

**DEPARTMENT OF HEALTH & FAMILY WELFARE,
GOVT. OF HIMACHAL PRADESH**

TENDER

FOR

**Construction of Dr. Y. S. Parmar Government
Medical College at Nahan, District Sirmour,
Himachal Pradesh & Pt. Jawaharlal Nehru
Govt. Medical College at Chamba, District
Chamba, Himachal Pradesh**

VOLUME – IV

TECHNICAL SPECIFICATIONS

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Tender No. HSCC/DHFW/NAHAN & CHAMBA /HP/2017

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, mumty 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 correlated 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.
- 1.22 The agency will have to take prior approval of the Engineer/ Architect for the make of materials before procurement of the same. It may also be noted that if any of the makes given in the List of Makes does not comply with Standards, it will not be allowed to use. No claim what so ever shall be entertained on this account.

2.0 LAMINATED FLOORING

Manufacturing Standards

Laminate flooring panels must be manufactured in conformance with the European Standard of Laminate Flooring EN 13329:1998. The European Standard Specifies characteristics, requirements, and gives test methods for laminate floor coverings. It includes a classification system, based on EN 685, giving practical requirements for areas of use and levels of use. Laminate flooring panels must be abrasion tested according to the above standard and meet or exceed the requirements for the Abrasion.

Preliminary

Remove wrapping and lay flooring panels out flat at room temperature for 48 hours. Check all panels for defects. and ensure the surface to be covered with panels is clean, smooth, and level. Uneven areas must be levelled. Do not install over carpets. Remove carpet along with any residual adhesive material and install on smooth, firm surface.

Concrete Surfaces

A 'Patch Test' must be performed on concrete sub-floors. If there is any evidence of moisture, the concrete must be treated with an appropriate sealer. NOTE: DO NOT install laminates floor if patch test reveals moisture build up, until concrete is sealed.

It is recommended that a moisture barrier (Poly) be placed all over concrete sub-floors to protect against any possible moisture emissions.

Moisture Barrier

To protect panels against moisture form surfaces where moisture is likely to occur, a moisture barrier must first be placed over the base surface. Use 6-milH (0.2mm) polyethylene film. Overlap the edges of the polyethylene by a minimum of 8 inches and seal the junction with moisture proof self-adhesive tape. Use on concrete floors and at floors below grade or other areas where condensation or moisture emission may occur.

A moisture barrier should be installed over floors with radiant heat. Before laying the barrier, turn heat down to 16 C (60 F) one week before. Keep the temperature below 27 C (80 F) at all times.

Underlayment

Panels must be installed on top of underlayment .Use a good quality underlayment (Cork or High Density Foam). Underlayment seams should not overlap and should be taped with self-adhesive tape. If installing both a moisture barrier and underlayment, place the underlayment on top of the moisture barrier, or preferably use a reliable combination product.

Underlayment - is a clear thin plastic sheet that is installed over the substrate before the laminate floor is floated. The plastic sheet helps the laminate floor to float freely above the substrate.

Installation

First Row: Measure the row before the first panel. Cut the first panel according to the length required for the last panel. Measure for straightness and cut the panels to make sure the inner edge of the first row panels is square before starting second row. Measure the last row of the panel width first. Then cut first row panels to the same width as the last row. Position the first row panels along one wall, leaving space for expansion between panels and the wall. Lock the ends of the panels together until the first row is finished.

Second Row: The first panel of the second row should be long enough so the ends of the second row panels reach past the end seams of the first row panels. If the remaining section

of the last panel of the first row is long enough, use it for the first panel of the second row; Line up the first panel of the second row so the outside end is even with the outside end of the first panel of the first row. After locking in place, lay the remaining panels of the row by first locking the long side in place and then tapping the end of the panel and slide it into firmly into place at its end; and

Lay each of the panels of the remaining middle rows.

Last Row: Because the width of the last row may be less than that of the previous rows, it may be necessary to cut the panels of the last row to the appropriate width .See instructions for first row

Expansion

Because changes in heat and humidity will cause laminate panels to expand and contract in both length and width, expansion spaces must be allowed on all sides of the installed floor. The use of spacers inserted between the panels and perimeter wall is recommended. The spacers should be removed after the panels are installed and before mouldings are attached to the walls. For rooms up to 25 feet (7.6 meters) in width and 40 feet (12.2 meters) long, allow for expansion between 3/8" and 5/8" (10 mm to16 mm) along each wall.

Expansion Joints

For floors more than 25 feet (7.6 meters) wide or more than 40 feet (12.2meters) long, an additional expansion joint must be inserted. Expansion joints are also required in doorways, and between adjoining rooms or areas where adjacent flooring is installed. Use a T-moulding to cover the expansion joint.

Pipes And Other Obstacles

When installing a laminate panel around a pipe or other obstacle, leave the same expansion gap as you would next to a wall, Measure and, precut the affected panel If there is condensation from pipe, cut the panel so there is sufficient space to keep the panel dry. Fill the space around a pipe with a caulking in order to protect the exposed (cut) edge of the panel.

Directions of Panels

For appearance, panels should be installed so the length direction of the panels is the same as the length direction of the room or as shown in the drawing.

Preparation

- Measure doors for clearance of Installed panels. Cut away doorframe and jambs at the bottom if necessary. Remove existing baseboards.
- Surface should be clean, smooth, and level surfaces with slopes steeper than 12.5mm over 1.62m (1/2* over 5') must be levelled. Measure the perimeter of the room to determine room's squareness, and the required width of the last row of panels. Allow for expansion gaps along each wall.
- Install tongue-and-groove panels, attach the tongue on one panel to the groove side of the other panel and the panels will lock snugly together.
- Start with the panel flat on the floor, decor surface up, and the groove side away from the wall. Insert the tongue of the second panel partially into the groove on the first, while holding the second panel at about a 20 angle from the floor. Press the second panel down and use a hammering block to lock firmly into place. (Reverse the procedure to release.) Continue in a similar fashion for the remaining panels.

Mouldings

Transition moulding should be used for the following purpose:

Reducer: Use in from laminate floor to linoleum or other type of hard surface.

T4Moulding: Use In doorways, between rooms and with adjacent floors, and expansion joints.

Stair Nosing: Use at the edge of each step in a staircase.

End molding: Use for transition form laminate floor to other types of floor covering,

Baseboard: Use at the base wail.

NOTE: Always fasten baseboard to the wall, never to the floor.

Measurement:

Length and breadth shall be measured correct to a centimeter. Height of dado shall be measured correct to a centimeter, and the height of skirting shall be measured correct to 5 mm. The area shall be calculated in sqm. Correct to two places of decimals. Length and height shall be measured along the finished face of skirting or dado.

Rates:

The rate of above item shall include the cost of all material and labour involved in all the operations described above.

3.00 Signages and associated works

General

1. The sign board shall be in both English and Hindi language
2. Suitable pictogram to be provided as per approved samples
3. The colour of signages to be as per discretion of Engineer.
4. All signages details including sizes of sheet, letters, pictogram and border allround to be submitted and got approved priorly from HSCC.
5. The quoted rate shall be for all heights and floor levels.
6. The scope of work include providing and fixing base frame with removable/ interchangeable signages. Which will be paid in respective items

PVC sheet / sun board

1. Sheet to be best available brand of minimum thickness 3mm.
2. Top vinyl film to be best available brands of LG, Samsung or equivalent.
3. The thickness of film without adhesive to be around 75 microns and with adhesive to be 100 microns.
4. The fixing to be done with screws / hanging chains/pipes/rods of approved make & material as per discretion of Engineer.
5. The rates to be quoted per square inch inclusive of pictogram & fixing up to any floor and height, wall fixing or hanging on ceiling.

MS

1. The make of material to be as approved by engineer.
2. The thickness of GI sheet to be at least 18 G.
3. The shop drawings of supporting structural frame and its foundation for signages to be submitted for approval by HSCC.

4. The welding joints to be rubbed and grinded to give a smooth finish. No undulations shall be visible.
5. The MS frame and sheets to be primered and painted with approved make material.
6. The rates shall be inclusive of above and fixing with cement concrete 1: 1.5 : 3 as per approved design.
7. The rate for structural frame to be quoted separately per kilograms and signage sheet in square meters.

Stainless steel

1. The thickness of sheet to be minimum 16 G for plate sign board and 18/20 G for SS letters.
2. The same to be fixed with SS screws.
3. The engraving of letters to be as per standard norms and colours.
4. The individual alphabets/ letters, wherever required to have an inbuilt arrangement for fixing to support base with stainless steel screws complete for all heights and levels. All corners to be smoothly finished & SS welding.
5. The sheet/letters may be shining or mat finish as approved by engineer.

Aluminum

The thickness of sheet to be minimum 3mm.

1. Fixing to be done with SS or appropriate screws to avoid bimetallic action with aluminum.
2. The rates to be quoted per square meter.
3. The hanging aluminum hollow section to be of 100mm and 150mm width & make to be got approved. The powder coating of approved colour to be done and letters of approved specs and design to be pasted on such hanging aluminium hollow sections.
4. The hanging will be done by adjustable MS/GI rods of approved diameter and painting thereafter

Neon Glow signages

1. The diameter of tube to be got approved.
2. Make to be got approved.
3. Matter to be got approved.
4. To be made from 100% handcraft glass.
5. Rate to include electric wiring to illuminate complete in all respect as directed.

SAMPLES OF ALL MATERIALS, LETTERS MATTERS AND DESIGNS TO BE GOT APPROVED by ARCHITECT/ CLIENT BEFORE EXECUTION OF WORK.

4.00 LIST OF APPROVED MAKES : CIVIL WORKS

S.No	Material	Recommended Makes
1	Doors & Windows fixtures/ Fittings	Dorma, Godrej, Arkay, Hafele, Ozone, Hettich
2	Door Closer / Floor spring	Dorma, Godrej, Dorset, D-Line, Hardwyn
3	Aluminium Sections.	Hindalco, Jindal, Indal
4	Clear Glass/ Clear Float Glass/ Toughened Glass	Saint Gobain, Asahi, Pilkington, Glaverbel, Modi Guard
5	Laminates	Greenlam, Merino, Formica, Kitply, Century
6	Synthetic Enamel Paints	Asian, Berger, ICI, Nerolac
7	Oil Bound Distemper	Asian, Berger, ICI, Nerolac
8	Cement Paint	Snowcem plus, Asian, Berger
9	Plastic Emulsion Paint	Asian, Berger, ICI, Nerolac
10	Other Paints/Primers	Asian, Berger, ICI, Nerolac, Shalimar
11	OPC 43 Grade Cement (Conforming to IS 8112)	ACC, Ultratech, Vikram, Shree Cement, Ambuja, Jaypee Cement, Century Cement & J.K.Cement
12	Reinforcement Steel (TMT Bars)	SAIL, RINL, TISCO
13	Glass Mosaic Tiles	Bissazza, Mridul, OpioMosaica, Paladio, Italia
14	MS Pipe/ Sections	Jindal, Tata, SAIL
15	Polycarbonate Sheets	GE Plastic, Gallina (USA), Macrolux (UK)
16	Wooden Fire Check Doors	Navair, Pacific
17	Metal Fire Check Doors	Navair. Shaktimet, Godrej, Pacific
18	Admixtures for concrete.	CICO, Fosroc, Sika, MC-Bouchemie, Pidilite, BASF, STP
19	Ceramic Tiles	Kajaria, Somany, Naveen
20	Pre-Laminated Particle Board	Greenlam, Duro, Merino, Kitlam, Century, Action Tesa
21	Flush Door Shutters	Greenply, Duro, Kitply, Century
22	White Cement	JK White, Birla White
23	Powder Coating Material Pure Polyester	Nerolac, Berger, J&N
24	Stainless Steel Screws For Fabrication and fixing of Windows.	Kundan, Pooja, Atul
25	Dash Fasteners./Anchor bolts, Cramps	Hilti, Fischer, Bosch, Canon
26	Stainless Steel Friction Stay	Earl-Bihari, Securistyle, Hafele, Hettich
27	Weather Silicon	Dow Corning, Wacker, G.E.
28	Structural Silicon at butt joints	Dow Corning, Wacker, G.E.
29	Water proofing Compound	CICO, Fosroc, MC-Bouchemie, BASF, Pidilite, Sika
30	Reflective Glass	Saint Gobain, Asahi, Glaverbel, Modiguard
31	Door Locks/Latches	Dorma, D-Line, Harrison, Yale, Hettich, Godrej

32	Aluminium Grill	Hindalco, Jindal, Bhoruka
33	Vitrified Tiles	Kajaria, Somany, Naveen
34	Aluminium Cladding sheets	Alucobond or equivalent
35	Stainless steel D-handles	D-Line, Dorma, Dorset, Giesse, Ozone, Hettich, Hafele
36	Stainless Steel Railing/ pipe/ sheet	Jindal, SAIL
37	Structural Steel	TATA, SAIL, RINL
38	Ready Mix Concrete	ACC, Ultratech, L&T, Lafarge
39	Epoxy Flooring/ wall coating	Fosroc, BASF, STP, Sika, Dr Beck
40	Acoustic Mineral Fibre	Armstrong, USG, Hunter Douglas, Dexune
41	Fire Panic bar/ hinges	Dorma, D-Line, Briton, Becker FS
42	Plywood/ Block Board	Greenply, Kitply, Merino, Duro, Century
43	PVC Flooring	Gerflor, Tarkett, Armstrong
44	Fire Seal	Pemco, Lorient, Astroflame
45	Fire rated door closer/Mortice Lock/ Door Co-ordinator	Dorma, D-Line, Briton, Becker FS
46	Gypsum Board System	Gyproc (Saint Gobain), USG, Boral
47	Adhesive for Wood Work	Fevicol, Vemicol, Dunlop, Pidilite
48	Epoxy/PU Paint	Fosroc, Pidilite, Cico, BASF, Sika, Berger, Nerolac
49	Glass Doors (Motorised)	Dorma, Hafele, Ozone, Besam, Hettich
50	Automaticaaly Hermetically Sealed Sliding (OT) Door	Metaflex, SHD Italia, Stryker
51	Calcium silicate boards/ Tiles	Hilux, Aerolite, Armstrong
52	Texture Paints	Asian, Berger, Nerolac, ICI Dulux, Snowcem
53	Wall care putty	JK, Birla
54	Frameless glass partition fixtures/ Spider fittings/ patch fittings	Dorma, Sevox, Geze, Ozone, Hafele, Hettich
55	U-PVC Windows	Fenesta or approved equivalent
56	Toilet Cubicles	GreenlamSturdo, Merino, Trespa
57	Agencies for PT Slab work	Ultracon Structural Systems Pvt. Ltd., GP Spiro Duct & Tube Gurgaon, BBR (India)Pvt. Ltd Bangalore, VSL India Pvt Ltd Chennai
58	Fire rated Glass	Saint Gobain, Pilkington, Schott
59	Fibre Glass Rigid Board	FGP Ltd., UP Twiga, Kimmco
60	Mineral Wool/ Rockwool	Rockwool India Pvt. Ltd., Lloyd
61	Heat Resistance Tile	Thermatek, National
62	Bitumen	Indian Oil, Hindustan Petroleum
63	AAC Block, Fly ash brick, pavers, kerb stone, 3D wall	As approved by Engineer In charge
64	Stainless Steel Door Handles, Locks and Fittings	Dorma, Hafele, Geze, Hettich, Ozone, Godrej
65	Acid/ Alkali Resistant Tile	Somany, Kajaria

66	Acrylic Exterior Paint	Asian, Berger, ICI Dulux, Nerolac, J&N
67	PVC Door frame and Shutters	Rajshri, Sintex
68	Metal False Ceiling	Armstrong, Durlum, Saint Gobain
69	Tendons for PT slab	TATA, Usha Martin
Note	Final choice of make mentioned above shall remain with the Engineer in charge	
	Other equivalent makes can also be added or deleted, subject to price adjustment if any.	
	Wherever makes have not been specified for certain items, the same shall be as per approval of Engineer	

TECHNICAL SPECIFICATIONS

PHE & FIRE FIGHTING WORKS

1.00 PLUMBING & SANITARY INSTALLATIONS

- 1.01 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.
- 1.02 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.
- 1.03 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.
- 1.04 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.
- 1.05 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.

