual units without having to shut down the bus.

2.16.5 All wires carried within the switch gear enclosure shall be pvc insulated and shall be neatly arranged to be readily accessible and to facilitate easy replacement. Only pvc copper cables shall be used for all power and control inter connections. The cables of 660 volts shall be used. Trained copper cables lugs shall be used. All small wires shall be colour coded and provided with numbered ferrules for easy identification of circuits. As for as possible, each essential circuit shall be connected within the respective switch gear unit. Control wiring terminal shall preferably be near the panel.

3. **Cable Termination:**

- 3.1 The cables entries and terminals shall be provided in the switch board to suit the number, type and size of aluminium conductor cables as given in the line diagram. Cable entries shall be so designed as to avoid damage to cables and there shall be sufficient space to avoid short bending of cables. The positions of the cable lugs and terminals shall be such that the cable could be neatly drawn and connected through one meter deep trench below the switch gear and the jointing carried out in a convenient and satisfactory manner. The cable entry, design panel, cable boxes and terminals and their locations will have to be approved by the engineer/owner. However the access for cabling shall preferably be from the back of the switch board. The panels shall be provided with control transformers of suitable va rating along with control bus and hr fuses from control supply to contractors.
- 3.2 The cables socket shall be of copper and of crimping type. Cables risers shall be adequately supported to withstand the effects of rated short circuit current without damage.
- 3.3 Cable glands of sizes as required shall be provided at all cable entry points in the bottom plate. The glands shall form part of switch board.

4. **Indication:**

Each incoming and outgoing feeder units shall be provided with 'on' 'off' indicating lamps of standard conventional colour coding.

5. **Subsidiary Panels:**

Subsidiary panels shall be provided wherever required such as ahu room, air washer room. The construction of these panels should be similar to the main panel and shall have all related accessories.

6. **Contactor Starters:**

6.1 **Star Delta Starter**

The star delta starter shall be air break automatic contactor starter provided with main contactor, star contactor, delta contactor, timer and automatic change over from start to delta, bimetallic over load relay, operating coil, start/stop push button, single phasing preventor, auxiliary make and break contacts, indicating lamps etc. The contactor shall quick make, quick break, double break consisting of robust silver contacts. The coil voltage shall be 415 volts ac at 50 hz. The starter shall be provided with trip indication light and overload reset push button for overload relay.

6.2 DOL Contactor Starter

The contactor shall be air break type coil operate, dol contractor starter, provides with cables entries, ambient temperature compensated bimetallic over load relay, single phasing preventor, solenoid coil, start and stop push buttons, 8 auxiliary make and break contacts, indicating lamps etc. The contactors shall be quick make and quick break, double break type consisting of robust silver contacts. The coil voltage shall be 440 volts at 50 c/s. The starter shall be provide with trip indication light and over load reset bush button for overload relay.

7. Squirrel Cage Induction Motors:

7.1 The motor shall be of well tried out and design and of reputed make. The motors provided on the equipment shall conform to is:325 in general. The motors shall be squirrel cage induction motors rates for operation at 415 volts, 3 phase, 50 hz a.c. supply. The motor for various equipments shall have the following enclosure level.

- (a) Cooling tower & exhaust blower - ip:55(tefc)
- (b) Compressor and A.H.U. motor-ip:55(tefc).
- (c) Pumps ip:55(tefc).

7.2 The horse power and speed of the motor shall match that of driven equipment and the motor shall be suitable for star delta starting or direct on line starting with class `3' insulation. The motors of 7.5 HP and above 7.5 HP shall be suitable for star delta starting and below 7.5 HP suitable for dol starting. The compressor motor shall be provided with automatic star delta starter

8.0 CENTRAL CONTROL CONSOLE

A floor mounting control and indication console shall be provided in the main control room, as shown on the plans.

Equipment	Push Bottons		Lamps	
	on	off	green	red
Water chilling units				
Machine status			x	x
Water circulation pumps	x	x	x	x
Air handling unit motors	x	x	x	x
Ventilation Fans, Centrifugal Blower,exhausters	x	x	x	x
Flow switch in water lines	-	-	-	x

Hot water generator	x	x	x	x
In line/ Tube axial fan	x	x	x	x
Cooling towers, AHUs	x	x	x	x

The console shall contain on/off push buttons and indication lamps for all the items as per the BOQ. Indicating light for strip heaters, if any shall be provided on the switch board, in the respective unit room.

The requirements given for the main panel are for one unit only. The actual number of switches and lights shall correspond to the number of units being installed. All controls and alarms shall be suitable for 230 volts on the panel.

The alarms shall be with reset buttons.

All controls circuits shall be functionally tested.

The red indicating lamps should switch on only in case of fault. Thus, the red light should come on in case of tripping of starter on overload or single phasing.

A common alarm shall be connected to all red indicating lamps through individual relays.

Lamp testing arrangements shall be provided in console.

All the airconditioning equipments shall be interlocked in sequence for safe and trouble free operations of the plant. Following should be the sequence of operation

- 8.1 Airhandling units
- 8.2 Chilled / condenser water pumps
- 8.3 Water chilling units.

During switch off operations the sequence shall be reverse.

- 8.4 For winter heating the following should be the sequence of operations
- 8.5 Airhandling unit
- 8.6 Hot water pumps.
- 8.7 Hot Water Generator/Boiler

During switch of operations the sequence shall be reverse.

DUCT WORK AND OUTLETS

1. General:

- 1.1 The work under this part shall consist of furnishing labour materials, equipment and appliances as specified necessary and required to install all sheet metal and other allied work to make the air conditioning supply, ventilating, exhaust system ready for operation as per drawings.
- 1.2 Except as otherwise specified all duct work and related items shall be in accordance with these specifications.
- 1.3 Duct work shall mean all ducts, casings, dampers, access doors, joints, stiffeners and hangers.

2 Duct materials

- 2.1 The ducts shall be fabricated from galvanized steel sheets class VIII GSS sheets conforming to IS:277-1962 (revised) or aluminium sheets conforming to IS:737-1955(with latest amendments) (wherever aluminium ducts are specified).
- 2.2 All duct work, sheet metal thickness and fabrication unless otherwise directed, shall strictly meet requirements, as described in IS: 655-1963 with amendment-i (1971 edition)

The thickness of the sheet shall be as follows :-

	size of duct	sheet thickness		type of joints	bracing if any
		GI	Aluminium		
2.2.1	Upto 750mm	0.63 mm	0.80 mm	GI flange	
2.2.2	751 mm to 1000 mm	0.80 mm	1.00 mm	25x25x3 mm Angle iron Frame With 8 mm dia.nuts & bolts.	25x25x3 mm at the rate of 1
2.2.3	1001 mm to 1500 mm	0.80 mm	1.00 mm	40x40x5 mm angle iron frame with 8 mm dia. Nuts & bolts.	40x40x3mm at the rate of 1
2.2.4	1501 mm to 2250 mm	1.00 mm	1.50 mm	50x50x5 mm angle iron to be cross braced diagonally with	40x40x3mm at the rate of 1.2

- 10 mm dia nuts & bolts at 125 mm centre.
- 2.2.5 2251 mm and above 1.25 mm 1.80 mm 50x50x6 mm 40x40x3 mm angle iron at the rate of 1.6 frame with 10 mm nuts & bolts at 125 mm centre.
- 2.3 The gauges, joints and bracings for sheet metal duct work shall further conform with the provisions as shown on the drawings.
- 2.4 Ducts larger than 450 mm shall be cross broken, duct sections upto 12 00 mm length may be used with bracing angles omitted.
- 2.5 Changes in section of duct work shall be affected by tapering the ducts with as long a taper as possible. All branches shall be taken off at not more than 45 deg. Angle from the axis of the main duct unless otherwise approved by the engineer-in-charge.
- 2.6 All ducts shall be supported from the ceiling/slab by means of m.s.rods of 9 mm (3/8") dia with m.s. angle at the bottom.

3. Installations

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

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

- 3.4 All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. turning vanes shall be securely fastened to prevent noise or vibration. All ducts shall be fabricated and installed in accordance with modern design practice. The sheet metal gauges and fabrication procedures as given in i.s.s specifications shall be adhered to and shall be considered as an integral part of these specifications.
- 3.5 The duct work shall be varied in shape and position to fit actual conditions at building. All changes shall be in accordance with accepted airconditioning duct

design and subject to the approval of the engineer-in-charge. The contractor shall verify all measurements at building and shall notify the engineer-in-charge of any difficulty in carrying out his work before fabrication.