1.06 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.

1.07 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

1.08 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.

1.09 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.

1.10 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.

1.11 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.

1.12 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.

1.13 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, in case the solar hot water has also provided in the building the supply of same shall be connected to inlet of water heater.

1.14 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.

- 1.15 CPVC PIPES: CPVC 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. The pipe and fitting approved make solvent shall be used as per approved manufacture specification.
- 1.16 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.
- 1.17 SS pipe: The SS pipe shall be provided in lab. And specific water supply as per drawings and BOQ. The jointing shall be press type fittings with S-C contour in accordance with DVGW regulation W-524 with fittings for payment only centre to centre total length of composite pipe and fitting shall be measured. A press joint is made by mechanical deformation of the tube and fitting means of special hydraulic tool and cutting of pipe shall also be carried by later cutting tools by authorized agency. An elastomer o-ring is inserted in the recess at the end of the fitting for sealing. When the joint is made, the cross section of the tube becomes hexagonal. A calibration tool is used to ensure that the joint made is up to standard, Clearances from wall, floor and ceiling should be allowed for making the joint refer to the manual of the press tool for clearance requirements.

2.00 BORE WELLS

2.01 Scope of Work

The general character and the scope of work to be carried out under this contract are illustrated in the following specifications. It gives only general guidance as regards design, drilling and construction of tubewells. Before selecting the method of construction to be adopted ,the contractor shall give due consideration to site condition and Geological data of the site. The construction and testing of tubewells shall be as per IS 2800- 1979 (Part 1 and 2). This contract is an item rate contract. All payments shall be made for the actual work executed. The Contractor shall ensure the required minimum yield. The work shall be carried out as per BOQ item. The details which are not available in BOQ, the details of technical specification are to be adopted.

2.02 Selection of Site

The site where the tubewell is proposed, shall be examined by tenderer, and changes if required shall be discussed with the engineer prior to start of work. Any previous data available with the Contractor regarding nearby tubewells should be made use of to evolve suitable procedure for drilling , developing, testing etc.

2.03 Geological Data

During the drilling operation, contractor shall collect the samples of different strata from suitable intervals or where change in strata is met with. It shall be carefully examined and analysed and the data shall be preserved carefully and handed over to Engineer. The contractor shall make one drilling time log during the execution of work for the bore well.

2.04 Design and lowering of pipe assembly

The length and diameter of the housing pipe shall be selected on the basis of static water level, the drawdown and the discharge expected from the well and the size of the pump to be installed. The size and length of blind pipes and the slotted/ strainer pipes shall be selected according to the expected discharge and the depth of tubewell. The size and distribution of the slots shall be as per IS 8110. After completion of the bore hole the contractor shall assemble the tube well assembly according to the water bearing strata met during boring, after getting the same approved from the Engineer and shall lower in to the drilled hole the same keeping the slotted strainer opposite to water bearing strata from which the water is to be extracted . The bail plug shall rest on firm ground. Before the bail plug is lowered, about one metre depth of the bore hole shall be packed with the gravel to avoid sinking of the assembly. In case part of a bore hole is not proposed to be utilized, it shall be filled with gravel before lowering the assembly. The slotted pipe and other pipes shall be provided with proper guides to keep them in the centre of the bore to ensure uniform gravel packing all around.

2.05 Gravel Packing

All gravel shall consist of hard rounded particles reasonably uniform in diameter and shall be of size, determined after analyzing the character of the water bearing formation tapped. The gravel shroud around the screen shall be uniform. It should be free from dust, dirt and other vegetable matters. Gravel packing once started shall be carried out continuously until it is completed. Pea gravel/Stone Chips shall be thoroughly washed.

2.06 Development of Borewell

The well shall be developed either by surging and agitating or by over pumping and back washing with an air lift and high velocity jetting. The tube well shall be developed as per IS 2800 -1979 or latest by air compressor to be arranged by the contractor as required and stipulated in BOQ to obtain the maximum discharge available from the completed tubewell. Another acceptable method may also be adopted. This development process shall be continued until the stabilisation of sand and gravel particles has taken place. The development shall continue until the gravel should stop sinking, discharge of depression ceases to improve and the sand content is not more than 20parts per million. A record of the hours of working of Air compressor shall be maintained by Employer Engineer which will be signed by the contractor or his authorised representative. Payment for development of tubewell shall be made at the hourly rate indicated in the schedule of quantities for the actual period during which the Air-Condition has worked. A statement showing the quantity of gravel initially filled in the bore and the quantity added during development should be prepared by the contractor and got signed by the representative of the Engineer.

2.07 Disinfection

The well shall be disinfected after completion of test for yield. All the exterior parts of the pump coming in contact with the water shall be thoroughly cleaned and dusted with powdered chlorine compound. In fact it shall be disinfected every time a new pump is installed or the one installed is replaced after repairs.

The stock solution of chlorine may be prepared by dissolving fresh chlorinated lime. For obtaining an applied standard concentration of 50 ppm, 1 litre of the stock solution shall be used to treat 300 litres of water.

2.08 Grouting and sealing

Grouting and sealing of tubewell may be done, if required depending upon the site conditions and the quality of the discharge of the strata encountered. To ensure that the grout shall be provided a satisfactory seal, it shall be applied in one continuous operation. Sealing of the tube well may be done by grouting the annular space between bore and the housing pipe, with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 : coarse aggregate 20 mm nominal size) to a depth of 5m below the grouted level.

2.09 Handing over of the borewell.

The tubewell shall be handed over in complete shape. The housing pipe shall be closed by a well cap for the period between the completion of the tube well and the installation of the pump set.

The following information shall be furnished by the drilling agency on completion of the tubewell :

- a) Strata chart of the tube well indicating the different types of soils met with, at different depths.
- b) Samples of strata collected , neatly packed and correctly marked in sample bags.
- c) Chart of actual pipe assembly lowered indicating the size of pipes, depth ranges, where slotted/ strainer pipes have been used, depth and diameter of housing pipe, reduced level of the top of the housing pipe and the diameter and depth of the bore hole.
- d) Position of every joint in the well assembly.
- e) Hours of development done by the compressed air, pump sets or by other means.
- f) Pumping water level at the developed discharge.
- g) Two copies of test certificates of the water samples results from approved testing agency.
- h) Results of development along with levels of static subsoil water and depth of draw for steady discharge.
- i) Results of mechanical (sieve) analysis of samples of aquifer materials wherever applicable.
- j) Yield analysis and recommendation on the safe pumping yield, pump settings and specifications for suitable pumps etc.
- k) Verticality tests results to be recorded in accordance with IS:2800-1979

2.10 TUBEWELL DATA/As per BOQ

1. Yield required 500 lpm (Sand free delivery from borewell)
2. Bore - 450 mm dia.
3. Approximate depth - 100 metre
4. Assembly - Blind/ Slotted Pipes - 200 mm dia. Upto complete depth.
5. Material - MS Class "C" pipes (Heavy Class)/UPVC pipe as per IS: 12818

6. Verticality – True verticality as per IS – 2800- 1979
7. Packing – Pea Gravel/Stone Chips
8. Developing – Minimum 72 Hrs or till sand free discharge is obtained.
9. Water for drilling – Contractor shall make his own arrangement for water required for drilling purposes as well for development purposes.
10. The design for the tube well indicating the depth range of the aquifer zones to be tapped shall be given after a detailed study of the data collected during drilling operations.
11. All the casings shall be of ERW steel/UPVC- IS 12818(As per BOQ) quality confirming to IS specifications and carry manufacturer’s certificate. The pipes shall have a wall thickness of not less than 7 mm or as per IS 1239. The slotted pipes must have an effective open area of atleast 15% and the slotted size should be 1.6 mm. All pipes shall be painted fresh before lowering. The pipes shall be welded thoroughly all round to prevent leakage and breakage. Centering guides may be used to maintain the verticality of the tube wells which shall be tested in accordance with the norms stipulated in IS 2800.
12. The annular space between the bore well and tube well assembly shall be packed with well-graded pea gravel of good quality, durability and high sphericity.

2.11 Guarantee

On award of the work contractor shall submit a guarantee covering the quality and performance of all material supplied and installed under the contract. This guarantee shall cover each and every material whether manufactured by the contractor or not.

2.12 Rate

The rate quoted for Borewell items shall provide for the cost involved in all the above described operations.

3.00 WATER TREATMENT & PUMPS

3.10 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

3.20 GENERAL REQUIREMENTS

- 3.2.1 All materials shall be new and of the best quality conforming to specifications and subject to the approval of Engineer.
- 3.2.2 All equipment shall be of best available make manufactured by reputed firms.

- 3.2.3 All equipment shall be installed on suitable foundations, true to level and in a neat work-man-like manner.
- 3.2.4 Equipment shall be so installed as to provide sufficient clearance between the end walls and between equipment to equipment.
- 3.2.5 Piping within the pump houses shall be so done as to prevent any obstruction in the movement within the pump house.
- 3.2.6 Each pumping set shall be provided with a valve and a flap type non-return valve on the delivery side.
- 3.2.7 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.
- 3.2.8 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.

3.2.9 **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.

3.2.10 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.

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

3.2.12 **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.

3.2.13 A tentative treatment scheme is shown in the drawings.

4.00 **WATER SUPPLY PUMPS**

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

4.02 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.

5.00 **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.

6.00 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.

7.00 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.

8.00 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

9.00 FILTER MEDIA

9.01 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)

9.02 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.

10.0 TEST KITS

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

Residual Chlorine Indicator

Valve

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

11.00 VALVES

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

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

11.03 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.

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

12.00 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.

13.00 MOTOR CONTROL CENTERS

13.01 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.

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

14.00 WATER SOFTENING PLANT

Mild steel pressure 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.

14.01 Hardness Test Kit

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

15.00 REVERSE OSMOSIS (R.O.) PLANT FOR PROCESS AND DRINKING WATER

- 15.01 On the basis of sample water analysis, the Contractor shall design, supply, erect, test and commission the pre-assembled RO system. The system shall consist of but not be limited to the following:
- a) PP wound Micron Catridge Filters in food grade material in combination of 5 & 10 micron rating or alternatively spring type cross filter with manual/auto backwashing system and shall be provided with necessary isolation valves, inlet & outlet pressure gauges etc. Micron filters shall be with differential pressure measurement system and cleaning frequency should not be more than once in a month.
 - b) Anti-scalent and pH correction system as per feed water quality along with process demanding instrumentation and piping etc.
 - c) RO module fitted with thin film composite TFC polyimide spiral wound element type membrane of adequate area/size & no. encased in SS housing and all necessary accessories/controls to perform the desired duty. Cleaning frequency shall not be more than once in a month.
 - d) High pressure pump for feeding RO system with necessary instruments like high & low pressure switch, pressure gauges and isolation valves etc.
 - e) On line panel mounted pH control and conductivity indicators.
 - f) Suitable NRV at the outlet of Permeate.
 - g) Electric control panel for the system operation consisting of HP Pump starter with overload protection, manual-auto-off operational selector switch, pre-wired instrumentation panel.
 - h) Decarbonator unit consisting have packed column of food grade FRP, degasser blower, degassed water tank etc. complete with frontal piping.
 - i) MS skid frame mounted cleaning in place system for easy movement with polyethylene tank and accessories.
 - j) In-built flushing system for flushing the deposition of concentrate in the membrane during non-operating period of plant.
 - k) Electronic type Rotameter for permeate and rejection along with companion flanges.
 - l) Dosing system having trip interlocks with HP feed pump to RO membrane to get ripped if the HP pump trips.
 - m) Interconnecting piping & strainers etc.
 - n) Low/High pressure cutouts
 - o) Back pressure regulator.
 - p) Pressure gauges of suitable rang in 4" dial with SS contact parts.