- 3.6 Sponge rubber of approved equal gaskets shall be installed between duct flanges as well as between all connections of sheet metal ducts to walls, floor columns, heater casings and filter casings. sheet metal connections shall be made to walls and floors by means of galvanized steel angles anchored to the building structure with anchor bolts and with the sheet bolted to the angles. sheet metal connections shall be as shown in the drawings or as directed by engineer-in-charge.
- 3.7 The ducts shall be supported from the structure by means of suitable supports grouted in the r.c.c. work. The type of support should meet the approval of the engineer-in-charge and should involve minimum damage or breakage. In no case the duct will be rested upon the false ceiling/boxing or on supports grouted in the wall.
- 3.8 Flanges and supports are to be black, mild steel and are to be primer coated on all surfaces before erection and painted with aluminium thereafter. accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish similar to the adjacent ducting as specified.
- 3.9 Joints, seams, sleeves, splitters, branches, takeoffs and supports are to be as per duct details as specified, or as decided by engineer-in-charge.
- 3.10 Joints requiring bolting or riveting may be fixed by hexagon nuts and bolts, stove bolts or buck bolts, rivets or closed centre top rivets or spot welding. Self tapping screws must not be used. all fixing must have a permanently non-corrosive finish such as cadmium plating or galvanizing as appropriate. Spot welds and bronze welds are to be coated on all surfaces with zinc rich paint, as approved by engineer-in-charge.
- 3.11 The flexible joints are to be fitted to the suction and delivery of all fans. The material is to be normally double heavy canvass or as directed by engineer-in-charge. On all circular spigots the flexible materials are to be screwed or clipband with adjustable screws or toggle fitting. For rectangular ducts the material is to be flanged and bolted with a backing flat or bolted to mating flange with backing flat.
- 3.12 The flexible joints are to be not less than 75 mm and not more than 250 mm between faces.
- 3.13 The duct work should be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling contractors.

4. **Dampers**

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

- 4.2 The 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.
- 4.3 The dampers shall be of splitter, butterfly or louver type. the damper blade shall not be less than 1.25 mm (18) gauge, reinforced with 25 mm angles 3 mm thick along any unsupported side longer than 250 mm angles shall not interface with the operation of dampers, nor cause any turbulence.
- 4.4 Automatic and manual volume opposed blade dampers shall be complete with frames and bronze bearings as per drawings. dampers and frames shall be constructed of 1.5 mm steel and blades shall not be over 225 mm wide. The dampers for fresh air inlet shall additionally be provided with fly mesh screen, on the outside, of 0.8 mm thickness with fine mesh spacking.
- 4.5 Wherever required for system balancing, provide a volume balancing opposed blade damper with quadrant and thumb screw lock. provide damper rod and damper block with upset screws.
- 4.6 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.
- 4.7 **Motorised Combined Smoke & Fire dampers:**

The fire dampers shall be provided at all supply and return air ducts at AHU room crossings and at all floor crossings or wherever shown on the drawings. The fire & smoke dampers shall be of at least 90 minutes fire rating certified by CBRI, Roorkee as per UL 555 : 1973. Fire damper blade & outer frame shall be formed of 1.6 mm galvanized sheet steel. The damper blade shall be pivoted on both ends using chrome plated spindles in self lubricated bronze bushes. Stop seals will be provided on top & bottom of the damper housing made of 16 G galvanized sheet steel. For preventing smoke leakage side seals will be provided. In normal position damper blade shall be held in open position with the help of a 24 V operated electric actuators thereby providing maximum air passage without creating any noise or chatter. The damper shall be actuated through electric actuator. The actuator shall be energised with the help of a signal from smoke detector installed in AHU room. Smoke detector shall be provided by the A/C contractor. The fire damper shall also close due to temperature rise in SA ducts through the electric temperature sensor factory set at 165 deg F micro switches with bakelite base will be provided to stop fan motor and give open & close signal at remote panel in case of motorised actuator.

Each fire dampers shall have its own panel which will incorporate necessary circuit required to step down voltage available from power supply to shown status of the damper (open or close), to allow remote testing of damper & indication in event of damper closure due to signal from smoke sensor/ temperature sensor & reset button. Additional terminal will be provided to have signal (sound beep or visual) in Central Control Room

Damper actuator shall be spring return Belimo make so as to close the damper in the event of power failure automatically and open the same in case of power being restored. Spring return action of the actuator shall be an in built mechanism and not mount externally.

The fire damper shall be mounted in fire rated wall with a duct sleeve 600 mm long. The sleeve shall be factory fitted on fire damper. The joints at sleeve end shall be slip on type. Minimum thickness of GI sheet shall be 18 G.

5. Access panel

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

6. Miscellaneous

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

6.2 All duct work joints are to be true right angle or approaching with all sharp edges removed.

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

6.4 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.

6.5 Inspection doors measuring at least 450 mm x 450 mm are to be provided in each system at an appropriate location, as directed by engineer-in-charge.

6.6 Diverting vanes must be provided at the bends exceeding 600 mm and at branches connected into the main duct without a neck.

6.7 Proper hangers and supports should be provided to hold the duct rigidly, to keep them straight and to avoid vibrations additional supports are to be provided where required for rigidity or as directed by engineer-in-charge.

6.8 The ducts should be routed directly with a minimum of directional change.

6.9 The duct work shall be provided with additional supports/hangers, wherever required or as directed by the engineer-in-charge, at no extra cost.

6.10 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.

6.11 All angle iron flanges to be welded electrically and holes to be drilled.

6.12 All the angle iron flanges to be connected to the gss ducts by rivets at 100 mm centres.

- 6.13 All the flanged joints, to have a 4 mm thick felt packing stack to the flanges with shellac varnish. the holes in the felt packing are to be burnt through.
- 6.14 The g.s.s. ducts should be lapped 6 mm across the flanges.
- 6.15 The ducts should be supported by approved type supports at a distance not exceeding 2.4 metres.
- 6.16 Sheet metal connection pieces, partitions and plenums required, shall be constructed of 1.25 (18 gauge) sheet thoroughly stiffened with 25 mm x 25 mm angle iron braces and fitted with access doors.

7. **Grilles**

- 7.1 The supply and return air grilles shall be fabricated from aluminium extruded sections and the supply air grilles shall have single louvers and the return air grille shall have single horizontal extruded section fixed louvers the grilles may or may not be with an outer frame.
- 7.2 The grilles shall have opposed blade dampers of m.s. black sheets, which shall be key operated from the grille face wherever required.
- 7.3 The damper blades shall be of 1.00 mm (18 gauge) m.s. black sheets and shaped to form air tight joints the frame work for dampers shall be fabricated from 1.00 mm (18 gauge) m.s. black sheet the grill flange shall be fabricated out of 25 x 25 x1.5 mm aluminium angle grilles longer than 450 mm shall have intermediate supports for the horizontal louvers.

7.4 **Linear Grille**

The linear grille shall be of 1.25 mm (18 G) aluminium extruded section with flush mounted with single louvers for air flow direction adjustment.

8. **Diffusers**

- 8.1 The ceiling type round or square diffusers shall be of 1.25 mm (18 gauge) aluminium extruded sections with flush or step down face, as specified with fixed pattern and round neck.
- 8.2 The diffusers shall be die formed for proper air diffusion.
- 8.3 All supply diffusers shall be provided with m.s. sheet dampers, with knurled knobs for adjustment from the bottom.

9. **Painting**

- 9.1 All grilles, and diffusers shall be anodised or powder coated, as required, before installation.
- 9.2 All ducts immediately behind the grilles/diffusers etc. are to be given two coats of

black paint in matt finish.

9.3 All grilles, diffusers & registers shall be provided with rubber gasket between flanges and the wall or ceiling.

10. **Testing**

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

10.2 The entire air distribution system shall be balanced to supply the air quantity as required in various areas and the final balance of air quantity through each outlet shall be submitted to the engineer-in-charge for approval.

PIPE WORK

1. General:

All piping work shall conform to quality standards and shall be carried out as per specifications and details given hereunder: -

2. Pipes:

2.1 All pipes in sizes upto 50 mm dia shall be m.s. e.r.w tube (black steel) heavy class as per i.s. 1239-79, part-i with amendment-i of January `81.

2.2 All pipes in sizes 65 mm to 150 mm dia shall be m.s. e.r.w. tube (black steel) heavy class, as per i.s. 1239/79 part-i with amendment i of January 1981.

2.3 All pipes in sizes above 150 mm dia shall be m.s. e.r.w. tube (black steel) of minimum 6 mm thickness as per i.s. 3589 with amendment (latest).

3. Fittings :

3.1 The dimensions of the fittings shall conform to i.s. 1239/69 part-ii unless otherwise indicated, in the specifications.

3.2 All bends in sizes upto and including 150 mm dia, shall be ready, made of heavy duty, wrought steel of appropriate class.