- q) Flow meters & control valves
 - r) Level Indicator/Controller in the R.O. Water Storage Tank for automatic shut off/starting of the plant.
 - s) Safety relief valves.
 - t) Instrument & Electrical panel with starter and overload protection.
 - u) TRFC type motor suitable for 415v, 3 phase, 50 Hz AC supply.
 - v) Minimum percentage recovery of the system shall be mentioned (and guaranteed by the Bidder).
 - w) The membrane element shall be suitable for handling 6.5 to 8 pH feed quality and the required service to provide permeate quality of less than 100 ppm TDS. The system shall be provided with stand by cartridge filter arrangement and all parts in direct contact with water in the RO system shall be in SS316 material. The Contractor shall also specify necessary procedure for membrane cleaning along with dosages of chemicals.
- 15.02 Power & control wiring for the feed pumps & R.O. output water transfer Pump will be as per Electrical drawings approved for the system.
- 15.03 Solenoid Valve will be provided at the outlet of RO Module.
- 15.04 Piping shall be as per system requirement.
- 15.05 Complete Scheme, Equipment Layout, P&I Diagram & Electric circuit diagrams shall be got approved from the owner or its authorized representative before execution of work.
- 15.06 Water storage tanks for storage of R.O. treated water:
- To be constructed from FDA approved food grade polyethylene, completely drinking water with built in UV stabilizer, screw able or lockable lid. Inner layer should preferably in white colour.
- 15.07 Following items will also be under Contractor's Scope of Work:
- a) RO Water Storage Tank.
 - b) All inter-connecting Pipes within the system battery limits
 - c) Power & signal cabling & control system with in battery limits
- 15.08 Hydro Test shall be offered at pressure 1.5 times the operating pressure or 5 kg/sq.cm, whichever is higher for all equipment during shop inspection.
- 15.09 Warranty: Membranes will be warranted for a period of 36 months.
- 16.00 Automation for Water Treatment & Water Supply System**

Raw water from Tube Wells would be received in the underground Fire Tank (T1) from there it overflows to the underground Raw Water Tank (T2).

There is no consumption of water from (T1) except in case of fire or during trail runs of the Fire Pumps and the above overflowing arrangement is provided to prevent stagnation of Water in Tank (T1).

The Tube Well Pump would be automatically switched on off by Level Controller provided in Tank (T2.) The same Level Controller would give audio/visual alarm in case of reaching very high (HH) or very low (LL) level. (Chlorination to kill bacterial/virus is done in the Filtered Water with a Chlorine Dosing Pump in the line going to OH Tanks.)

Raw Water from Tank (T2) is pumped by Pumps P6 A/B to the Filter Water Tank, after passing through Filter. Raw Water from Tank (T2) is also pumped by Pumps P7 A/B to the Over Head Fire Water Tank (T5) from there it overflows to the Over Head Flushing Water Tank (T6 & T5). Filtered water pump P6 A/B would be automatically controlled by the Level controller provided in tank (T5) and Raw Water Lift Pump P7 A/B would be automatically controlled by the Level controller provided in tank (T6 & T5). These Level Controllers as in earlier cases would also give audio visual/ alarm in case of very high or very low level.

Filter Water from Tank (T3) is pumped by Pumps P8 A/B to the Soft Water Tank, after passing through Softener. Filter Water from Tank (T3) is also pumped by Pumps P9 A/B to the Over Domestic Water Tanks (T7 & T12). Filtered water pump P8 A/B would be automatically controlled by the Level controller provided in tank (T4) and Filter Water Lift Pump P9 A/B would be automatically controlled by the Level controller provided in tank (T7 & T12). These Level Controllers as in earlier cases would also give audio visual/ alarm in case of very high or very low level.

Soft Water from Tank (T4)s pumped by Pumps P10 A/B to the Over Head Soft Water Tank. Soft Water pump P10 A/B would be automatically controlled by the Level controller provided in tank (T8) These Level Controllers as in earlier cases would also give audio visual/ alarm in case of very high or very low level.

Domestic Water from Over Head Domestic Water Tank (T7) shall be go into the R.O. Plant placed on the terrace of super specialty block and from there the RO water would be distributed for bother super specialty block and service block

R.O. Water Plant would be automatically controlled by the Level controller provided in tank (T9) Similarly, R.O. Water Plant on Library Block would be automatically controlled by the Level controller provided in tank (T13) This Level Controller as in earlier cases would also give audio visual/ alarm in case of very high or very low level.

Electric Control Panel containing DOL starters for all the pumps described above would be supplied by the Owner. The Automation System Vendor has to provide interface with the contractors of these Pump Motor Starters. There would be enough empty space in the bottom tier of this Electric Control Panel. However, Automation System Vendor has to provide full details of such relays controllers indication lights/ alarms etc. to the Owner for incorporating there in the Electric Control Panel.

17.00 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.

18.00 HYDROPNEUMATIC SYSTEM

18.01 SCOPE

This section of the contract involves the design, supply, installation, testing and commissioning of the complete Hydropneumatic pumping system and other pumping systems complete with all controls and electrical work for domestic water supply. All submersible, drainage pumps for the project are also included in this contract. It also involves testing and commissioning of the pumping system with the domestic water and flushing water supply & distribution.

This specification described the particulars of the contract, designs and systems chosen, and mode of operation.

All installation work shall comply with the latest rules and regulations.

The work embraced by this specifications covers the design, submission to authorities, supply, delivery on site, installation, testing, commissioning and maintenance of the Hydropneumatic pumping system, other pumping system installation of the building in accordance with this specification and associated drawings.

The scope of work shall include the following (list is indicative and not exhaustive) :

- Variable speed pumping units domestic water supply & distribution.
- Suitably sized food grade quality, non-toxic diaphragm type pressure vessels complete with necessary interconnections and controls.
- Control panel for pump control complete with variable speed drives, circuit breakers, fuses, pressure transmitters etc. complete with all interconnections to pumps and electrical supply panels.
- Pump control units complete with pre-programmed micro-processorchip.
- Pump monitoring units to monitor operation of pumps.
- Each Hydropneumatic Pumping unit shall be supplied as a complete set including variable speed pumps, pressure vessels suction and discharge common manifolds, non-return valves, isolating valves, pressure transmitters on the discharge side and level electrode at the suction tank. Each unit shall be provided with electronic microprocessors for unit control and all necessary electrical work for the unit.
- Submersible drainage pumps for plant room drainage complete with electrical panels and necessary accessories with automation for pump operation.
- The Hydropneumatic system supplier shall provide the pumping units in the designated pump rooms as complete units included all necessary piping within plant such that only discharge connections are required to be connected into the unit's discharge manifolds just inside the plant room, by the Plumbing tenderer. The Hydropneumatic system tenderer shall guarantee specified pump performance at various pump speeds and Hydropneumatic pumps must be able to supply at least 2 bar pressure at the highest/farthest fitting.
- Electrical equipment and installation work including the PLC in Control panel.
- Painting and labelling of pipework and equipment;
- Provision of all hold down bolts, spigots struts and the like required to be built in during construction;
- Provision of all level switches, flow switches and other sensing devices for status indication.
- All interfacing work with other trades.

- Testing and commissioning and balancing of the Hydropneumatic & Pumping system;
- Provisions of operating instructions and maintenance manuals;
- Provision of spare parts;
- Training of the employer's staff for proper operation of the entire systems;
- Liaison with Local Authorities to obtain all necessary certificates and approvals, including the completion of all submission drawings, forms and payment of any fees and charges. All the costs for all the tests required by Local Authorities shall be included. To attend to any Authorities inspection regardless of whether this inspection is carried out after the defect liability period;
- Provisions of the necessary installation which include pumping works, pipework within the pumping unit up to suction and discharge manifolds, conduit and control wiring, etc. to form a workable system required;
- All other works and systems as specified in the Contract document and or shown on the drawings.
- All cutting, patching, framing up, furring in, chasing and making good associated with the building construction for the passage of pipes, conduits and the like including providing GI pipes sleeves of required size corresponding to pipe dia, wherever pipes crossing fire rated walls and floors and sealing with glass wool in between and fire sealant compound on either end. Details on shop drawings shall also be provided.

18.02 GENERAL

Equipment offered for supply and installation shall include the following:

All minor items and incidental work, equipment accessories and materials may not be specifically mentioned but are required for the proper completion of the installations in accordance with the true intent and meaning of this Specification.

Readily accessible, dust-proof lubricating facilities on all moving parts and equipment including provision for cleaning all lubricating lines and bearings and charging same with the correct lubricants after installation but prior to testing and commissioning.

Clearly visible and robust manufacturer's name-plates permanently fitted each and every item of equipment and showing the manufacturer's name, type and/or model number, serial number, and all essential operating data such as speed, capacity, voltage, current draw, etc.

The Tenderer also shall allow provision for the inspection of all plant and equipment by the manufacturer or his licensed representative, at least twice during the course of the installation.

18.03 PIPING

The pipes and fittings in the domestic Water Treatment plant room shall be GI class `C' (heavy class) conforming to IS: 1239 (Part-I) for pipes and IS:1879 (Part 1 to 10) for malleable cast iron galvanized fittings or specified in the BOQ.

19.00 PUMPS FOR HYDROPNEUMATIC & DRAINAGE SYSTEM

19.10 PUMPS

Pumps shall be vertical, centrifugal, multistage directly coupled to motor. Provision of pump with pump head & base of cast iron and other parts in SS 304 shall be made for pumps required in Hydropneumatic System. Impeller shall be hydraulically balanced and keyed to shaft. Pump shall be mounted on a concrete foundation, projecting at least 15 CM above finished floor level. The pumps base shall be set on a vibration elimination pad. The pump shall be lubricated in strict accordance with the manufacturer's instructions and shall be factory aligned prior to shipment. All motors and bases shall be painted with approved finish shop coat of paint. The pump shall be selected for the lowest operating noise level and shall be complete with flexible connections, valves, and pressure gauges. The pumps shall include cost of foundation channel complete.

The Tenderer shall supply and install pumps of the type and performance as shown on the drawings. All duties of pumps given in the Tender Drawings shall be checked and where necessary corrected before ordering. All the parts of the pumps that are in contact with water e.g. shaft, impeller etc. shall be of stainless steel construction.

Pumps shall be so selected that the design duty point is within 5% of the maximum efficiency point. The pump casing so selected shall have ample space to take an impeller one size larger than that capable of performing the design duty.

Pumps of 2900 rpm with high efficiency and low noise motor can be selected and noise data submitted for approval. All pumps and motors shall be of minimum vibration and noise level during operation. Vibration isolators shall be provided for all pump sets.

Facilities shall be provided to prevent starting of pumps when the water tank is at low water level. An indicator for this low water level alarm shall be provided.

Facilities to select which pump to be duty pump and standby pump shall be provided and be interchangeable.

Pump curves for all pumps offered shall be submitted. All curve indicating excessive shut-off head will not be approved.

Each pump shall be provided with a gate valve at suction and discharge, approved check valve at discharge, approved strainer at suction, flexible connections at pump suction and discharge, eccentric reducer at suction,

concentric reducer at discharge, pressure gauges at suction and discharge, circulation relief valve and automatic air relief valve.

Appropriate neoprene vibration isolation mountings shall be provided for each pump sets.

19.10.1 Vertical Pumps

Multi-stage pumps shall be of centrifugal type and arranged with shafts vertically installed. The impellers shall be of stainless steel mechanically balanced and keyed to shaft. Renewable guide rings are to be provided in the casting, keyed to prevent rotation.

Pumps shall be driven by elevated in-line TEFC squirrel cage motors via extended vertical shafted complete with universal couplings.

The shafts shall be stainless steel. Stainless steel sleeves shall be provided to protect the shaft in the water space and through the sealing glands. The sleeves shall be keyed to prevent rotation and secured against axial movement.

The bearings shall be of ball or roller type protected against ingress of water, dirt and other matter.

Vertical multistage pumps shall have universal flanges. Intermediate bearing, support bearing shall be provided in the pump.

The shaft seal shall be easily serviceable and shall allow for correct adjustment and loading of the seal.. Pump motors above 7.5 kW shall be equipped with a spacer coupling which allows changing of shaft seals without removing the motor. The pump motors shall be of Class "F" insulation and IP55 rating and shall be provided with built-in thermistors for protection against over heating.

19.20 VARIABLE SPEED HYDROPNEUMATIC PUMPING SYSTEM

Variable speed Hydropneumatic pumping units shall be provided for supply of domestic water, flushing water supply for the project. The units shall be selected so as to provide at minimum of 2 bar pressure at the highest/farthest fitting in each plumbing system, the unit serves. The hdyropnematic pumping units shall have the following features;

19.20.1 System Description

The system shall be supplied as complete sets including suction and discharge common manifolds, non-return valves, isolating valves, pressure transmitter on the discharge side and electrode at the suction tank.

The system operation will be such that the initial small water demand shall be met by the charged diaphragm pressure vessel. Should the water demand continue the system pressure will dip to a preset pump cut-in point when the lead pump starts to operate at reduced speed through the variable speed drive. However, should the system pressure be still below the preset

value, the controller continuously increases pump speed to meet the system demand. When the lead pump is not able to meet the system pressure at full speed, the second pump also starts to operate.

At peak demand all the pumps operate, Similarly, if there is a drop in water demand the duty pump speed starts to reduce, then standby pumps cuts-off, followed by stopping of the duty pump.

The closed diaphragm pressure vessel shall be of polyethylene material with a pressure gauge and isolating valve. The interior shall be of non-toxic lining suitable for use with potable water. The vessel shall be manufactured to conform to ASME pressure vessel code/standards.

The system shall be under the control of an electronic microprocessor unit (EMU).

A pressure transmitter shall detect the pressure at the delivery manifold and feedback to the microprocessor control panel via control circuit.

The system shall incorporate a frequency converter or frequency converter motors on the pumps and the pressure transmitter shall register the actual pressure on the discharge side.

The variable speed drive pumping system shall maintain a constant pressure regardless of the system demand. If there is a drop in pressure outside the preset point, the Variable Speed Drive (VSD) pump shall start to run until the pressure increases to the preset limit, or it will continue to increase the pump speeds to the upper limit of the frequency. If the water system demand still cannot be met, the second pump shall be called in to run, the VSD will then alter the pump speed to meet the preset pressure point. If the set point is still unable to be met, the third pump is then activated to run (in case of 3 pumps units).

This shall be achieved by continuously varying the motor speed of the duty pump according to the demand up to a maximum designed capacity.

Under decreasing hydraulic demand the reverse sequence to the above description shall apply.

The EMU shall ensure alternation of all the duty and standby pumps for even running hours for all the pumps.

The frequency converter shall be linked to the motor of the duty pump for continuous speed adjustment and ultimately the water delivery shall be maintained at constant pressure at the preset value.