3.3 All bends in sizes 200 mm and larger dia, shall be fabricated from pipes of the same dia and thickness, with a minimum of 4 sections, and having a minimum centre line radius of 1.5 diameter of pipes.

3.4 All fittings such as branches reducers etc. in all sizes shall be fabricated from pipes of the same dia and thickness, and its length should be at least twice the dia of the pipe.

3.5 The branches may be welded straight to the main line, without making a separate fitting, where specified on drawings or required by engineer-in-charge.

3.6 Blank ends are to be formed with flanged joints and 6 mm thick blank between flange pair for 150 mm and over, in case where, a future extension is to be made otherwise blank end discs of 6 mm thickness are to be welded on, with additional cross stiffeners from 50 mm x 50 mm m.s. heavy angles, for sizes upto 350 mm. All ends larger than 400 mm dia shall have dished ends.

3.7 Air valves (included in piping) shall be provided at all high points in the piping system for venting with a size of 25mm for pipes up to 100 mm and 40mm for larger pipes

4. Flanges:

4.1 All flanges shall be of mild steel as per i.s. 6392/71 and shall be steel slip-on-type, welded to the pipes, flange thickness shall be to suit class-ii pressures.

- 4.2 Flanges may be tack welded into position, but all final welding shall be done with joints dismantled 3 mm thick gaskets shall be used with all flanged joints. The gaskets shall be fibre re-inforced rubber as approved by the engineer-in-charge. Special adhesive compound shall be used between flanges of steam, air and gas lines.
- 4.3 Flanges shall be used as follows: -
- 4.3.1 Counter flanges for equipment having flanged connections.
- 4.3.2 Flanged pairs shall be used on all such equipment, which may require to be isolated or removed for service e.g. pumps, refrigeration machines, air handling units etc.
- 4.3.3 All threaded valves shall be provided with nipples and flanged pairs on both sides to permit flange connections, for removal of valves from main lines for repair/replacement.
5. **Valves:**
- 5.1 **Butterfly Valves**
- 5.1.1 The butterfly valve shall consist of cast iron body preferably in two piece construction.
- 5.1.2 The disc shall consist of disc pivot and driving stem shall be in one piece centrally located.
- 5.1.3 The valve seat shall be synthetic material suitable for water duty it shall line the whole body.
- 5.1.4 The disc should move in slide bearings on both ends with 'O' ring to prevent leakage.
- 5.1.5 The handle should have arrangement for locking in any set position.
- 5.1.6 The valve should be suitable for 12 kg/sq.cm working pressure. PN 1.6 rating.
- 5.2 The check valves shall be wafer type. The body shall be of cast iron and the plate of aluminium bronze. The valve shall have plain face and shall have a synthetic seal. The valve shall be suitable for 12 kg /cm² pressure.
- 5.3 All guage cocks shall be of gunmetal plug type, complete with siphon (brass chrome plated).
- 5.4 All drain valves shall be of gunmetal with a hose union connection of one hand.
- 5.5 All valves on the return line of fan coil units shall be as in 5.6 but without integral water strainer.

6. **Balancing Valves:**

- 6.1 The balancing valves upto 80 mm dia shall be of gun metal screwed type confirming to b.s. 5154 or equivalent specifications.
- 6.2 The valve shall be cast gunmetal astm b-62 and complete with non rising spindle. ptfе disc seal cast metal hand wheel.
- 6.3 The port opening shall permit precise regulation of flow rate, by accurately measuring the pressure drop across the port.
- 6.4 The valve shall be complete with two ports for connections to a mercury manometer to measure the pressure drop, as well as a drain port.
- 6.5 The spindle shall have a shielded screw to set the flow at the desired level.
- 6.6 This valve shall be used wherever specified.

7. **Strainers:**

- 7.1 The strainers shall either be pot type or 'y' type with cast iron or fabricated steel body tested upto pressure applicable for the valves as shown on the drawings.
- 7.2 The strainers shall have a perforated bronze sheet screen with 3 mm perforation and with a permanent magnet to catch iron fillings.
- 7.3 Pot strainers shall be provided with flanged connections and 'y' strainers shall be provided with flanged ends.
- 7.4 The strainers shall be designed to facilitate easy removal of filter screen for cleaning, without disconnection of pipe line.

8. **Jointing:**

- 8.1 All pipe lines shall be welded type.
- 8.2 Square cut plain ends will be welded for pipes upto and including 100 mm dia.
- 8.3 All pipes 125 mm dia or larger will be bevelled by 35 deg before welding.

9. **Miscellaneous:**

- 9.1 Provide all pipe work as required to make the apparatus connected complete and ready for regular and safe operation. Unless otherwise noted connect all apparatus and equipment in accordance with manufacturer's standard details, as approved by engineer-in-charge.

- 9.2 Unless otherwise specified, pitch the lines of piping as follows: -

All condensation drainage, including air handling unit and fan coil unit shall be

pitched in the direction of flow to ensure adequate drainage, with an adequate trap seal to prevent leakage of air due to static pressure developed by air conditioning units. Pitch, 20 mm per metre wherever possible, but not less than 10 mm per metre.

Drains from other equipment shall be pitched similarly without trap seal.

- 9.3 Provide necessary valves (included in piping) and capped connections for all low points in piping system, where necessary or required for draining systems. Provide isolating valves & drain valves in all risers to permit repairs without interfering with the rest of the system.
- 9.4 During construction, temporarily close, open ends of pipes with sheet metal caps, where necessary, or required to prevent debris from entering the piping system.
- 9.5 Support piping independently of all equipment so that the equipment is not stressed by the piping weight or expansion.
- 9.6 To facilitate the maintenance, repair and replacement:
 - 9.6.1 Provide shut-off valves where indicated and for individual equipment, units at inlet and outlet, to permit unit removal for repairs, without interfering with the remainder of the system. Additional shut-off valves shall be provided as required to enable all systems to be fully sectionalized. By-pass and stop valves shall be provided for all automatic control valves as specified.
 - 9.6.2 Arrange piping for maximum accessibility for maintenance and repair, locate valves for easy access and operation. No valves shall be installed with handles pointing down, unless unavoidable.
 - 9.6.3 Cut the pipes accurately according to measurements, established at building site & work into place without springing or forging.
 - 9.6.4 Pipe supports shall be adjustable for height and prime coated with rust preventive paint & finish coated with grey paint, both as approved by engineer-in-charge. The spacing of pipe supports shall not be more than that specified below: -

Nominal pipe size mm	Spacing (metres)
15 	1.25
20 & 25 	2.00
32,30,50 & 65	2.50
80,100 & 125	2.50
150 & above 	3.00

- 9.6.5 Extra supports shall be provided at the bends and at heavy fittings like valves to avoid undue stresses on the pipes. Pipe hangers shall be fixed on walls and ceiling

by means of metallic approved dash fasteners.

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

9.6.7 Where pipes are to be buried under ground, they should be coated with one coat of bituminous paint. The top of the pipes shall not be less than 75 cms. From the ground level. Where this is not practical permission of engineer-in-charge shall be obtained for burying the pipes at lesser depth. The pipes shall be surrounded on all sides by sand cushions of not less than 15 cms. after the pipes have been laid and top sand cushions provided, the trench shall be refilled with the excavated soil, excess soil shall be removed from the site of work by the contractor.

10. **Hangers & Supports:**

10.1 Hangers and supports shall be provided and installed for all piping and tubing wherever indicated, required or otherwise specified. Wherever necessary, additional hangers and supports shall be provided to prevent vibration or excessive deflection of piping and tubing.

10.2 All hangers and supports shall be made of steel or other durable and non-combustible materials, galvanized or plated. Wood wire or perforated strap iron shall not be used as permanent hangers or supports.

10.3 Hangers shall be supported from structural steel, concrete inserts & pipe racks, as specifically approved.

10.4 No hangers shall be secured to underside of light weight roof decking and light weight floor glass.

10.5 Mechanical equipment shall be suspended midway between steel joists and panel points.

10.6 Drilling or punching of holes in steel joist members will not be permitted.

11. **Sleeves:**

11.1 Where pipes pass through floors, walls, etc provide galvanized steel pipe sleeves 50 mm larger than outside diameter of pipe. Where pipes are insulated, sleeves shall be large enough to ample clearance for insulation.

11.2 Where pipes pass through outside walls or foundations, the space between pipe and sleeve shall be caulked with lead wool and oakum.

11.3 The centre of pipes shall be in the centre of sleeves, and sleeves shall be flush with the finished surface.

12. **Expansion or Contraction:**

12.1 The contractor shall provide for expansion and contraction of all piping installed by

the use of swing connections and expansion loops.

13. Arrangement and Alignment of Piping:

- 13.1 All piping shall be arranged and aligned in accordance with the drawings as specified. Where special conditions are encountered in the field, the arrangement and alignment of piping shall be as directed by the engineer-in-charge.
- 13.2 The piping shall be installed in a uniform manner, parallel to or perpendicular to walls or ceilings, and all changes in directions shall be made with fittings. The horizontal piping shall be run at right angles and shall not run diagonally across rooms or other piping. Wherever possible all piping shall be arranged to provide maximum head room.
- 13.3 All piping shall be installed as directly as possible between connecting points in so far as the work of other trades permits. Where interference occurs with another trade whose work is more difficult to route this contractor shall reroute his pipes as required to avoid interference, at the discretion of the engineer-in-charge.
- 13.4 All piping shall be carefully installed to provide for proper alignment, slope and expansion.
- 13.5 The stresses in pipe lines shall be guided and pipes shall be supported in such a manner that pipe lines shall not creep, sag or buckle.
- 13.6 Anchors and supports shall be provided wherever necessary to prevent any misalignment of piping.
- 13.7 Small tubing gauges, controls or other equipment installed on any apparatus, shall not be coiled nor excessive in length, but shall be installed neatly, carefully bent at all changes in direction, secured in place and properly fastened to equipment at intervals to prevent sagging.
- 13.8 The piping shall be grouped wherever practical and shall be installed uniformly in straight parallel lines in either vertical or horizontal positions.

14. Testing:

- 14.1 In general, tests shall be applied to piping before connection of equipment and appliances. In no case shall the piping, equipment or appliances be subjected to pressures exceeding their test ratings.
- 14.2 The tests shall be completed and approved before any insulation is applied. Testing of segments of pipe work will be permitted, provided all open ends are first closed, by blank-offs or flanges.
- 14.3 After tests have been completed the system shall be drained and flushed 3 to 4 times and cleaned of all dust and foreign matter. All strainers, valves and fittings shall be cleaned of all dirt, fillings and debris.
- 14.4 All piping shall be tested to hydraulic test pressure of at least one and half times the

maximum operating pressure but not less than 10 kg/sq.cm for a period of not less than 12 hours. All leaks and defects in the joints revealed during the testing shall be rectified to the satisfaction of the engineer-in-charge, without any extra cost.

- 14.5 All the piping systems shall be tested in the presence of the engineer-in-charge or their authorised representative. Advance notice of test dates shall be given and all equipments, labour, materials required for inspection, and repairs during the test shall be provided by the contractor. A test shall be repeated till the entire systems are found to be satisfactory to the above authority. The tests shall be carried out for a part of work if required by engineer-in-charge in order to avoid hindrances in the work of the insulation contractor.
- 14.6 All steam and condensate pipes shall be tested and proven tight under hydrostatic pressure of 20 kg/sq.cm, unless otherwise stated, for a minimum period of 4 hours without drop in pressure.
- 14.7 Miscellaneous piping, tests with air at 10.5 kg/sq.cm for a minimum of 24 hours without drop in pressure.
- 14.8 The contractor shall make sure that proper noiseless circulation is achieved through all piping systems. If due to poor bond, proper circulation is not achieved, the contractor shall bear all expenses for carrying out the rectification work including finishing of floors, walls and ceiling damaged in the process of rectifications.
- 14.9 The contractor shall provide all labours and materials to make provision for removing water and throwing it at the proper place, during the testing or/and after the testing to avoid damages to employer or other contractors ' properties. Any damages caused by the contractor to the employer or other contractors' properties, shall be borne by the contractor.

15.0 Copper Piping:

- 15.1 Heavy gauge soft copper tubing, type m shall be used to make connections to equipment, wherever required or specified by engineer-in-charge.
- 15.2 Flare fittings e.g. flare nuts, tees, elbows, reducers etc. shall all be of brass.

16. Refrigerant Piping:

- 16.1 The refrigerant circuit piping shall be heavy class m.s the fittings shall be heavy class. The pipes and fittings shall be connected by means of welded joints. The connections to gauges, controls etc. shall be with soft copper tubing and flare fittings.
- 16.2 The refrigerant valves, required in the circuit shall be as follows.

	Valve Size	Valve Material	Type of Connections
16.2.1	upto 12 mm	brass/packless type	flare fittings
16.2.2	16mm & above	brass/steel packed type	brazed/welded

note :- all valves shall be tested against leaks upto 20 kg/sq.cm.

16.3 The strainers for the refrigerant liquid line shall be 'y' type with gun metal body and bronze filter screen of fine mesh. The filter screen shall be easily removable type without dismantling the strainer from the circuit.

16.4 The moisture indicator in the liquid line shall have leak proof glass on opposite sides to permit easy inspection of the liquid refrigerant.

17. **Drain Piping:**

17.1 The drain piping shall be medium class galvanised steel as per IS 1239/1979.

17.2 The fittings shall be of 'R' brand or equal forged with screwed connections.

17.3 The gate valves (included in piping) shall be of gun metal as described earlier.

17.4 Pipe crosses shall be provided at bends, to permit easy cleaning of drain line.

17.5 The drain line shall be provided upto the nearest drain trap and pitched towards the trap.

17.6 Drain lines shall be provided at all the lowest points in the system, as well as at equipments, where leakage of water is likely to occur, or to remove condensate and water from pump glands.

18. **Painting:**

18.1 All pipes supports, hangers, etc., shall be given two coats of red oxide primer.

18.2 All pipes, which are not to be insulated, shall then be given one coat of finish paint, of a type and colour, as approved by the engineer-in-charge.

INSULATION

1. **General:**

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

2. **Materials:**

The materials to be used for insulation shall be as follows, unless some other material is specifically mentioned elsewhere.

2.1 **Pipe Insulation:**

The insulation for chilled water and drain piping, chillers, pump etc. shall be carried out from 'TF' quality expanded polystyrene having a 'K' value of 0.014 kcal/hr/°c. at mean temperature of 10°c. and a density of 24 to 28 kgs/cubm.

2.2 **Other Insulation**

2.2.1 The material for acoustic treatment of ducts, rooms, roofs etc. shall be resin bonded fibre glass, as described earlier, conforming to i.s. 8183 of 1976. the density of fibre glass shall be 32 kg/cub.m and the material shall be in the form of slabs of uniform density. The 'K' value at 10°c. shall not be less than 0.028 kcal/mhr/°c. Facing shall be provided with 0.5 mm perforated aluminium sheet held with G.I. nuts bolts or nailed to the batten work as required.

2.2.2 The materials for duct insulation shall be resin bonded glass wool, as described earlier but conforming to i.s. 8183 of 1976. The density of insulation shall not be less than 24 kg/cub/m. and material shall be in the foam of blankets/rolls of uniform thickness. The 'K' value at 10°c. shall not be less than 0.03 kcal/mhr/oc.

3. **Air Handling Units:**

3.1 The casing of the sheet metal type air handling unit from the beginning of the fan section till the end of the coil section, including the drain pan, shall all be insulated.

3.2 The insulation shall be 12 mm polyethylene flexible sheets.

3.3 The insulation shall first be fixed to the casing by applying cold sticking compound both to the surface and the insulation and all joints shall be sealed completely.

4. **Cold Equipment Insulation:**

4.1 The complete shell of the chiller as well as its two heads, the chilled water pumps ,and high pressure AHUSs shall all be insulated.

4.2 The insulation shall be 'TF' quality expanded polystyrene as below :

- i) Chillers - 100 mm

- ii) High pressure AHUs - 50 mm
- iii) Chilled water pumps - 50 mm

4.3 All insulation excepting chiller heads shall be covered with 0.63 mm 12 mm wire netting and finished with 12 mm thick sand cement plaster.

4.4 The insulation on the two end heads of the chiller shall be covered with 0.80 mm g.i. casing to permit easy removal.

4.5 Insulation (Chiller)

4.5.1 The cooler surface shall first be cleaned with wire brush.

4.5.2 Then one layers of cold setting compound shall be applied.

4.5.3 The insulation shall then be fixed in two layers, staggering the joints and sealing them with cold setting adhesive.

4.5.4 The insulation shall then be covered with 0.63 mm 19 mm mesh wire netting which shall be fixed to the insulation with brass 'U' nails.

4.5.5 The final finish shall be 12 mm sand cement plaster which shall be applied in two layers of 6 mm each and trowelled to a smooth round finish.

4.5.6 After the insulation is fixed on the head as above, it shall then be covered with a properly shaped jacket of 0.80 mm G.I. sheet. Pump casing shall be finished with aluminium cladding.

4.6 Insulation (Others)

The AHUs and the chilled water pumps shall be insulated as above in 4.5 and finished with plaster excepting that the insulation of 30 mm shall be fixed in a single layer.

5. Chilled Water Piping/Drain Piping :

5.1 The chilled water and drain pipes shall be insulated with 'TF' quality expanded polystyrene. The thickness of the insulation for chilled water pipes will be 50 mm and for drain pipes will be 25 mm.