19.20.2 Local Motor Control Panel

The motor control panel shall be equipped with all the necessary electrical components including a microprocessor control unit and a frequency drive. The control panel and the microprocessor shall cover the followings functions:

- Flexibility and simplicity in allowing the necessary re-adjustment of the pumping system pre-set delivery pressure to operate the pumps within the specified maximum and minimum delivery ranges.
- Built-in frictional loss compensation factor which will automatically increase the delivery pressure setting, in collaboration with the increase in flow demand. This shall be able to minimise the system pressure differences and provide a more constant pressure along the supply line and also to save the energy consumption of the motor when running at low speed.
- Automatic changeover of the pumps to be controlled by the microprocessor which dictates the duty and standby pumps to run at variable speed.
- Built-in clock functions with weekly programming and with switch on system to operate at at least 10 different pre-set pressure points as required.
- When the system has not been operated for more than 24 hours, it shall automatically start the pumps for a few seconds/day to ensure the pumps readiness at all times. The standby pumps shall be activated upon failure of duty pump(s). In event of control failure, the pumps shall be able to be start/stopped manually at the local panel by means of pressure switches.
- The microprocessor control panel shall be able to cut-off the pumping system when excess pressure is registered in the discharge common manifold.
- The system shall have the capability of receiving input signal concerning reduced water level in suction tanks and shall have control mechanisms to prevent the pumps from running dry.
- Automatically starting the pumps when the water level is back to normal.
- In case of pump failure due to motor overload, the standby pump is switched on automatically. Alarm signal is displayed on the LCD Display unit and alarm lights are activated.
- Functions to limit the no. of start/stop of pumps per hour.
- The system control panel shall incorporate at least the following components:
 - a. LCD Display
 - b. Pumps selections for up to 4 pumps so that system controller can control up to 6 pumps
 - c. Pump status button to display duty pump speed and system capacity
 - d. Zone status button to display operating parameters for different pumping units
 - e. Setting button to input preset pressure, system start/stop time etc.
 - f. ± 1 button to key in numeric data such as pressure set point, etc.

- g. Enter button for confirmation of input into the system
- h. Alarm button to show location of fault - self diagnostic function display
- i. Hour Run measurement for each supplied pumpset
- j. Buttons for scrolling to select the actual display reading for system configuration, i.e. up and down scroll concept.
- k. Necessary devices for programming, supervising and monitoring operation data/system, status shall be incorporating into the control panel.

19.20.3 Operations

Local control panel shall perform as follows:

Auto mode

The desired delivery pressure within the range specified shall be set at the duty local control panel. The pressure transmitter shall detect the delivery pressure continuously within 1 second and feedback to the microprocessor which will control the variable speed drive frequency converter for speed control of the duty pump. When demand increases, the subsequent pumps in the system will be activated to boost up the pressure. Ultimately the duty pump set shall be operated fully automatically to maintain the delivery pressure constantly at the desired set value.

Manual Mode

The on/off function of the pumps shall be manually adjusted at the microprocessor located at the local control panel.

Frequency Control By-pass Mode

All the pump sets shall be started/stopped automatically with the pump output at fixed maximum rotational speed. All the control and protection functions shall remain active. The cut in/cut out pressure shall be internally calculated by the microprocessor for each pump.

19.20.4 System Features

The required performance features of each Hydropneumatic pumping unit shall be as follows:

- a. System Configuration
- b. Variable speed pumps with pressure vessels.
- c. Control panel consisting of the following components:

- Pump Functional Unit (PFU) - control unit c/w pre-programmed microprocessor chip. This unit shall control all pumping unit operations through electronic controller.
- Pumping Monitoring Unit (PMU) - monitor the operation of the pumpsets. This unit shall allow for monitoring and setting of all control parameter.
- Variable Speed Drive
- Circuit Breakers
- Fusses
- Pressure Transmitter

Set Point

Ten separate pressure “set points” shall be able to be programmed into the PMU, and switching between set points is timed by a real time clock when a lower pressure is acceptable during certain periods, for instance after hours or weekends, the set point shall be lowered to minimise power consumption.

An external input shall also be used to switch between set points, or manually adjust a set point at any time.

Friction Loss Compensation

It shall be possible to allow for the friction loss component of the system, calculated at full flow and set as a percentage of the set point which will reduce the working pressure of the pump set depending on the actual no. of pumps in operation. A linear approximation of system resistance curve can therefore be allowed for, and pressure will automatically increase as system flow and subsequent frictional losses increase. As such power consumption shall reduce which is required for the pumping system.

Displays

Through the PMU keypad all variable parameters shall be adjustable, current status of settings and measured values shall be able to display on the 2 line x 24 character liquid crystal display.

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

Pump Status

Running hours of each pump
 Actual pump status (running, not available, standby, allocated to zone, fault)
 Maximum head of pump at zero flow.

Zone Status

This menu shall be the main operating menu where at the setting and operating parameters can be viewed,

Current operating set point
Measured values in the system
Operating capacity in terms of total output
Mode of operation for the zone
Clock programs (relating to set point pressures)
Standby pumps
Pump change over time
Zone configuration
Pressure transducer scaling
Friction loss compensation
Pump priority
Inlet pressure measuring (if required)
System response times
Allowable number of starts per hour for the pumps
Minimum limit (loss of water, burst mains protection)

Setting Menu (Set)

In this menu all parameters for the operation of the pump set shall be able to be adjusted as required.

- a. Set points (up to 10)
- b. On/Off function (used to prevent unnecessary cycling at low demands)
- c. Displayed pressure units (Bar, PSI, mBar, kPa)
- d. Real time clock programming for any time of the day, week, or weekend
- e. Zone configuration
- f. Friction loss compensation

Alarm

The alarm menu shall display all faults that occur during operation, logging the time and date of when the fault occurred and when it was corrected, or whether it is still an actual fault, up to 10 faults can be maintained as history in the controller. The following type of faults shall be diagnosed by the controller.

- a. Mains failure
- b. Frequency converter fault
- c. Analogue input (pressure transducer) fault
- d. High discharge pressure fault
- e. Low discharge pressure fault
- f. Motor thermal overload fault

Variable Frequency Drive

Variable frequency drive shall be of a reputable make acceptable to Project Manager and shall be complete with RFI filter and harmonic dampers.

Enclosure

An IP 54 powder coated steel enclosure shall house all the electrical components.

The enclosure can be supplied loose for remote mounting, or mounted on a common base with the pumps, it shall be adequately ventilated for use in conditions up to a maximum ambient temperature of 45 degrees Celsius.

Electrical Componentry

All circuit breakers, thermal overloads and contactors shall be of reputable make acceptable to the architect. Electrical supply to the pump controller shall be protected using an isolating circuit breaker.

Method of Starting

The panel shall be built to start the pumps in suitable starting modes, i.e. D.O.L., Star/Delta, or using Soft Starters.

Quality and Testing

Manufacture of the pumps, plus design and assembly of the complete packaged Hydropneumatic pumping system shall be factory assembled and the pump station shall be fully tested hydraulically and electrically prior to dispatch to site. Test reports etc. shall be submitted for review before dispatch.

19.20.5 Pump Pressure Vessel

Diaphragm type pressure vessels shall be provided as shown on the drawings. They shall be incorporated into the system so that during normal operation the pump shall not need to be start within 30 seconds of it switching off in order to prevent the pump hunting.

The pressure vessel shall be of adequate capacity to accommodate a considerable fluctuation in water demand by the system with minimum start/ stop cycles of the pumps. The vessel shall be constructed of steel plate built to ASME Standards for Unfired Pressure Vessel. A rubber diaphragm shall be provided in the vessel for separating the water and pre-charge nitrogen. The pre-charge pressure shall be adjustable and charging port with non-return device shall be provided. The adjustable cut-in and cut-off pressure unit for the pumps shall be built-in at the vessel to suit the system.

19.20.6 FLOATLESS TYPE LEVEL SWITCH IN WATER TANKS

The Tenderer shall supply and install floatless type switch probes in the water tanks as indicated below and shown on the drawings.

Raw Water Tanks at Pump Room

- High level alarm (over-flow);
- Low level alarm;
- Low level cut-out for raw water pumps;
- Earthing probe.

Cooling Tower Make-up

- High level alarm (over-flow);
- Low level alarm;
- Low level cut-out for supply pumps;
- Earthing probe.

Potable Water Tank

- High level alarm (over-flow);
Low level alarm;
- Low water level cut-out for the domestic hydropneumatic pumps;
- Earthing probe.

Each probe shall be of the correct length for the particular application and tank location. Electrodes shall be of polished stainless steel 20 mm OD. Electrode holders shall be weatherproof in all respect.

The earthing probes shall be connected and wired to the building earth systems of the building.

Each set of electrodes shall be installed inside a 230 mm diameter PVC pipe acting as a wave barrier.

The level switch set shall operate with a stepped down voltage at 24V maximum. Stepped down transformers shall be provided for each set of control probes and shall be installed inside centralised control cubicles inside pump room.

Mechanical steel stuffing boxes shall be used.

Control of Duty / Standby Pumps

Operation of the duty and standby pumps shall be carried out by the following method:

- a. Automatically by means of pressure sensor (i.e. pressure switches);
- b. Manually by means of a local start/stop push buttons on pump local motor control panel and emergency stop switch.

The pressure switch shall be installed next to the manual release valve. When the pressure drops to the pre-determined level, a signal will be sent to the pump local motor control panel to start the pump.

Automatic controls shall be operated by electronic, floatless type level switches.

Pump Indicator

The following audible and visible indication shall be provided at the pump local control panels as applicable:

- a. Red "overflow level" indicator with buzzer for the associated water tanks;
- b. Amber "extra high water level" indicator for the associated water tank;

- c. Amber "high water level" indicator;
- d. Amber "low water level" indicator;
- e. Red "pump trip" indicator for each pump;
- f. Green "pump on" indicator for each pump;
- g. "Pump electrical supply healthy" indicator for each pump;
- h. Amber "remote/local" status indicator.

20.00 FIRE FIGHTING SYSTEM

GENERAL

- 20.01 Work under this contract shall be executed as shown on the drawings and given in the specifications and required at site whether explicitly shown or not.
- 20.02 Not-with standing the sub-division of the documents into separate sections and volumes every part of each shall be deemed to be supplementary to and complementary of every other part and shall be read with and in to the contract so far as it may be practicable to do so.
- 20.03 Where it is mentioned in the specifications that the contractor shall perform certain work or provide certain facilities, it is understood that the contractor shall do so without any extra cost to the Employer/HSCC.
- 20.04 The material, design and workmanship shall satisfy the local fire regulations. The job specifications contained herein and codes referred to where the job specifications stipulate in addition to these contained in the standard codes and specifications, these additional requirements shall also be satisfied.
- 20.05 Portable fire extinguisher shall be provided in the building as per BOQ which should not contain halogen to minimize the use of ozone depleting substance as per GRIHA.

21.00 SCOPE OF WORK

- 21.01 Work under this contract consist of furnishing labour, materials, equipment and appliances necessary and required to completely do all works relating to the fire protection system as described here-in-after and shown and the drawings, consisting of:
 - i) Supply, installation, testing and commissioning of:
 - Fire hydrant system including fire pumps and ancillary equipment's described later in the Volume.
 - Fire sprinkler system, as described later in the volume.

Portable Fire Extinguishers

- ii) Preparation of plans and getting pre-installation approval by the Local Fire Authority.

Getting tested by and approval of the installation by the Local Fire Authority during the fabrication/construction stage as well as after completion. It will be the responsibility of the Contractor to get all approval and completion certificate from the Local Fire Department without which the work will not be taken over by the owner. Fee payable to the local bodies for such activities shall be borne by the Owner on production of receipts for money paid and the all other expenses barring the fee will be borne by the Contractor.

- iii) Supply of necessary spare parts during the commissioning stage.
- iv) Supply of any other item or services not specifically mentioned anywhere but required by the Local Fire Authority or essential for the completion & operation.

22.00 INTERPRETATION

22.01 In interpretation of specifications, the following order of decreasing importance shall be followed:

- a. Statutory Rules & Regulation
- b. Schedule of quantities
- c. Additional specifications
- d. List of approved make of materials
- e. General rules and conditions

22.02 Matters not covered by the specifications given in this contract, as a whole shall be covered by relevant and latest CPWD specifications / Indian Standard Codes. If such codes on a particular subject have not been framed, the decision of the engineer shall be final and binding.

23.00 SPECIFICATIONS

23.01 Work shall be carried out strictly in accordance with the specifications attached to the tender.

23.02 Works not covered in the specifications shall be carried out as per relevant latest CPWD specifications/ Indian standard Code of practice specifications of materials.

24.00 EXECUTION OF WORK

24.01 The work shall be carried out in conformity with the contract drawings and within the requirements of architectural, HVAC, plumbing, electrical, structural and other specialized services drawings.

25.00 TENDER DRAWINGS

- 25.01 For guidance of the bidder, drawings as listed are enclosed with these tender documents. These drawings are broadly indicative of the work to be carried out. The Contractor on award of work will furnish shop drawings based on the working drawings issued to him, as required in advance for approval of Engineer and get the same approved by Local Fire Authority/other statutory bodies. No claim whatsoever shall be admissible on account of changes that may be introduced by the Engineer /Local Fire Authority.
- 25.02 The Contractor shall examine all specifications, tender conditions and drawings before tendering for the work.
- 25.03 Information, levels and dimensions given in the tender drawings are supposed to be correct but the contractor shall make independent inquiries and verify the same. No claims for extras shall be admissible in case of any deviations for incorrectness of the information, levels or dimensions.
- 25.04 The contractor shall obtain all information relating to the local regulations, bylaws, and application of any and all laws relating to him work or profession. No additional claims shall be admissible on this account.

26.00 SHOP DRAWINGS

- 26.01 The Contractor shall prepare and furnish all shop drawings in quadruplicate at no extra cost for approval by the Engineer before commencing fabrication/manufacture of the equipment. Such shop drawings shall be based on the Architectural & Fire fighting drawings and requirements laid down in the specifications and as per site conditions. The manufacture of equipment shall be commenced only after the shop drawings are approved in writing by the Engineer. Such drawings shall be co-ordinated with all disciplines of work.
- 26.02 Contractor shall verify all dimensions at site and bring the notice of the HSCC any or all discrepancy or deviations notices. The decision of the HSCC in the regard shall be final.
- 26.03 Large size details and manufacturer's dimensions for materials to be incorporated shall take precedence over small-scale drawings.
- 26.04 All drawings issued by the consultants for the work are the property of the Consultants and shall not be lent, reproduced or used on any other works than intended, without the written permission of the Consultants.
- 26.05 Working drawings shall be approved by the consultant. 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.

27.00 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. Location of Hydrants, Earth pipes, route of earthing conductors etc.
- e. Route of all cables and pipes run along with detail sizes and mode of installation.

28.00 DOCUMENTS

The Contractor shall submit to the Engineer, the following documents on completion of the work and before issuance of virtual completion.

- i. Warranty for equipment installed.
- ii. Test certificates.
- iii. History sheets of the equipments.
- iv. Catalogues.
- v. Operation and Maintenance manuals.
- vi. List of recommended spares and consumables.
- vii. Reconciliation statement.
- viii. All approvals and sanctions.

29.00 MATERIALS

- 29.01 All materials used on this work shall be new, conforming to the specifications.
- 29.02 Materials shall conform to the technical specification and/or the latest CPWD Specifications /Indian Standards Specifications as amended up to date and carry certification mark, wherever so required.

29.03 Only approved make of material shall be used. The contractor shall get the samples of all the items approved from the Engineer before commencing the supply.

30.00 TESTING OF MATERIALS

30.01 Contractor shall be required to produce manufacturer's test certificates for the particular batch of materials supplied to him. The test carried out shall be as per the relevant CPWD specifications/Indian Standards.

30.02 Any weights of sizes given in the tender having changed due to metric conversion, the nearest equivalent sizes accepted by Indian Standards shall be acceptable without any additional cost. The decision of the HSCC shall be final and binding on the contractor.

30.03 The Engineer shall have full power to get any material of work to be tested by an independent agency at Contractor's expense in order to prove the soundness and adequacy.

31.00 INSPECTION AND TESTING

31.01 All equipment shall be inspected and tested as per an agreed quality Assurance Plan before the same is packed and dispatched from the Contractor's Works. The Contractor shall carry out tests as specified/directed by Engineer.

31.02 Contractor shall perform all such tests as may be necessary to meet requirements of Local Authorities, Municipal or other statutory laws/ by-laws in force. No extra shall be paid for these.

31.03 The Engineer may, at his sole discretion, carry out inspection at different stages during manufacturing and final testing after manufacturing.

31.04 Approvals or passing of any inspection by the engineer or his authorized representative shall not, however, prejudice the right of the Engineer to reject the plan if it does not comply with the specification when erected or give complete satisfaction in service.

31.05 All materials and equipment found defective shall be replaced and the whole work again tested to meet the requirements of the specifications, at the cost of the contractor. Contractor has to obtain a performance certificate/approval for the complete layout of piping/equipment erected.

32.00 WELDING

32.01 The welding procedure, types of electrodes etc. shall be in accordance with the following IS specifications.

Welding Procedures IS: 823

Welding Electrodes IS: 814, but of approved makes only

Testing of Welders IS: 817

32.02 Only Welders fulfilling the requirements of IS: 817 and approved by the HSCC shall be employed by the Contractor.

33.00 JOINING MATERIAL (GASKET)

Gasket, for use in between flanged joints, to be of CAF as per IS-2712, thickness as specified in S.O.Q.

34.00 PAINTING

34.01 All above ground pipes, pipe fittings, hose cabinets structural steel work pipe supports etc. shall be painted as per specifications given below.

34.02 Painting shall be done only after the completion of fabrication work and testing.

34.03 The instructions of paint manufacturer shall be followed as far as possible otherwise the work is to be done as directed by the HSCC.

34.04 All cleaning materials, brushes, tools and tackles, painting, material etc. shall be arranged by the Contractor at site in sufficient quantity.

34.05 All rust, dust shall scales, welding slag or any other foreign materials shall be removed fully so that a clean and dry surface is obtained prior to painting. Any other oily containment shall be removed by use of a solvent prior to surface cleaning.

34.06 First coat of primer paint must be applied by brush on dry clean surface immediately or in any case within 3 hours of such cleaning.

34.07 Primer paints - one coat (minimum thickness 100 microns) self-priming epoxy mastic.

34.08 Finishing coats:

a) For Pump Rooms - 2 coats (thickness minimum 50 microns each) of epoxy paint, fire red shade as per IS: 4.

b) For other than Pump Rooms - 2 coats of synthetic enamel paint, fire red shade as per IS: 4.

35.00 COATING WRAPPING FOR UNDERGROUND PIPES

35.01 All underground piping shall be protected by coating and wrapping as per the following procedure.

35.02 The materials and workmanship shall in general conform to IS: 10221, 1982 or as directed by the HSCC.

35.03 Cleaning - The pipes shall be thoroughly cleaned by dust, rust will scales, oil, grease etc. by stiff wire brush and scrappers. The surface shall be coated with the primer immediately after cleaning.

- 35.04 Priming - Suitable primer shall be applied as an undercoat. The manufacturers recommended procedure would be followed for applying the primer.
- 35.05 Paste Application - Paste shall be applied to fill up uneven surfaces in order to ensure smoothness for subsequent wrapping with multi-layer tape.
- 35.06 Tape Wrapping - The tape is to wrap while the second coat of primer is still tacky. Winding is to be done with 50% overlap so that the total thickness of 2.0mm tape would become 4.0mm. It should be ensured while wrapping that air bubbles are not trapped. The ends of tape shall be secured with nylon binding to ensure that the tape doesn't get loosened while handling.
- 35.07 The total thickness including 2 coats of primer, 50% overlap of tape etc. should not be less than 4.5mm or as per manufacturer recommendations.
- 35.08 The 'Holiday Test' is to be conducted as per IS: 10221 for detecting any entrapped air or any other defect. The Contractor is to arrange for the Holiday Test and to rectify the defects if found any.

36.00 TRAINING OF DEPARTMENT PERSONNEL

- 36.01 The Contractor shall train the Owner's personnel to become proficient in operating the equipment installed. Training shall be done before the expiry of the defects liability period.
- 36.02 The period of training shall be adequate and mutually agreed upon by the Engineer and Contractor.
- 36.03 The Owner's personnel shall also be trained for routine maintenance work and lubrication, overhauling, adjustments, testing, minor repairs and replacement.
- 36.04 Nothing extra shall be paid to the Contractor for training Owner's personnel.

37.00 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.

1102 SPECIFICATIONS FOR PUMPS AND ANCILLARY EQUIPMENT

38.00 SCOPE OF WORK

38.01 Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install electrically/diesel engine operated pumps for fire hydrant installations as required by the drawings and specified hereinafter or given in the schedule of quantities.

38.02 Without restricting to the generality of the foregoing the pumps and the ancillary equipment and shall include the following:

Electrically/diesel operated pumps with motors/diesel engine, base plate and accessories.

Pump suction and delivery headers, valves, air vessel and connections.

- a) Alarm system, Pressure gauges/Pressure switch.
- b) Electrical switchboards, wiring, cabling, cable tray, control panel and properly connecting to earthing system of the Factory.
- c) Foundations, vibration eliminator pads and foundation bolts.

39.00 GENERAL REQUIREMENTS

39.01 Pumps shall be installed true to level on suitable concrete foundations. Base plate shall be firmly fixed by foundation bolts properly grouted in the concrete foundations.

39.02 Pumps and motors shall be truly aligned with suitable instruments.

39.03 All pump connections shall be standard flanged type with appropriate number of bolts.

39.04 Manufacturer instructions regarding installation connections and commissioning shall be followed with respect to all pumps, switchgear and accessories.

40.00 QUALITY CONTROL

40.01 These shall comply with the IS Codes as specified.

41.00 SUBMISSIONS

41.01 Product Manuals

41.02 Hydraulic Details

42.00 STORAGE

These shall be stored as delivered in original packings.

43.00 FIRE AND JOCKEY PUMPS

43.01 Pump Sets

- i) Centrifugal, split casing, horizontal pump should be selected as per IS. Pump should have following specification.
Materials of Construction

PARTS	
CASING	CAST IRON
IMPELLER	BRONZE IS:318, GR.LTBJ/LTB 2 SS-410
CASING WEARING	CAST IRON
SHAFT	STAINLESS STEEL
SHAFT SLEEVE	SS-410
SHAFT SEAL	MECHANICAL
THRUST BEARING	ANTI-FRICTION OF TITLING PAD TYPE

- ii) Pumps shall be connected to the drive by means of spacer type love joy couplings, which shall be individually balanced dynamically and statically.
- iii) The coupling joining the prime movers with the pump shall be provided with a sheet metal guard.
- iv) Pumps shall be provided with approved type of mechanical seals.
- v) Pumps shall be capable of delivering not less than 150% of the rated capacity of water at a head of not less than 65% of the rated head. The shut off head shall not exceed 120% of the rated head.
- vi) The pump shall meet the requirements of the Tariff Advisory Committee and the unit shall be design proven in fire protection services.
- vii) Pumps shall be provided with pressure gauge with isolation cock on the delivery side.
- viii) In case of motor driven pump the motor rating should be adequate to drive the pump at 150% of rated discharge.

Waterproof PVC coated windings.

43.02 Electric Drive

- i) Electrically driven pumps shall be provided with totally enclosed fan cooled induction motors. For fire pumps the motors should be rated not to draw starting current more than 3 times normal running current.

- ii) Motors for fire protection pumps shall be at least equivalent to the horse power required to drive the pump at 150% of its rated discharge and shall be designed for continuous full load duty and shall be design proven in similar service.
- iii) Motors shall be wound for class B insulation and winding shall be vacuum impregnated with heat and moisture resistant varnish glass fibre insulated.
- iv) Motors for fire pumps shall meet all requirements and specifications of the Tariff Advisory Committee.
- v) Motors shall be suitable for 415 volts, 3 phase 50 cycles a/c supply and shall be designed for 38 deg. C ambient temperature. Motors shall conform to I.S. 324.
- vi) Motors shall be designed for two start system.
- vii) Motors shall be capable of handling the required starting torque of the pumps.
- viii) Contractor shall provide inbuilt heating arrangements for the motors for main pumps to ensure that motor windings shall remain dry.
- ix) Speed of the motors shall be compatible with the speed of the pump.
- x) The fire pumps shall operate on drop of pressure in the mains as given below. The pump operating sequence shall be arranged in a manner to start the pump automatically but should be stopped manually by starter push buttons only.

43.03 Operating Conditions for Fire & Sprinkler Pumps

	CUT IN	CUT OUT	REMARKS
Operating Pressure	-----	(10M+Head of pump as per BOQ in M). ie 1.0+(H)Kg/Sq m	-----
Jockey Pump	(H-0.5) Kg/Sqcm.	H Kg/Sqcm.	Jockey pump to stop when main fire pumps starts
Main Fire Pump (One No)	(H-1.0) Kg/Sqcm.	Push button manual	To start by pressure switch No. 2 on air vessel
Common Diesel Engine (One NO)	(H-2.0) Kg/Sqcm.	Push button manual	To start by pressure switch No. 3

44.00 Vibration Eliminators

- 44.01 Provide on all suction and delivery lines double flanged reinforced neoprene flexible pipe connectors. Connectors should be suitable for a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connector shall be as per manufacturer details.

45.00 Installation

- 45.01 Pumps shall be installed true to level on suitable concrete foundations. Base plate shall be firmly fixed by foundation bolts properly grouted in the concrete foundations.
- 45.02 Pumps and motors shall be truly aligned by suitable instruments.
- 45.03 All pump connections shall be standard flanged type with appropriate number of bolts. In case of non-standard flanges companion flanges shall be provided with the pumps.
- 45.04 Manufacturer's instructions regarding installation, connections and commissioning shall be followed with respect to all pumps and accessories.
- 45.05 Contractor shall provide necessary test certificates and performance charts with NPSH requirement of the pumps from the manufacturer. The contractor shall provide facilities to the Architect or their authorised representative for inspection of equipment during manufacturing and also to witness various tests at the manufacturer's works without any cost to the owners.

46.00 DIESEL ENGINE

- 46.01 Diesel engine shall be of 6 cylinders with individual heat assemblies. The engine shall be water cooled and shall include heat exchanger and connecting piping strainer, isolating and pressure reducing valves, by pass line, exhaust pipe, silencer day tank for fuel all interconnected piping etc. complete in all respects.
- 46.02 The speed of the engine shall match the pump speed for direct drive.
- 46.03 The engine shall be capable of being started without the use of the wicks, Cartridge heater plugs or either at the engine room temperature 4 deg.C and shall take full load within 15 second from the receipt of the signal to start.
- 46.04 The engine shall effectively (i.e. without any derating) operated at 46 deg.C ambient temperature at 150 meter above mean sea level.
- 46.05 Noise level of the engine shall not exceed 90 db (free sound pressure) at 3-meter distance
- 46.06 The engine shall be self starting type upto 4 deg.C shall be provided with one 24 volts heavy duty D.C. battery, starter, cutout, battery leads complete in all respects. One additional spare battery leads complete in all respects. One additional spare battery shall be provided. The battery shall have an adequate capacity for cold cranking amperage as recommended by the Engine Manufacturer.
- 46.07 An automatic change over system shall be provided so that the spare battery comes into operation in case the engine is not started by its own battery.
- 46.08 Pump Control Panel should have visual and audio alarm and indication for battery failure.
- 46.09 The working battery as well as battery should have output amperage capacity for at least 3 consecutive cranking/starting of the Engine.

- 46.10 Provide a battery charger of sufficient amperage capacity of fully charge the batteries in 20 hours with tickle and booster charging facility and regulators.
- 46.11 Arrangement for starting shall be automatic on receiving the signal. But shut-off shall be manual.
- 46.12 The engine shall be provided with an oil bath or dry type air cleaner as per manufacturer's design.
- 46.13 Engine shall be suitable for running on high-speed diesel oil.
- 46.14 The system shall be provided with a control panel with push button starting arrangement also wired to operate the engine by differential pressure switches.
- 46.15 The entire system shall be mounted on a common structural base plate with anti vibration mounting and flexible connections on the suction and delivery piping.
- 46.16 Contractor shall provide one fully mounted and supported day oil tank fabricated from 6mm thick MS sheet electrically welded with capacity for 8 hours working at full load but not less than 200 ltrs. Provide level indicators - low level and full level in the day oil tank on the control panel through float switches and an air breather. Day oil tank shall also be provided with filling connection (threaded) with cap, gauge glass indication & cocks, drain cock, inspection/cleaning cover with gasket and nuts/bolts. M.S. dyke to hold 150% of the day tank capacity to be built around the Day Tank.
- 46.17 Contractor to provide one exhaust pipe with suitable muffler (residential type) to discharge the engine gases to outside in open air as per site conditions (contractor to check the site).
- 46.18 Contractor to provide all accessories, fittings, and fixtures necessary and required for a complete operating engine set. The exhaust pipe shall be taken outside the building with minimum number of bends (approx. length 30 Mts.) and shall be duly heat insulated with 50mm thick glass wool covered with 24 gauge aluminum cladding.
- 46.19 Contractor shall submit to the Owner special requirements, if any, for the ventilation of the pump room.