5.2 Preformed pipe sections shall be used for pipes upto and including 350 mm dia.

5.3 Pipes above 350 mm dia. shall be insulated with insulation slabs cut in mitred sections.

5.4 Installation

Chilled Water and Drain Piping

- 5.4.1 The pipe shall be thoroughly cleaned with a wire brush and rendered free from all rust and grease.
- 5.4.2 The pipes shall be treated with a coat of cold setting compound.
- 5.4.3 The insulation preformed section shall be fixed tightly to the surface taking care to seal all joints.
- 5.4.4 All joints along the circumference of the pipe sections shall be sealed with adhesive.
- 5.4.5 The insulation than shall be covered with 0.63 mm x 19 mm mesh wire netting than finally finished with 12 mm sand cement plaster in two layers of 6 mm each and trolled to a smooth round finish.
- 5.4.6 Insulation on pipes in areas exposed to weather or underground shall additionally be covered with tar-felt sheets manufactured by shalimar tar products (1935) ltd. and fixed with G.I. wires of 1.0 mm. The tar felt sheet shall be stuck with bitumen r 85/25.

6. Refrigerant Piping:

- 6.1 The suction line of refrigerant piping shall be insulated with 50 mm thick expanded polystyrene as specified for chilled water pipe lines.

7. Ducting:

- 7.1 The air handling ducts shall be insulated with resin bonded glass wool with density not below 24 kg/cub.m.

- 7.2 Duct insulation thickness shall be as follows :

Duct in conditioned space	- 25 mm thick
Duct in unconditioned space	- 50 mm thick
Duct with treated fresh air	- 50 mm thick

7.3 Installation

- 7.3.1 Clean the surface with a wire brush and make it free from rust and oil.
- 7.3.2 Apply one coat of cold setting compound.
- 7.3.3 Wrap the duct with insulation blankets of the thickness mentioned in item 7.2 above and then with 250 g polythene sheet and covered with 0.1mm thick aluminium sheet using 50 mm wide aluminium adhesive tape of Johnson make.
- 7.3.4 Reinforce and tie with G.I. wire of 1.0 mm at intervals of 450 mm.

7.3.5 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.

8. **Acoustic Lining:**

8.1 The acoustic lining shall consist of 25 mm resin bonded glass wool of density 48 kg/cub.m (min) then it shall be covered by 0.5 mm perforated aluminium sheets having 3 mm perforation at 6 mm centres.

8.2 **Installation**

8.2.1 The duct surface shall first be cleaned from inside.

8.2.2 The insulation boards shall be wrapped in glass cloth of 7 mil thickness with the end stitched.

8.2.3 Then the boards shall be fixed inside the duct.

8.2.4 The insulation shall then be covered with 0.5 mm thick perforated aluminium sheets.

8.2.5 The sheet and the insulation shall be secured to the duct by means of cadmium plated bolts, nuts and washers. The ends should be completely sealed off, so that no insulation material is exposed.

9. **Walls and Ceiling Acoustic Treatments of Plant Rooms and A.H.U. Room**

9.1 **Material**

Resin bonded glass wool of density 32 kg/cub m of 50mm thickness.

10. **Installation:**

10.1 Fix 40 mm x 50 mm g.i. sheet channel at 0.5 mtr interval longitudinally then fix cross battens at 1.0 mtr centre using suitable gutties, and brass screws. The battens & gutties shall be treated with fire retardant chemical before fixing.

10.2 Fill each rectangle with 50 mm glass wool wrapped in glass cloth.

10.3 Tie with 24 gauge G.I. wires at 300 mm intervals.

10.4 Then cover with 26 gauge (0.50 mm) perforated g.i. sheet having 3mm perforations at 6 mm centres. Overlap all joints and provide beading of 25 mm by 2 mm flats.

ELECTRIC WIRING

1. General :

The electric wiring of motors for compressors, pumps, air handling units etc. As well as controls, heaters etc. and earthing of all equipment shall be carried out as per specifications given hereunder.

2. Power Cabling for Motors, Heaters etc :

- 2.1 Unless otherwise specified, the power cables shall be PVC insulated, and PVC sheathed aluminium conductor, armoured cables to 1100 V grade conforming to IS 1554. The power cables shall be of 2 core for single phase, 4 core for sizes upto and including 25 sq.mm, 3-1/2 core for sizes higher than 25 sq.mm for 3 phase. Where high voltage equipments are to be fed, the cables shall be rated for continuous operation at the voltages to suit the same.
- 2.2 Power cables shall be of sizes as indicated in the tender specifications. In all other cases, the sizes shall be as approved by the Engineer-in-Charge, after taking into consideration the load, the length of cabling and the type of load.
- 2.3 Cables shall be laid in suitable metallic trays suspended from ceiling, or mounted on walls, or laid directly in ground or clamped on structures, as may be required. Cable ducts shall not be provided in plant rooms. Cable trays shall be fabricated from slotted angle/solid angles to make ladder type cable tray, designed with adequate dimensions for proper heat dissipation and also access to the cables. Alternatively, cable trays may be of steel sheet with adequate structural strength and rigidity, with necessary ventilation holes therein. In both the cases, necessary supports and suspenders shall be provided by the Air-conditioning Contractor as required.
- 2.4 Cable laying work shall be carried out in accordance with IS 1255/1967, Indian standard code of practice. The scope of work for the Air-conditioning Contractor shall include making trenches in ground and refilling as required, but excludes any masonry trenches for the cable work.

3.0 CONTROL WIRING

- 3.1 Control wiring in the plant rooms and AHU rooms shall be done using control wire as per IS 1554 PVC insulated and PVC sheathed, 2.5 sq.mm copper conductor, 1100 V grade, cables drawn in ISI marked steel or PVC conduits. The control cables interconnecting the plant room and the AHU rooms shall be of multi-core armoured type only, and suitable for laying direct in ground.
- 3.2 The number and size of the control cables shall be such as to suit the control system design adopted by the Air-conditioning Contractor.
- 3.3 ISI marked steel conduit pipes, wherever used, shall be of gauge not less than 1.6 mm thick for conduits upto 32 mm dia and not less than 2.0 mm thick for higher sizes. All conduit accessories shall be threaded type with substantial wall

thickness.

- 3.4 Control cables shall be of adequate cross section to restrict the voltage drop.
- 3.5 Runs of control wires within the switchboard shall be neatly bunched and suitably supported/clamped. Means shall be provided for easy identification of the control wires.
- 3.6 Control wiring shall correspond to the circuitry/sequence of operations and interlocks approved by Engineer-in-Charge.
- 3.7 In cold storage involving temperatures below zero deg. C, polythene cables shall be used instead of PVC cables.

4.0 **Laying**

- 4.1 The cables shall be laid, as per drawings or along a short and convenient route between switch board and the equipment, either in trenches, on wall or on trays. Hangers, supported from the slab. Cable routing shall be checked on the site to avoid interference with structure, equipment etc. Where more than one cables are running close to each other, proper spacing should be provided between them
- 4.2 The radius of bends of the cable should not be less than 12 times the radius of cable to prevent undue stress and damage at the bends, the cables should be supported and fixed on M.S. supports, when running in trenches, wall or ceiling suspended hangers when laid under ground the cables should be covered with sand and protected with cement concrete covering. Suitable G.I. pipe shall be used wherever cable is laid across road, crossing of other services and when passing through R.C.C.
- 4.3 Wooden bushes shall be provided at the ends of pipes through which cables are taken.

5. **Earthing :**

5.1 **Pipe Earth Electrode**

G.I. pipe shall be of medium class 40 mm dia 4.5 m. long in length. galvanising of the pipe shall conform to relevant is. G.I. pipe electrode shall be cut tapered at the bottom and provided with holes of 12 mm dia drilled not less than 7.5 cm from each other upto 2m of length from bottom. The electrode shall be buried in the ground vertically with its top not less than 20 cms below ground level.

5.2 **Plate Earth Electrode**

For plate electrode minimum dimensions of the electrode shall be as under :

- i. G.I. plate electrode : 60cm x 60cm x 6mm thick.
- ii. Copper plate electrode: 60cm x 60cm x 3mm thick.

The electrode shall be buried in ground with its faces vertical and top not less than 3 m below ground level.

In case of plate earth electrode a watering pipe of 20 mm dia of medium class gi pipe shall be provided and attached to the electrode. A funnel with mesh shall be provided on top of this pipe for watering the earth. In case of pipe electrode a 40mm x 20mm reducer shall be used for fixing the funnel. The watering funnel attachment shall be housed in massonary enclosure of not less than 30cm x 30cm x 30cm. A cast iron/ms frame with cover having locking arrangement shall be suitable embedded in the massonary enclosure.