47.00 BASE PLATE

Pumps and motors shall be mounted on a common structural base plate and installed as per manufacturer instructions.

48.00 AIR VESSEL

The contractor shall provide one air vessel fabricated from 8mm M.S. plates with 10mm dished ends and suitable supporting legs. Each air vessel shall be provided with a 80mm dia, flanged connection from pump, one 25mm dia, drain with valve, one gun metal water level gauge and 25mm sockets for pressure switches. The vessel shall be 450mm dia x 1800mm high and tested to 20 Kgs./Sq.cm. pressure.

49.00 CUBICLE TYPE SWITCH BOARDS/L.T. PANEL

49.01 Cubicle type switch boards and components shall conform to the requirements of the latest revision including amendments of the following codes and standards.

IS:8623	:	Specification for factory built assemblies of switch-gear and control gear for voltage up to and including 1000-V AC/1200 V-DC.
IS:4237	:	General requirements for switchgear and control-gear for voltage not exceeding 1000-V.
IS:2147	:	Degree of protection provided by enclosures for low voltage switchgear and control-gear.
IS:1018	:	Switchgear and control-gear selection/installation and maintenance.
IS:6005	:	Code of practice for phosphating of iron and steel.
IS:13947-1993/ IE:C947-1989	:	Air circuit breaker/Moulded case circuit breaker.
IS:1248	:	Direct acting indicating analogue electrical measuring instruments and testing accessories.
IS:2705 Part I, II & III 1964	:	Current transformers for metering & protection with classification burden & insulation.

The board shall be metal enclosed single front, indoors, floor mounted free standing type or wall mounting type as mentioned in BOQ. The panel shall be designed for a degree of protection of IP-52. The panel height shall not exceed 2350 mm including horizontal main bus bar at top. Keeping in view the operating height of the top switch 1750mm from finish floor. 400-mm clear space shall be left through out the panel at bottom. The cold rolled sheet steel will be of 2mm thick.

All cutouts and covers shall be provided with synthetic rubber gaskets. (Preferably neoprene).

The panel shall be divided into distinct vertical sections each comprising of:

- i) Complete enclosed bus bar compartment for running horizontal and vertical bus bars.
- ii) Complete enclosed switchgear compartment one for each circuit for housing air circuit breaker, MCCB etc.
- iii) Compartmentally for power and control cables of at least 300mm width covering entire height provided.

All cable alley must be provided with threaded nipples for CO2 flooding system and shall be connected to all compartment with centralized CO2 system

- vi) The panel shall have 20% spare space duly wired for future use.

The front of each compartment shall be provided with hinged single lead door with locking facilities. Panel shall be provided with suitable lifting facilities. Isolators & MCCB/ACBs shall be of fixed/drawout type as described later.

Each feeder shall have compartmentalized construction cable entry shall be from top/bottom (3mm thick gland plate shall be provided) as required.

The panel shall be provided with three phase buses and neutral bus bars of aluminum sections throughout the length of the panel and shall be adequately supported and braced to withstand the stresses due to the short circuit current of 50 KA rms. For 1 sec. Maximum temperature rise of bus bars and bus bar connection while carrying rated current shall not exceed 40 amp. over an ambient temperature of 50 deg.C.

The minimum clearance in air between phases and between phases and earth for the entire run of the bus bar connections shall be 25mm minimum bus bars support insulators shall be made of non-hydroscopic non-combustible track resistant and high strength type porcelain or polyester fiber glass moulded material.

All bus bars shall be colour coded as per IS: 375 and the current density shall be 1 amp/sq.mm.

G.I. earth bus of 50x6mm size shall be provided at the bottom of the panel throughout the length. Similarly 40x6mm G.I. strip in each vertical section for earthing the individual equipment/accessories shall be provided and connected to main horizontal bus.

Contractors shall be electro-magnetic types with interrupted duty as per IS: 2959. The main contacts shall be of Silver or silver alloy, provided with minimum 2 NO and 2 NC auxiliary contacts. The push button should be of shrouded type and each should be provided with 1 NO and 1 NC contact. Colour coding shall be as per IS: 6875 (Part II).

50.00 ACB

The circuit breaker shall be of air break type in order to eliminate fire and explosion risk and shall comply with the IS: 13947-1993 with a rupturing capacity of not less than 50 MVA at 415 volts or as specified elsewhere (The service short circuit breaking capacity shall be as specified and equal to the short circuit with stand value). The breaker shall be provided with microprocessor based releases for over load and short circuit protection.

The breaker shall consist of a horizontal drawout pattern triple pole, fully interlocked, independent manual spring operated mechanism. The mechanism should be such that the circuit breaker is at all times free to open immediately. The trip coil is energized. Current carrying parts should be silver plated and suitable arcing contacts shall be provided to protect the main contact arc-chutes for each pole shall be provided and shall be lifted out for the inspection of main and arcing contact.

Self-aligning cluster type isolating contacts shall be provided on breaker for interlocking protection metering and for any other purposes.

Breaker shall be provided with automatic safety shutters to screen the main live contact when the breaker is withdrawn. The frame of the circuit breaker should be positively earthen when the breaker is racked into the cubicle.

The following safety arrangements shall be provided for the safety of the personnel to preventnal-operation.

- i) Interlock to prevent the truck from being withdrawn or replaced except in the fully isolated position.
- ii) Interlock to prevent earth connection from being made by the earthing device except breaker is open.
- iii) Interlock to prevent the breaker from being made alive without its rack in position.

51.00 Moulded Case Circuit Breaker (MCCB)

MCCB shall conform to the latest IS: 13947-1993/IEC 947-1989. The Service Short Circuit Breaking Capacity (ICS at 415 VAC) should be 50 KA.

MCCB shall be Current Limiting and comprise of Quick Make - Break switching mechanism preferably Double Break Contact system are extinguishing device and the tripping unit contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses. All MCCBs shall be capable of defined variable overload adjustment. All MCCBs rated 200 Amps and above shall have adjustable magnetic short circuit pick up.

The trip command shall over ride all other commands. MCCB shall employ maintenance free double break contact system to minimize the let thru' energies and capable of achieving discrimination upto the full short circuit capacity of downstream MCCB. The manufacturer shall provide both the discrimination tables and let thru' energy curves. The MCCB shall not be restricted to Line/Load connections.

The handle position shall give positive indication of 'ON', 'OFF' or 'Tripped' thus qualifying to disconnection as per the IS/TEC indicating the true position of all the contacts. In case of 4 poles MCCB the neutral shall be defined and capable of offering protection.

The general-purpose control switch shall be provided for ON/OFF Auto/Manual. The switch shall be provided with engraving plates on the front with the complete inscription.

The switch shall be normally a fixed control box type heavy-duty unit.

Indicating lamps shall be of the panel mounting, LED type and shall have execution plates marked with its function wherever necessary. The colour of the lamp cover shall be red for 'ON' and green for 'OFF'.

52.00 Motors and Starters for Fire Pumps

The starters shall be of DOL type. The motors should have double sq. cage or other provision to limit the starting current to 4 times the full load current.

53.00 Name Plates & Lables

- i) Panel and all modules shall be provided with prominent engraved identification plates. The module identification designation. For single front switchboards, similar panel and board identification lables shall be provided at the rear also.
- ii) All nameplates shall be of non-rusting metal or 3-ply lamicold, with white engraved lettering on black background. Inscription and lettering sizes shall be subject to Owner's approval.
- iii) Suitable stenticilled paint marks shall be provided inside the panel/module identification of all equipment in addition to the plastic sticker lables, if provided. These labels shall be partitioned so as to be clearly visible and shall have the device number, as mentioned in the module wiring design.

54.00 Painting of all Steel Work

The steel used for fabrication of electrical/panels/equipment should be stove enameled as per the detailed specifications given below:

- a) Degreasing: All the steel components, to be painted, should be effectively cleaned by alkaline degreasing.
- b) Pickling: Oxide scale rust formation are to be removed in a hot bath of sulphuric acid. Pitting of the surface is to be prevented by the use of pickling inhibitors.
- c) Cold Rinsing: The parts are then to be washed with cold water to remove all traces of acidic solution.
- d) Phosphating: In order to attain durable paint coating the metal surface is to be given phosphating treatment by development a phosphate layer on the surface. Preferably hot grenadine solution is to be used in the phosphating plant.
- e) Passivating: This process is to be carried out by using deoxidate solution.
- f) Drying: The treated parts should then be dried in a hot chamber in dust free atmosphere to ensure that they are absolutely clear and dry before the paint is applied.
- g) Primer Coating: The treated and dried parts are to be sprayed with high corrosion resistance primer.
- h) Stove Drying: The primer coating is to be backed in an electrically heated, air circulated area type storing oven.
- i) Finishing Coat: The finishing paint coat is to be applied by spraying two coats of 15 micron thickness powder coated paint of approved shade.

55.00 Wiring

Control and protective wiring shall be done with copper conductor PVC insulated 1100 volts grade multi-stranded flexible wire of 2.5 sq.mm 2 cross section. The colour coding shall be as per latest edition of IS: 374.

Each wire shall be identified by plastic ferrule. All wire termination shall be made with type connection. Wire shall not be taped or spliced between terminal points.

Terminal blocks shall preferably be grouped according to circuit function and each terminal block group shall have at least 20% spare capacity.

Not more than 1 (one) wire shall be connected to any terminal block.

56.00 Current Transformer

Current transformers shall be of ratio, burden (shall be worked out by panel supplier), class/accuracy specified in Single Line Diagram.

Current transformers shall conform to latest edition to relevant standards. Current transformers shall be epoxy resins cast with bar Primary or ring type.

The design and construction shall be sufficiently robust to withstand thermal and dynamic stresses due to the maximum short circuit current of the circuit.

The current transformer shall preferably be capable of being left open circuited on the secondary side with primary carrying rated full load current, without overheating or damage. Short time current rating and rated withstands time shall be same as corresponding C.B.

CT core laminations shall be of high-grade silicon steel.

Secondary terminals of CT shall be brought out to a terminal block, which will be easily accessible for testing and external connections. Facility shall be provided for short-circuiting and earthing of CT secondary leads through a removable and accessible link with provision for attaching test link.

Rating plate details and terminal markings shall be according to the latest edition of relevant Indian Standard specification.

Generally separate current transformers (core) shall be used for metering and protection.

57.00 CABLES

- a) Contractor shall provide all power and control cables from the motor control center to various motors and control devices, of ratings as per IS: 3961.
- b) All power and wiring cables shall be FRLS with (inner and outer sheath) aluminium conductor PVC insulated armoured and PVC sheathed of 1.1 KV grade. Control cables and power cables of 2.5 sq.mm or less shall be of copper, FRLS, armoured. Cables and wires shall comply with requirements of IS: 5831, 694, 8130, 7098 (I) & 1554 as the case may be.
- c) All cables shall have stranded conductors. The cables shall be supplied in drums as far as possible and bear the manufacturer's identification mark.

- d) All cable joints shall be made in an approved manner as per accepted practice.

58.00 CABLE TRAYS

58.01 Cable trays shall be 2mm thick GI/CRCA powder coated as per approved shade of client. Sheet steel, ladder type/perforated cable trays including fixing along wall/ceiling complete with M.S. rod/flat hangers directly grouted in walls/ceiling etc as required.

58.02 The sizes shall be as follows and as directed by the Owner.

A. PERFORATED CABLE TRAY

- a) 150 mm wide 75 mm deep
- b) 300 mm wide 75 mm deep

B. LADDER TYPE CABLE TRAY

- a) 150 mm wide
- b) 300 mm wide

59.00 EARTHING

59.01 Fire Fighting Contractors shall have to provide earthing strips (G.I. 25x3mm) or earthing wires (G.I. 8 SWG) as may be required for proper earthing of the equipments supplied by him. Thickness of galvanization to be 75 microns (minimum). Each electrical equipment is to be earthen at 2 points.

1103 SPECIFICATIONS FOR FIRE HYDRANT SYSTEM

60.00 SCOPE OF WORK

60.01 Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install wet riser fire hydrant system as required by the drawings and specified hereinafter or given in this schedule of quantities.

60.02 Without restricting to the generality of the foregoing, the fire hydrant system shall include the following: -

Mild steel mains including valves, hydrants and all other accessories.

Mild steel pipe fire risers within the building.

Landing valves, synthetic hose pipes, hose reels, hose cabinets, fire brigade connections, connection to pumps, appliances and pressure reducing devices.

Excavation, anchor blocks and valve chambers.

61.00 GENERAL REQUIREMENTS

61.01 All materials shall be of the best quality conforming to the specifications and subject to the approval of the employer. The wet riser system shall remain pressurized at all

times during operation, and as such the piping work shall be carried out to withstand the same.

61.02 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

61.03 Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages, etc.

61.04 Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for RCC ceilings and walls.

61.05 Valves and other appurtenances shall be so located that they are easily accessible for operations, repairs and maintenance.

62.00 PIPES AND FITTINGS

FOR INTERNAL WORK:

a. All pipes within the building in exposed locations and shafts including connections buried under floor shall be ERW mild steel tubes conforming to IS: 1239 (Heavy class) up to 150mm AB and IS 3589 above 150 NB's with screwed or welded joints as specified by the engineer in charge at least 10% of welded joints shall be radiographically tested.

b. Fittings of 50mm or below shall be forged steel with socket weld ends of approved makes. For 65mm and above shall be W.I./M.S. with butt weld ends.

63.00 JOINTING

Gasket, for use in between flanged joints, to be of CAF as per IS-2712, thickness as specified in S.O.Q.

64.00 EXCAVATION

64.01 Excavations for pipeline shall be in open trenches to levels and grades shown on the drawings or as required at site. Pipelines shall be buried to a minimum depth of 1 to 1.5 meter or as shown on the drawings.

64.02 Wherever required contractor shall support all trenches or adjoining structures with adequate supports to prevent land slides.

64.03 On completion of testing and painting, trenches shall be refilled with excavated earth in 15-cm layers and compacted.

64.04 Contractor shall dispose off all surplus earth within the site.

65.00 ANCHOR BLOCKS

65.01 Contractor shall provide suitable cement concrete anchor blocks as may be necessary for overcoming pressure thrusts in under ground/external pipes. Anchor blocks shall be of cement concrete 1:2:4 mix.

66.00 VALVES

- 66.01 Butterfly valves above 65mm shall be of cast iron body and bronze/gunmetal seat. They shall conform to type PN 1.0 of IS: 13095.
- 66.02 Non return valves shall be of cast iron body and bronze / gunmetal seat. They shall be swing conform to Class 1 of IS: 5312 and have flanged ends. They shall be swing check type in horizontal runs and lift check type in vertical runs of piping. They shall not be spring loaded type.
- 66.03 Check valves shall be cast iron double flanged conforming to IS 5312-1975 with cast iron steel body and stainless steel internal trims.

Valves on pipes 65mm and below shall be heavy pattern gunmetal valves with cast iron wheel seat tested to 20kg/sqcm pressure. Valves shall conform to IS:778.

67.00 FIRE HYDRANTS

67.01 EXTERNAL HYDRANTS

Contractor shall provide external hydrants. The hydrants shall be controlled by a cast iron sluice valve. Hydrants shall have instantaneous type 63-mm dia outlets. The hydrants shall be of gunmetal and flange inlet and single outlet conforming to I.S.5290-1983 with G.I. duck foot bend and flanged riser of required height to bring the hydrant to correct level above ground.

- 67.02 Contractor shall provide for each external fire hydrant two nos. of 63 mm dia 15 meter long synthetic fibre non perculating hose pipe with gunmetal male and female instantaneous type couplings machine wound with copper wire hose to I.S. 636 type B and couplings to IS 903 with IS certification), gunmetal branch pipe with 16 mm nozzle to I.S. 903-1984.

68.00 INTERNAL HYDRANTS

- 68.01 Contractor shall provide on each landing and other locations as shown on the drawings one single headed gunmetal landing valve with 63 mm dia outlets and 80 mm inlet (I.S. 5290-1969) with individual shut off valves and cast iron wheels. Landing valves shall have flanged inlet and instantaneous type outlet as shown on the drawings.
- 68.02 Instantaneous outlets for fire hydrants shall be of standard pattern approved and suitable for fire brigade hoses. Contractor shall provide for each internal fire hydrant station four numbers of 63 mm dia 7.5 meter long synthetic non perculating hose pipes with gunmetal male and female instantaneous type coupling machine wound with G.I. wire (Hose to I.S. 636 type B and couplings to I.S. 903 with I.S. certification), fire hose reel, gunmetal branch pipe with nozzle I.S. 903 fireman's axe.
- 68.03 Each hose box shall be, after thorough cleaning of surface, painted as per Section 28 of General Technical Specifications. The words FIRE HOSE to be painted on the inner face of the glass.

69.00 FIRST AID HOSE REELS

69.01 Contractor shall provide standard fire hose reels with 20 mm dia high pressure rubber hose of 36 meters length with gunmetal nozzle with 5mm bore, and control valve, shut of nozzle connected wall mounted on circular hose reel of heavy duty mild steel construction and cast iron brackets. Hose reel shall conform to IS: 884-1969. The hose reel shall be connected directly to the M.S pipe riser through an independent connection.

70.00 PRESSURE GAUGES

70.01 All pressure gauges shall be of dial type with bourdon tube element of SS 316. The gauge shall be of reputed make. The dial size shall be 150-mm dia and scale division shall be in metric units marked clearly in black on a white dial. The range of pressure gauge shall be 0 to 12 kg/sq.cm.

70.02 All pressure gauges shall be complete with isolation cock, nipples, tail pipes etc.

71.00 PRESSURE SWITCHES

71.01 The pressure switch shall be industrial type single pole double throw electric pressure switch designed for starting or stopping of equipment when the pressure in the system drops or exceeds the pre-set limits. It shall comprise of a single pole changeover switch, below element assembly and differential sprindle.

71.02 All the pressure switches shall have 1/4" B.S.P (f) inlet connection and screwed cable entry for fixing cable gland.

71.03 The electric rating of the switch shall be as under:

Type of supply	Voltage	Non -Inductive	Inductive
A.C.	110-380	10 Amp	6 Amp
D.C.	24-250	12 Watts	12 Watts

72.00 FIRE BRIGADE CONNECTION

72.01 The contractor shall provide as shown on drawing gunmetal four ways collecting head with 63mm dia instantaneous type inlets with built in check valve and 100/150 mm dia. Outlet connection to the fire main grid and for tank filling, collecting head shall conform to IS: 904-1964.

73.00 AIR VALVES

73.01 The contractor shall provide 25 mm dia screwed inlet cast iron single acting air valve on all high points in the system or as shown on drawings.

74.00 DRAIN VALVE

50mm dia black steel pipe conforming to IS:1239 heavy class with 50mm gunmetal full way valve for draining and water in the system in low pockets.

Pressure gauge of suitable range shall be installed on the discharge side of each pump vacuum gauge shall be provided on suction side for pumps with negative suction. The dial size shall be 250mm. The gauges shall have brass cocks.

Orifice plates shall be of 6mm thick stainless steel to reduce pressure on individual hydrants to operating pressure of 3.5kg/sq.cm. Design of the same shall be given by the Contractor as per location and pressure condition of each hydrant.

75.00 VALVE CHAMBERS

75.01 Contractor shall provide suitable brick masonry chambers in cement mortar 1:5 (1 cement: 5 coarse sand) on cement concrete foundations 150 mm thick 1:5:10 mix (1 cement: 5 fine sand 10 graded stone aggregate 40 mm nominal size) 15 mm thick cement plaster inside and outside finished with a floating coat of neat cement inside with cast iron surface box approved by fire brigade including excavation, back filling, complete.

75.02 Valve chamber shall be of the following size:

For depths 130 cm and beyond 120x120 cms
Weight of C.I. frame and cover shall be 38 kg.

76.00 PIPE PROTECTION

See Clause 15.0 & 16.0 on 'Painting' and 'Coating/wrapping' under General Technical Specifications).

77.00 PIPE SUPPORTS

77.01 All pipes shall be adequately supported from ceiling or walls by means of anchor fasteners by drilling holes with electrical drill in an approved manner as recommended by manufacturer of the fasteners.

77.02 All supports/clamps fabricated from M.S. structural e.g. rods, channels, angles and flats shall be painted as described in specifications for "Painting" under General Technical Specifications.

77.03 Where inserts are not provided the contractor shall provide anchor fasteners. Anchor fasteners shall be fixed to walls and ceilings by drilling holes with electrical drill in an approved manner as recommended by the manufacturer of the fasteners.

Pipe Support Spacing	Horizontal	Vertical
Pipe upto 50 mm	2 Mtr	3 Mtr
Pipe 65 - 100 mm	1.75 Mtr	3 Mtr
Pipe above 100mm	1.50 Mtr	3 Mtr

78.00 AIR VESSEL AND AIR RELEASE VALVE

Air vessel on top of each wet riser piping shall be installed before execution for approval fabricated out of at least 8mm thick steel to withstand the pressure, with dished ends and supporting legs. This shall be of 300 mm dia and 1m high. This shall be completed with necessary flange connection to the wet riser piping and air release valve with necessary piping to meet the functional requirement of the system. The air vessel shall be of continuous welded construction and galvanized to IS: 4736-1968. This shall be tested for twice the working pressure.

79.00 TESTING

- 79.01 All piping in the system shall be tested to a hydrostatic pressure of 11.0 kg/sq.cm without drop in pressure for at least 2 hours.

Rectify all leakages, make adjustments and reset as required and directed.

80.00 HOSE CABINETS

- 80.01 Provide doors/hose cabinets for internal/external hydrants respectively fabricated from 16 gauge M.S. sheet with double glass front door and locking arrangement, with breakable glass key access arrangement, duly painted red as per specifications given on page 12 para 28.8 fixed to wall/floor as per site conditions. The cabinet shall have a separate chamber to stove a key with breakable glass as per approved design. Hose cabinets shall be hinged double door partially glazed with locking arrangement, painted as per Section 28 of General Technical Specifications with 'FIRE HOSE' written on it prominently. Samples of hose cabinet for indoor and outdoor works shall be got approved from HSCC before production/delivery at site.
- 80.02 For external hydrants the hose cabinets shall be fabricated from 16 gauge thick M.S. sheet with double shutter glass front door and locking arrangement with breakable glass key access arrangement. The cabinet shall have 'FIRE HOSE' written on it prominently. Sample of hose cabinet shall be got approved from the HSCC before installation at the site.

81.00 MEASUREMENT

- 81.01 Mild steel pipes shall be measured per linear meter of the finished length along the center line and shall include all fittings (including flanges), welding, jointing, clamps for fixing to walls or hangers, anchor fasteners and testing.
- 81.02 Butterfly valves, check valves and full way valves shall be measured by numbers and shall include all items necessary and required for fixing and as given in the specifications/schedule of quantities.
- 81.03 Landing valves hose cabinets, synthetic non-perculating fire hose pipes, First-aid fire hose reels (with gunmetal full way valves) and gunmetal branch pipes shall be measured by numbers and shall include all items necessary and required for fixing as given in the specifications/schedule of quantities.
- 81.04 Suction and delivery headers shall be measured per linear meter or finished length and shall include all items as given in the schedule of quantities.
- 81.05 Painting/wrapping/coating of headers, pipes shall be included in the rate for pipes and no separate payment shall be made.
- 81.06 Brick masonry chambers shall be measured by number and shall include all items as given in the schedule of quantities/specifications.
- 81.07 No additional payment shall be admissible for cutting holes or chases in walls or floors, making connections to pumps, equipment and appliances.

1104 SPECIFICATIONS FOR SPRINKLER SYSTEM

82.00 SCOPE OF WORK

82.01 Work under this section shall consist or furnishing all labour, materials, equipment and appliances necessary and required to completely install the sprinkler system as required by the drawings and specified herein after or given in the schedule of quantities.

- a) Sprinkler mains, branch and external piping complete with valves, alarm, hangers and appurtenances and painting.
- b) Sprinkler heads with spare sprinklers
- c) Connections to risers, pumps and appliances

82.02 GENERAL REQUIREMENTS

82.01 All materials shall be of the best quality conforming to specifications and subject to the approval of the engineer.

82.02 Pipes and fittings shall be fixed truly vertical horizontal or in slopes as required in neat workman like manner.

82.03 Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages, etc.

82.04 Pipes shall be supported from walls and ceiling by suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for RCC ceilings and walls.

82.05 Valves and other appurtenances shall be so located that they are easily accessible for operations, repairs and maintenance.

82.06 Sprinkler heads shall be approved by the underwriters Laboratories (U.L.) or Fire officers Committee (FOC). The finish shall be as specified in the schedule of quantities. The contractor shall give required tools for removing and fixing of different types of sprinklers free of cost as directed by the HSCC.

83.00 SPRINKLER HEADS

a) Sprinkler heads shall be of quartzoid bulb type with bulb, valve assembly yoke and the deflector. The sprinklers shall be of approved make and type.

b) Types:

i) Conventional Pattern:

The sprinklers shall be designed to produce a spherical type of discharge with a portion of water being thrown upwards to the ceiling. The sprinklers shall be suitable for erection in upright position or pendant position.

ii) Spray Pattern:

The spray type sprinkler shall produce a hemispherical discharge below the plane of the deflector.

iii) Ceiling (flush) Pattern:

These shall be designed for use with concealed pipe work. These shall be installed pendant with plate or base flush to the ceiling with below the ceiling.

c) Constructions:

i) Bulb: - Bulb shall be made of corrosion free material strong enough to with stand any water pressure likely to occur in the system. The bulb shall shatter when the temperature of the surrounding air reaches a predetermined level.

ii) Valve Assembly:-Water passage of the sprinkler shall be closed by a valve assembly of flexible construction. The valve assembly shall be held in position by the quartzoid bulb. The assembly be stable and shall withstand pressure surges or external vibration without displacement.

iii) Yoke: - The yoke shall be made of high quality gun metal. The arms of yoke shall be so designed as to avoid interference with discharge of water from the deflector. The sprinkler body shall be coated with an approved anti-corrosive treatment if the same is to used in corrosive conditions.

iv) Deflector:-The deflector shall be suitable for either upright or pendent erection. The deflector shall be designed to give an even distribution of water over the area protected by each sprinkler.

d) Colour Code:

The following colour code shall be adopted for classification of sprinkler according to nominal temperature ratings:

e) Size of Sprinklers Orifices:

The following sizes of sprinklers shall be selected for various classes or hazards.

Extra light hazard	10/15 mm nominal bore
Ordinary light hazard	15 mm nominal bore
Extra high hazard	15/20 mm nominal bore

f) Stock of replacement sprinkler:

The following spare sprinklers shall be supplied along with the system:

Extra high hazard systems	6 sprinklers
Ordinary hazard systems	24 sprinklers
Extra high hazard systems	36 sprinklers

g) Temperature Rating:

For normal conditions in temperature climates rating of 68/74 deg. C shall be used. However the temperature rating shall be as closed as possible to, but not less than 30 deg. C above the highest anticipated temperature conditions.

84.00 Installation Control Valve:- Installation control valves shall comprise of the following:

- a. One man stop valve of full way pattern with gunmetal pointer to indicate where open/shut.
- b. One automatic alarm valve, fitted with handle and cover.
- c. One hydraulic alarm motor and gong for sounding a continuous alarm upon out-break of fire.
- d. One combined waste and testing valve including 5mtr of tubing and fittings.
- e. Alarm stop valve
- f. Strainer
- g. Drain plug
- h. Padlock & strap
- i. Wall box for installation of valve

85.00 Pressure Gauges:-Burden type pressure gauges conforming to IS/BS specifications shall provide at the following locations.

- a. Just above alarm valve.
- b. Just below alarm valve, on the installation stop valve.
- c. One pressure gauge on delivery side of each pump.
- d. Required number of pressure gauges on pressure tank.

86.00 INSTALLATION OF PIPING

86.01 Below ground piping: - Under ground piping shall be installed in masonry trenches with cover or reinforced concrete. The pipe work shall be supported at regular intervals of 2.5m with masonry or RCC supports. Wherever pipes pass through roads/pavements suitable size hue pipes shall be provided for protection of piping. Underground pipes shall be protected against corrosion with two coats of bituminous painting and wrapped with tarfelt or similar covering. If the piping is to be buried in ground with back filling of earth, a coat of epoxy painting shall be given.