5.3 Loop Earthing

Loop earthing shall be providing for all mountings of main board and other metal clad switches and db's with G.I. strip of size specified but not less than 14 swg copper or 12 swg gi or 4 sq mm aluminium wite. The earthing lead from electrode owner's shall be suitably protected from mechanical injury by a 15 mm dia g.i.pipe in case of wire and 40 mm dia medium class G.I. pipe in case of strip. Metallic covers or supports of all medium pressure or ht apparatus or conductor shall in all cases be connected to not less than two separate and distinct earths.

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

Earthing should be carried out as per is-3043

Size of phase wire sq.mm aluminium tape/wire (swg)	Size of G.I. conductor
185	25 mm x 4 mm (strip)
150	25 mm x 4 mm (strip)
120	20 mm x 3 mm (strip)

Size of phase wire sq.mm	Size of G.I. conductor aluminium tape/wire (swg)
95	20 mm x 3 mm (strip)
70	4 swg
50	4 swg
35	6 swg
25-6	6 swg
4	8 swg

6. Miscellaneous :

6.1 The final connections to the equipment shall be through flexible connections where the equipment is likely to be moved back and forth, such as on slide rails.

- 6.2 An isolator switch shall be provided at any motor which is separated from the main switch panel by a wall or partition or other barrier or is more than 15 metres away from the main panel.
- 6.3 Two separate and distinct earthing conduits shall be connected from the equipment upto the main switch board panel.
- 6.4 The entire installation shall be tested as per electricity rules and I.S. 732-1973/is-3043 with amendments 1,2&3 prior to the commissioning of the plant and a suitable test report furnished by competent local authorities. The test report will be obtained by contractor himself at his own expenses.
- 6.5 All exposed hangers etc. shall be given 2 coats of suitable paint of approved colour, when all work has been completed.

TESTS AT SITE

1. **General :**

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

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

- 2.1 Identification of materials in accordance with test certificates.
- 2.2 Inspection of various laboratory test certificates for physical properties and technical composition conducted on test samples of materials to be used for fabrication, forgings etc. for all important components of various equipment.
- 2.3 Hydraulic test for various components and assembled equipments at 1.5 times design pressure or double the operating pressure whichever is higher.
- 2.4 Pneumatic leak test after assemblies at design pressure
- 2.5 Static and dynamic balancing on electronic precision machine for rotating parts, links, impellor/crank shaft assemblies etc.
- 2.6 Inspection of assemblies and dis-assemblies of various parts of equipments and complete equipments themselves as desired by inspection engineer.
- 2.7 Noise level test for various rotating/reciprocating equipments.
- 2.8 Pressure drop test for condenser, chiller and evaporator.
- 2.9 Inspection of manufacturer's test certificates shall be supplied for all electrical motors.
- 2.10 Inspection of welding including welders qualifications as desired by inspection engineers.
- 2.11 For compressor assembly, electronic leak, air running test, pneumatic test with dry nitrogen and leak test in water.

3. **Air Handling Units:**

3.1 **Blowers**

- 3.1.1 Identification of material in accordance with test certificates.
- 3.1.2 Dynamic/static balancing of impeller.
- 3.1.3 Performance test as per applicable codes.

3.2 **Coils**

3.2.1 Identification of material in accordance with test certificates.

3.2.2 Pneumatic test.

3.3 **Filters**

3.3.1 Manufacturer's test certificates also to be produced for the assembled A.H.U. final dimensional check will be done. Inspection will be done during assembly of components for quality of workmanship, painting etc.

Piping : materials check for specifications and size.

3.4 **Valves**

Hyd./Pneumatic test certificates.

3.5 **Motors**

Manufacturer's test certificate as per motor data sheet.

3.6 **Instruments and Controls**

Visual examination.

4. **For Associates Works at Site :**

4.1 All electrical items will be subjected to inspection at any stage during manufacturing activity. Routine electrical test as per relevant codes. Inspection of manufacturer's test certificates.

4.2 Inspection of raw materials to be used for fabrication and assembly and inspection of manufacturer's certificates.

4.3 Inspection of welding including welders qualification as desired by inspection engineers. Inspection of fabricated items.

4.4 Pressure testing of pipe fit used for the refrigerant and water services.

4.5 Pressure testing, leak testing of complete piping network for chilled water. Condenser water and refrigerant/services.

4.6 Vacuuming and gas/oil charging for refrigeration system.

4.7 Checking of electrical circuits (power & controls) and checking functioning of controls of refrigerant systems and other circuits of air conditioning plant.

4.8 Checking of calibration of controls and instrumentation

- 4.9 Checking of assemblies for electrical control panel, instruments panels, local panels (dimensional and functional) annunciator panels etc.
- 4.10 Inspection of complete electrical installation at site.
- 4.11 Installation of main equipments like compressor, condenser, chiller, evaporator.
- 4.12 Performance testing of complete A/C plant as per specifications.
5. The above inspection procedure is given for general guidance and information of vendors and inspection of purchaser/consultant is strictly not limited to these and inspection engineer of purchaser/consultant will have full right to have detailed inspection at any stage right from placement of order to completion of project as desired by inspection engineer, co-ordination of inspection agency of purchaser/consultant with his factory/sub-vendor's factory/erection site will be the sole responsibility of successful vendor after placement of order for complete air conditioning plant covered under these technical specifications.
6. **Piping System:**
- 6.1 In general pressure tests shall be applied to piping only before connection of equipment and appliances. In no case shall piping, equipment or appliances be subjected to pressure exceeding their test ratings.
- 6.2 Tests shall be completed and approved before any insulation is applied.
- 6.3 After tests have been completed, the system shall be drained and cleaned of all dust and foreign matter. All strainers, valves and fittings shall be cleaned of all dirt, fittings, and debris.
- 6.4 **Water Piping**
- All water piping shall be tested and proven tight under hydrostatic pressure of 1 1/2 times the design pressure unless stated otherwise in the specifications. Prescribed pressure shall be maintained for four hours.
7. **Duct Work:**
- 7.1 All branches and outlets shall be tested for air quantity, and the total of the air quantities shall be within plus five percent (5%) of fan capacity.
- 7.2 Fire dampers, volume dampers and splitter dampers shall be tested for proper operation.
8. **Balancing and Adjustment:**
- All air handling ventilation equipment, duct work and outlets shall be adjusted and balanced to deliver the specified air quantities indicated, at each inlet and outlet, on the drawings. If these air quantities cannot be delivered without exceeding the

speed range of the sheaves or the available horse power, the architect shall be notified before proceeding with the balancing of air distribution system.

9. **Electrical Equipment:**

- 9.1 All electrical equipment shall be cleaned and adjusted on site before application of power.
- 9.2 The following tests shall be carried out:
 - 9.2.1 Wire and cable continuity tests.
- 9.3 Insulation resistance tests, phase to phase and phase to earth, on all circuits and equipment, using a 500 volt meggar. The meggar reading shall be not less than one megohm.
- 9.4 Earth resistance between conduit system and earth must not exceed half (1/2) ohm.
- 9.5 Phasing out and phase rotation tests.
- 9.6 Operating tests on all protective relays to prove their correct operation before energising the main equipment.
- 9.7 Operating tests on all starters, circuit breakers, etc.

10. **Performance Tests:**

- 10.1 The installation as a whole shall be balanced and tested upon completion, and all relevant information, including the following shall be submitted to the architects.
 - 10.1.1 Air volume passing through each unit, duct, grilles, apertures.
 - 10.1.2 Differential pressure readings across each filter, fan and coil, and through each pump.
 - 10.1.3 Static pressure in each air duct.
 - 10.1.4 Electrical current readings, in amperes of full and average load running, and starting, together with name plate current of each electrical motor.
 - 10.1.5 Continuous recording over a specified period, of ambient wet and dry bulb temperatures under varying degrees of internal heat loads and use and occupation, in each zone of each part of the building.
- 10.2 Daily records should be maintained of hourly readings, taken under varying degrees of internal heat load and use and occupation, of wet and dry bulb temperatures, upstream "on-coil" of each cooling coil. Also suction temperatures and pressures for each refrigerating unit. The current and voltage drawn by each machine.
- 10.3 Any other readings shall be taken which may subsequently be specified by the

architect.

11. Miscellaneous:

- 11.1 The above tests are mentioned herein for general guidance and information only but not by way of limitation to the provisions of conditions of contract and specification.
- 11.2 The date of commencement of all tests listed above shall be subject to the approval of the architect, and in accordance with the requirements of this specification.
- 11.3 The contractor shall supply the skilled staff and all necessary instruments and carry out any test of any kind on a piece of equipment, apparatus, part of system or on a complete system if the architect requests such a test for determining specified or guaranteed data as given in the specification or on the drawings.
- 11.4 Any damage resulting from the tests shall be repaired and/or damaged material replaced, all to the satisfaction of the Engineer.
- 11.5 In the event of any repair or any adjustment having to be made, other than normal running adjustment, the tests shall be void and shall be recommended after the adjustment or repairs have been completed.
- 11.6 The contractor must inform the architect when such tests are to be made, giving sufficient notice, in order that the architect or his nominated representative may be present.
- 11.7 Complete records of all tests must be kept and 3 copies of these and location drawings must be furnished to the architect.
- 11.8 The contractor may be required to repeat the test as required, should the ambient conditions at the time not given, in the opinion of the architect, sufficient and suitable indication of the effect and performance of the installation as a whole or of any part, as required.

MODE OF MEASUREMENTS

1. Unit Prices in the Schedule of Quantities:

- 1.1 The item description in the schedule of quantities is in the form of a condensed resume. The unit price shall be held to include every thing necessary to complete the work covered by this item in accordance with the specifications and drawings. The sum total of all the individual item prices shall represent the total price of the installation ready to be handed over.
- 1.2 The unit price of the various items shall include the following:
 - 1.2.1 All equipment, machinery, apparatus and materials required as well as the cost of any tests which the consultant may request in addition to the tests generally required to prove quality and performance of equipment.
 - 1.2.2 All the labour required to supply and install the complete installation in accordance with the specifications.
 - 1.2.3 Use of any tools, equipment, machinery, lifting tackle, scaffolding, ladders etc. required by the contractor to carry out his work.
 - 1.2.4 All the necessary measures to prevent the transmission of vibration.
 - 1.2.5 The necessary material to isolate equipment foundations from the building structure, wherever necessary.
 - 1.2.6 Storage and insurance of all equipment apparatus and materials.
- 1.3 The contractor's unit price shall include all equipment, apparatus, material and labour indicated in the drawings and/or specifications in conjunction with the item in question, as well as all additional equipment, apparatus, material and labour usual and necessary to make in question on its own (and within the system as a whole) complete even though not specifically shown, described or otherwise referred to.

2. Measurements of Sheet Metal Ducts, Grilles/Diffusers etc.

2.1 Sheet Metal Ducts

- 2.1.1 All duct measurements shall be taken as per actual outer duct surface area including bends, tees, reducers, collars, vanes & other fittings. Gaskets, nuts, bolts, vibration rotation pads are included in the basic duct items of the BOQ.
- 2.1.2 The unit of measurements shall be the finished sheet metal surface area in metres squares. No extra shall be allowed for lapse and wastages.
- 2.1.3 All the guide vanes, deflectors in duct elbows, branches, grille collars quadrant dampers etc. shall be measured for actual sheet metal surface and paid for at the

same rate as duct of same thickness.

- 2.1.4 The unit duct price shall include all the duct hangers and supports, exposing of concrete reinforcement for supports and making good of the same as well as any materials and labour required to complete the duct frame.

2.2 **Grilles/Diffusers**

All grilles/diffusers as per tender requirements shall be treated as a lump sum item. Where extra grilles diffusers are ordered upto award of work, they should be measured as follows:

- 2.2.1 All measurements of grilles/diffusers shall be the actual neck size excluding the outer flanges.
- 2.2.2 The square or rectangular grilles/diffusers shall be measured in plain sq.m.
- 2.2.3 All round diffusers shall be measured by their diameters in cm.
- 2.2.4 All linear diffusers shall be measured as per actual length in metres.

3. **Measurements of Piping, Fittings, Valves, Fabricated Items:**

3.1 **Pipe**

Including water piping, steam piping and all other piping required to be executed at site for completion of the works.

- 3.1.1 All pipes shall be measured in linear metre (to the nearest cm) along the axis of the pipes and rates shall be inclusive of all fittings e.g. tees, bends, reducers, elbows etc. deduction shall be made for valves in the line.
- 3.1.2 Exposing reinforcement in wall and ceiling and floors of possible and making good the same or installing anchor fasteners and inclusive of all items as specified in specifications and schedule of quantities.
- 3.1.3 Rates quoted shall be inclusive of providing and fixing vibration pads and wooden pieces, wherever specified or required by the project co-ordinator.
- 3.1.4 Flexible connections, wherever required or specified shall be measured as part of straight length of same diameter, with no additional allowance being made for providing the same.
- 3.1.5 The length of the pipe for the purpose of payment will be taken through the centreline of the pipe and all fittings (e.g. tees, bends, reducers, elbows, etc.) as through the fittings are also presumed to be pipe lengths. Nothing extra whatsoever will be paid for over and above for the fittings for valves and flanges, section 3.2 below applies.

3.2 **Valves and Flanges**

- 3.2.1 All the extra ci & cm flanged valves shall be measured according to the nominal size in mm and shall be measured by number. Such valves shall not be counted as part of pipe length hence deduction in pipe length will be made wherever valves occur.
- 3.2.2 All gun metal (gate & globe) valves shall include two Nos. of flanges and two numbers 150 mm long ms nipples, with one side threaded matching one of the valves, and other welded to the M.S. slip-on-flange. Rate shall also include the necessary number of bolts, nuts and washers, 3 mm thick insertion gasket of required temp. grade and all items specified in the specifications.
- 3.2.3 The rates quoted shall be inclusive of making connections to the equipment, tanks, pumps etc. and the connection made with an installed pipe line shall be included in the rates as per the b.o.q.

3.3 **Structural Supports**

Structural supports including supports fabricated from pipe lengths for pipes shall be measured as part of pipe line and hence no separate payment will be made. Rates shall be inclusive of hoisting, cutting, jointing, welding, cutting of holes and chases in walls, slabs or floors, painting supports and other items as described in specifications, drawings and schedule of quantities or as required at site by project co-ordinator.

3.4 **Copper Connections for Fan Coil Units**

- 3.4.1 Copper connection assembly for making connections to the fan coil units shall be measured, as part of the fan coil unit price and shall include brass flare nuts, brass straight connector, brass tees, brass reducing fittings, fixing of automatic 3 way valve, making connections and leak testing, complete assembly as per specifications and drawings. Nothing extra shall be payable on account of any variation in the length of copper pipe.

4. **Insulation:**

- 4.1 The measurement for vessels, piping, and ducts shall be made over the bare uninsulated surface area of the metal.

4.2 **Pipes, Ducts & Vessels**

4.2.1 **Pipes**

The measurements for installation of piping shall be made in linear metres through all valves, flanges, and fittings. Pipes/bends shall be measured along the centreline radius between tangent points. If the outer radius is r_1 and the inner radius is r_2 the centre line radius shall be measured as $(r_1+r_2)/2$. Measurement of all valves, flanges and fittings shall be measured with the running metre of pipe line as if they are also pipe lengths. Nothing extra over the above shall be payable for insulation over valves, flanges and fittings in pipe line/routings. Fittings that connect two or

more different sizes of pipe shall be measured.

4.2.2 **Ducts**

The measurements for insulation of ducts shall be made in actual square metres of bare uninsulated duct surface through all dampers, flanges and fittings. In case of bends the area shall be worked out by taking an average of inner and outer lengths of the bends. Measurements for the dampers, flanges, fittings shall be for the surface dimension for the connecting duct, nothing extra over the above shall be payable for insulation over dampers, flanges and fittings in duct routing.

4.2.3 **Vessels**

The area of standard dished and flat ends of vessels shall be the square of the diameter of the uninsulated body of the shell. Areas for other shapes shall be the actual calculated area. There shall be no deduction or additions for nozzles, handles ribs, dampers, expansion joints etc. All projections on vessels or tanks shall be measured separately as pipe/duct.

4.3 **Accessories Insulation**

4.3.1 The unit of measurement for accessories such as expansion tank, pumps, chiller heads etc. shall be uninsulated are in square metres.

4.3.2 In case of curved or irregular surfaces, measurements shall be taken along the curves.

4.3.3 The unit insulation price shall include all necessary adhesives, vapour proofing and finishing materials as well as additional labour and material required for fixing the insulation.

4.4 **Acoustic Duct Lining**

4.4.1 In case of acoustic lining of air ducts, measurements of the bare inside duct surface in square metres shall be final for billing purposes.

4.4.2 The insulation/acoustic panels shall include cost of battens, supports, adhesives, vapour proofing, finished tiles/boards/sheets as well as additional labour and materials required for completing the work.

SCHEDULE OF EQUIPMENT

S.No	Description	Unit	Condition of Services
1.0	Water Chilling Unit :(Screw Type with water cooled condenser)		
1.1.1	Type	---	Screw Type
1.1.2	Quantity	Nos.	2 (1 Working + 1 Stand By)
1.1.3	Capacity (each)	TR	200 (actual)
1.1.4	Refrigerant		R134a
1.2	Motor (Per Unit)		
1.2.1	Type		Double Wound Sq. Cage
1.2.2	Rating	KW	To suit above
1.2.3	Qty. of comp. & motor per m/c	Nos.	Minimum two
1.2.4	Starting Current	Amps	not to exceed 2 times the full load current
1.2.5	Power consumption	IKW/TR	0.7 (Max)
1.3	Chiller (Per Unit)		
1.3.1	Water quantity	usgpm	480
1.3.2	Water temp in	° c	12.8
1.3.3	Water temp out	° c	7.2
1.3.4	Pressure drop	m	5
1.3.5	Fouling factor	(fps)	0.0005
1.4	Condenser (Per Unit)		
1.4.1	Water quantity	usgpm	800
1.4.2	Water temp in	° c	32.2
1.4.3	Water temp out	° c	36.3
1.4.4	Pressure drop	m	5
1.4.5	Fouling factor	(fps)	0.001

2.0 Hot water generator

Design Features

Application	Winter Heating/ Mansoon reheating
Minimum capacity	180 KW
Location	Plant room
Numbers Required	(1W + 1 S)
Water Flow Rate	180 Usgpm
Water Temperature	
Out	125 deg F
In	110 deg F

3.0 Pumps

3.1 Primary Chilled Water Pump

a.	Type	:	End suction back pull out Vertical discharge type
b.	Quantity (No.)	:	2 (1 W + 1 stand by)
c.	Capacity, USGPM	:	480
d.	Operating Head, m wg.	:	14 m
e.	Speed RPM	:	1450
f.	Motor H.P.	:	To suit duty
g.	Motor type	:	TEFC
h.	Power supply	:	415 V/50Hz/3Ph/AC

3.2 Secondary Chilled Water Pump

a.	Type	:	End suction back pull out Vertical discharge type
b.	Quantity (No.)	:	2 (1 W + 1 stand by)

- d. Capacity, USGPM : 480
- d. Operating Head, m wg. : 25 m
- e. Speed RPM : 1450
- f. Motor H.P. : To suit duty
- g. Motor type : TEFC
- h. Power supply : 415 V/50Hz/3Ph/AC

3.3 Condenser Water Pump

- a. Type : End suction back pull out Vertical discharge type
- b. Quantity (No.) : 2 (1 W + 1 stand by)
- c. Capacity, USGPM : 800
- d. Operating Head, m wg. : 16
- e. Speed RPM : 1450
- f. Motor H.P. : To suit duty
- g. Motor type : TEFC
- h. Power supply : 415 V/50Hz/3Ph/AC

3.4 Hot Water Pump

- a. Type : End suction back pull out Vertical discharge type
- b. Quantity (No.) : 2 (1 W + 1 stand by)
- e. Capacity, USGPM : 180
- d. Operating Head, m wg. : 25 m
- e. Speed RPM : 1450
- f. Motor H.P. : To suit duty
- g. Motor type : TEFC

h. Power supply : 415 V/50Hz/3Ph/AC

4.0 Double Skin Air handling Unit:

AHU TAG NO.	AREA SERVED	AIR QTY CFM	No. of Rows deep	Static pressure (mm wg)	Filtration Levels	QTY
<u>Basement</u>						
AHU-1	Animal holding	11650	4+4	135	3	2
AHU-2	Animal holding	7600	4+4	135	3	2
<u>Ground</u>						
AHU-3	Animal holding	3250	4+4	125	3	1
AHU-4	Office areas	2300	4	40	1	1

5.0

SCHEDULE OF EXHAUST FANS				
S.No	Area served	Static Pressure	AIR QTY	QTY (NOS.)
	Basement	mm wg.		
	Animal Holding Area etc.	60	8000 CFM	2 NO.
	Animal Holding Area etc.	60	12500 CFM	2 NO.
	Ground Floor			
	Ground floor area	50	2000 CFM	1 NO.
	Wet exhaust system for cage wash area	50	1500 CFM	1 NO.

LIST OF APPROVED MAKES AND MANUFACTURERS

The subcontractors/makes/brands of equipment listed below are approved for installation.

All items to be used in the works samples, catalogues and specifications are to be submitted by the contractor for approval of the Engineer. Only approved makes shall be used in the works. The approved samples shall be kept in the custody of the Engineer for comparison.

ITEM	APPROVED MAKES/SUBCONTRACTORS
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Subcontractors:	Voltas/ ETA/ Blue Star/ Suvidha/ Sterling & Wilson/ Unique Engineers
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Water chilling machines

Screw Type water chilling machine	Carrier / Dunham Bush / Mcquay / York / Trane
Air Handling Unit all types with heating/cooling coils	Carrier Aircon/Caryaire/Blue Star/ZECO/Saiver/Waves
Centrifugal fan of double skin type AHU.	Nicotra/Comefri/Flakt/Kruger/GEC
Air Washer	Roots Cooling / Ambassador / Humidin
Scrubber system	Thermax / Peema / Batliboi
End suction back pull out pump	Kirloskar/Beacon-weir/Mather & Platt/KSB/Greaves
Pumps coupled with VFD	ITT / Bell & Goset / Grundfos/wilo
VFD for AHUs	Danfoss/Siemens/AllenBradley/ABB
Humidifier	Rapid cool/Emerald/Khokar
FCUs	Hitech/Blue Star/Carrier/Zeco/Voltas

Ventillation Fans

Centrifugal fan	Swent / Krugger/Flakt/ Nicotra /Nadi / Divine/ comefri
Inline Fan	Krugger/Flakt/ Nicotra/system air

Propeller Fan	GEC(Alsthom)/Crompton Greaves/ Khaitan/Usha/Polar
Axial Fan	Krugger/ Flakt/ Nicotra
Pipes	
GI	ITC/ Jindal/Tata/SAIL/HSL
MS upto 150 mm dia	ITC/ Jindal/Tata/SAIL/HSL
MS 200 to 300 dia	ITC/ Jindal/Tata/SAIL/HSL
GI Sheets	TATA/SAIL/Jindal/Bhushan Steel
Aluminium Sheet	Balco/Nalco/Hindalco
Grilles/Diffusers	Ravistar/Caryaire/ Mapro/Dynacraft/Servex
Fire dampers (Motorized)	Caryaire/Dynacraft / Ravistar
Cooling Tower	Paharpur/Bell/Mihir/Aadi/Advance
Electric Hot Water Generator	Rapid cool/Emerald/Khokar
Window /Split Airconditioner	Carrier Aircon/LG/Hitachi/Voltas/Bluestar
Valves	
Gate Valve	Leader/Divine/Sant/Bankim Sarkar
Butterfly Valves	Advance/Castle/Audco/Intervolve /Arrow/C&R
Balancing Valves	Advance/Castle/Audco/Arrow/C&R
Non-return Valves	Advance/Castle/Kirloskar/C&R/Arrow
Pot & Y- Strainer	Emerald/Sant/Rapid cool
Three way mixing valves	Staefa/Johnson/Honeywell/Danfoss/Anergy/Rapid controls
Two way motorized valve	Staefa/Johnson/Honeywell/Danfoss/Anergy/Rapid controls
Actuating motor for 3 way & 2 way valve	Staefa/Johnson/Honeywell/Danfoss/Anergy
Ball Valve with & without strainer	Rapid Control/Sant/Leader

Insulation

Fibre glass	FGP Ltd./UP Twiga/Kimmco / Owens Corning
Expanded Polystrene	Beardsell Ltd./ BASF/Styrene Packing/ Indian Packaging Industries/ Lloyd
Air Filters	Thermadyne/Klenzaid/Kirloskar /Anfilco/Johnflower/Dynafilter
Thermometers/Pressure Gauge	Fiebig/Emerald/H Guru/Japsin
Thermostats/Humidistats	Honeywell/Penn /Staefa/Johnson/ Anergy/Rapid Controls
Electric Strip Heaters	Escorts/Daspass
Controls	Honeywel/ Johnson / Staefa
Electric Panels	CPRI approved make (To be approved by HSCC)
Electric Motors	Siemens/Kirloskar/ABB/ Bharat Bijlee. /Crompton Greaves
Starters/Contactors	L&T/ GE Power/ Siemens/ ABB
ACB/MCCB	L&T/ GE Power/ Siemens/ ABB
Switch Fuse/ Fuse Switch Units	L&T/ GE Power/ Siemens/ ABB

Cables

Power Cables & Control cable	CCI/Universal/ICC/NICCO/INCAB/ National/Rallison Cables
Lamps & Push Buttons Relays Current Transformer/ Ammeter/Voltmeter	L&T/GE/ Siemens/ Schneider