86.02 Above ground piping:-

a. All above ground piping shall be installed on suitable to pipe hangers/supports as required. The hangers shall be made of MS angles, channels etc. and painted to the required finish (with suitable synthetic enamel Paint). The spacing of piping supports shall be as follows:

- | | | |
|-----|------------------|-------|
| i) | 20mm to 32mm dia | 2 mtr |
| ii) | 40mm to 65mm dia | 2 mtr |

- | | | |
|------|-------------------|----------|
| iii) | 65mm to 100mm dia | 1.75 mtr |
| iv) | above 150mm dia | 1.50 mtr |
- b. Piping shall be so installed that the system can be thoroughly drained. All the pipes shall be arranged to drain to the installation drain valve. In case of basement and other areas where the pipe work, is below the installation drain valve/auxiliary valves of the following sizes shall be provided.
- i) 20mm dia valve for pipes upto 50mm dia
ii) 25mm dia valve for 65mm dia pipes
iii) 32mm dia valves for pipes larger than 65mm dia
- c. Piping shall be screwed type upto 50mm dia. Welding of joints will be allowed for pipes of 50mm of larger diameters.
- d. The piping shall be pressure tested by the hydrostatic method upto a pressure of 1.5 times the working pressure the piping shall be slowly charged with water so that all the air is expelled from the piping by providing a 25mm inlet with a stop cock. The piping shall be allowed to stand full of water for a period of 2 hours and then the piping shall be put under pressure by means of manually operated test pump or by a power driven test pump. The pressure gauges used for testing shall be accurate and shall preferably be calibrated before the testing is carried out. All the leakages and defects in joints revealed during the testing shall be rectified to the entire satisfaction of the Consultant. The system may be tested in sections parts as the work of erection of piping proceeds. The piping shall withstand 1.5 times the working pressure for at least 2 hours.

87.00 FLOW SWITCH

- 87.01 Provide one electrically operated flow switch of appropriate dia, at the head of each circuit. Flow switches should be capable of the required flow in the circuit. The electrical cabling for the flow switches and control panel shall be provided by the contractor.

88.00 PUMP SETS

Same as wet riser & Hydrant system specification.

89.00 ANNUNCIATION SPRINKLER PANEL

The equipment for control panel should be compact neatly wired and enclosed in a suitable 14 gauge M.S. sheet/16 CRCA sheet Metal Box which is suitably treated against corrosion. The control panel should be painted with over banked enamel paint. The panel shall consist of:

- a) Panel should be made in a modules of 10 zones e.g. Each module will have audible and visual indications and will monitor the circuit conditions.

A.C. Power Supply
Fault and Fire indication lamp.
Alarm acknowledgment push buttons.

- b) The circuits provided in the control panel for each zone shall indicate the following conditions:
 - i) Open Circuit in zone wiring
 - ii) Short Circuit in zone wiring
 - iii) Normal conditions
 - iv) Power failure
 - v) Low battery
- c) The Automatic annunciation panel shall suitable for operation on 24V DC and shall be provided with power supply unit suitable to operate on A.C. mains of 230V with a variation of 10%. The system shall be so designed that in case of failure of A.C. main supply it shall automatically change over to battery supply.
- d) Suitable protection may be provided against charging of the battery over and above the specified values.

90.00 BATTERY UNIT

- i) The system shall be powered by lead acid storage stationery complete with automatic dual rate charger boost and trick operating from 220V, 50 Hz, single phase, mains supply. The battery capacity should be adequate for operation of the system connected to it for at least 24 hours in the non-alarm state followed by 30 minutes operation of all sounders and other connected equipments after a power (mains) failure.
- ii) The automatic charger should operate at the boost charge when the battery terminal voltage is less than about 2.1V 20 per cell, and operate at a trickle charge rate of 100 to 200 HA, when the battery terminal voltage exceeds about 2.25 per cell.
- iii) The power unit should have the following:
 - a) Voltmeter 0-30 V
 - b) Ammeter of suitable range
 - c) Indicator lights for mains
 - d) Indicator lights for DC output
- iv) The preferred nominal DC voltage shall be 24 V and shall preferably be isolated. (IF an isolated supply is provided a line earthing indicator should also be provided).
- v) The DC system and the detection and sounder circuits shall be protected against their attaining a voltage to earth exceeding 50V.
- vi) The connection to the 220V, 50Hz, single phase system shall be through a three pin plug socket especially provided for the connection to the annunciation panel. This connection should in addition utilized for earthing all non-current carrying metal parts of the sprinkler system, except those that are either doubly insulated or mounted at a height exceeding 2.2 meters.

- vii) The battery unit shall be housed in a steel cabinet with suitable mounting at least 2.5mm thick suitably painted with two coats of Post Office Red, Enamel necessary vent holes should be provided for proper ventilation.
- viii) One battery unit complete with battery charger shall be provided for each control panel.

91.00 TESTING

- 91.1 All pipes in the system shall be tested to a hydrostatic pressure of 11.0 kg/sq.cm without drop in pressure for at least 2 hours. Rectify all leak ages, make adjustments and retest as required.

92.00 MEASUREMENT

- 92.01 Black steel pipes shall be measured per linear meter of the finished length and shall include all fittings including flanges, welding, jointing clamps for fixing to walls or hangers and testing.
- 92.02 Butterfly valves, check valves and full way valve and flow indicating switches shall be measured by numbers and shall include all items necessary and required for fixing as given in specifications.
- 92.03 Cabinet and the spare sprinkler heads, with spanner etc. shall be measured as per actual item given in the schedule of quantities.
- 92.04 Sprinkler heads shall be measured by numbers.
- 92.05 No additional payment shall be admissible for cutting holes, or chases in the wall or floors, making connections to pumps, equipment and appliances.
- 92.06 Painting and coating/wrapping of pipes shall be included in the rates for pipes and no extra payment shall be made.

1105 COMMISSIONING OF FIRE FIGHTING SYSTEM

93.00 SCOPE OF WORK

- 93.01 Work under this section shall consist of pre commissioning, commissioning testing and providing guarantees for all equipment, appliances and accessories supplied and installed by the contractor under this contract.

94.00 GENERAL REQUIREMENTS

- 94.10 Work under this section shall be executed without any additional cost. The rates quoted in this tender shall be inclusive of the works given in this section.
- 94.20 Contractor shall provide all tools, equipment, metering and testing devices required for the purpose.
- 94.30 All inspection and testing for gauging the efficacy of all equipment would be as per the TAC regulations.

A survey of the site of the work shall be made by the Contractor before preparation of the detailed drawings for submission to the department for approval. The installation shall be carried out strictly in accordance with the approved drawing.

- 94.40 The scope of installation work shall include the following, where or not expressly mentioned in the schedule of work.
- i. Cement concrete (1:2:4mix) foundation for all pump sets.
 - ii. Vibration isolation arrangement for all pump sets.
 - iii. Filling up the hole in flooring with cement concrete, after laying the wet riser pipes.
 - iv. Necessary supports and clamps for wet riser pump room.
 - v. Necessary supports and clamps for wet riser plumbing the building.
 - vi. Supporting bracket/frame work for the fuel oil tank of the engine.
 - vii. Excavation of the earth, consolidation and refilling after laying of wet riser piping in ground.
 - viii. Provision of necessary brick base or intermediate support as required in approved manner in case of soils which are not strong enough to support the pipes, thereby likely to cause different settlement.
 - ix. Necessary anchor block of ample dimensions in 1:2:4 cement concrete at all bends, tee connections, foot of the wet riser, and other places as required to stand the pressure thrust in pipes.
 - x. Necessary masonry work/steel work for supporting hose cabinets near external (yard) hydrants.
 - xi. Valve chambers of approved design with external (yard) hydrant.
 - xii. Ground level hydrants of approved design, where specified.
 - xiii. Cutting and making good the damages for the installation work of the riser system
 - xiv. Strainers and foot valves for pumps with negative suction and strainers for pumps with positive suction.
 - xv. All the required control piping, exhaust piping (5m long) from engine, oil piping for fuel oil and lubricating oil for the engine, drain piping from the pumps to the drain pit in the pump room, overflow piping from priming tank to the sump. The piping work shall include all necessary fittings, valve and accessories for effective functional requirements.
 - xvi. Inter-connecting cable work with controls, control panel, batteries etc. including battery leads.
 - xvii. Orifice plates at individual hydrants, as required.

Where provision of GI/MS pipe shall below ground become inescapable, it shall be protected from soil corrosion by 2 coats of coal tar hot enamel paint and 2 wraps of reinforced fiber glass tissue or bituminized horizon.

Each CI pipe/GI pipe shall be subjected to hydraulic pressure test before installation, in presence of the Engineer or his authorized representative.

External (yard) hydrants shall be located at least 2m away from the face of the buildings but not more than 15m and be accessible.

Where external hydrants below ground level are specifically indicated in tender specifications, there shall be enclosed in masonry or cast iron structure of size 75cm² and 8cm above ground level. The hydrant shall be with in 8cm from the top of the enclosure.

Necessary facility for draining the rise pipe shall be provided at ground floor level with 40mm size sluice valve.

Internal hydrants at each floor shall be located at about 1m above floor level.

Valve chambers shall be of 1sqm meter in size, with cover.

All hoses shall be numbered and a record submitted with completion plane. The number and length shall be easily recognizable on each hose pipe.

External hose boxes shall be installed such that the hose is not exposed to sun rays.

94.50 PRECOMMISSIONING

On completion of the installation of all pumps, piping, valves, pipe connections, electrical wiring motor control panels and water level controlling devices the contractor shall proceed as follows:

94.60 TESTING OF M.C.C

Tests to be carried out for motor control centers shall be :

- 94.60.1 Insulation resistance test with 500 volt merger, before and after high voltage test, on all power and control wiring.
- 94.60.2 High voltage test at 2000 volts A.C. for one minute on all power and control wiring.
- 94.60.3 Low voltage continuity test (6 volts) on power wiring of each feeder, between bus bars and outgoing terminals with switches and contractors in closed position.
- 94.60.4 Low voltage continuity test (6 volts) on all control wiring.
- 94.60.5 Operation test for all feeders with only control supply made "ON" to ensure correctness of control wiring, operation of the various equipment used, such as push buttons, protective devices, indicating lamps and relays, etc. All contractors shall be checked for the presence of humming and chattering.

94.60.6 Earth continuity test with voltage not exceeding 6 volts between various non-current metallic of equipment, steel work, etc. and the earth bus provided in the M.C.C.

94.60.7 Operation of all instruments and meters provided on the M.C.C.

95.00 FIRE PROTECTION SYSTEM

95.01 Check all hydrant valves and close if any valve is open. Check that all suction and delivery connections are properly made.

95.02 Test run and check rotations of each motor and correct the same if required.

96.00 PIPE WORK

96.01 Check all clamps, supports and hangers provided for the pipes.

96.02 Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specifications if any leakage is found. Rectify the same and reset the pipes.

97.00 COMMISSIONING AND TESTING

97.10 FIRE HYDRANT SYSTEM

97.10.1 Pressurize the fire hydrant system by running the main fire pump and after attaining the required pressure shutoff the pump.

97.10.2 Open by-pass valve and allow the pressure to drop in the system. Check that the jockey pump cuts-in and cuts-out at the pre-set pressure. If necessary adjust the pressure switch for the jockey pump. Close by-pass valve.

97.10.3 Open by-pass valve and allow the water to flow into the fire water tank in order to avoid wastage of water. The main fire pump should cut-in at the preset pressure and should not cut-out automatically on reaching the normal line pressure. The main fire pump should stop only by manual push button. However, the jockey pump should cut out as soon as the main pump starts.

97.10.4 Switch off the main fire pump and test check the diesel engine driven pump in the same manner as the electrically driven pump.

97.10.5 When the fire pumps have been checked for satisfactory working on automatic controls, open fire hydrant simultaneously and allow the hose pipe to discharge water into the fire tank to avoid wastage. The electrically driven pump should run continuously for eight hours so that its performance can be checked.

97.10.6 Diesel engine driven pump should also be checked in the same manner as given in para above by running for 8 hours.

97.10.7 After laying and jointing, the entire piping shall be tested to hydrostatic test pressure. The pipes shall be slowly charged with water so that the air is expelled from the pipes. The pipes shall be allowed to stand full of water for a

period of not less than 24 hours and then tested under pressure. The test pressure shall be 10kg/cm². The test pressure shall be applied by means of manually operated test pump or by a power driven test pump to be provided by the Contractor. In either case precautions shall be taken to ensure that the required test pressure is not exceeded.

- 97.10.8 The open end of the piping shall be temporarily closed for testing.
- 97.10.9 Test shall be conducted on each pump set after completion of the installation with respect of delivery head, flow and B.H.P. The test shall be carried out by the Contractor at his own cost.
- 97.10.10 All leaks and defects in different joints noticed during the testing and before commissioning shall satisfaction of Engineer.
- 97.10.11 Check each landing valve, male and female couplings and branch pipes for compatibility with each other. Any fitting, which is found to be incompatible and does not fit into the other properly, shall be replaced by the contractor. Landing valves shall also be checked by opening and closing under pressure.
- 97.10.12 Testing of fittings/equipments shall be carried out either at site or at works in the presence of a representative of the Engineer. Test certificates shall also be furnished by the Contractor.
- 97.10.13 The automatic operation of the system for the various functional requirements and alarms as laid down in his specification shall be satisfactory carried out on as described above.
- 97.20 HANDING OVER
- 97.20.1 All commissioning and testing shall be done by the contractor to the complete satisfaction of the engineer /consultants, and the job handed over to the client.

Contractor shall also hand over to the client all maintenance and operation manuals and all items as per the terms of the contract.

1106 SPECIFICATIONS FOR ELECTRICAL PANEL PROTECTION SYSTEM

Electrical Panel Protection System: This includes Supply, Installation, Testing and Commissioning of FK-5-1-12 (Dodecafluoro-2-Methylpentan-3one), Novec-1230 gas Suppression system in accordance with the Contract Documents.

98.00 Scope of Work:

- 98.01 Supply, Installation, Testing and Commissioning of clean Agent (Novec 1230) Fire Suppression system designed to provide a uniform concentration within the electrical panels in accordance with NFPA 2001 and requirements of the contract documents).
- 98.02 Provide all engineering design and materials for a complete agent suppression system including FK-5-1-12 storage cylinders with steel bracket,

extinguishing agent, detection tube, cylinder valve and associated accessories including but not limit to; adaptors, pressure switch, tube fittings etc, required for complete operation of system.

- 98.03 All necessary safety requirements such as warning signs, discharge alarm shall be part of system.
- 98.04 The necessary nomenclature such as pressurization level, agent volume, gross/net weight of cylinder shall be clearly marked on cylinder.
- 98.05 Prior to supply of material at site. Contractor must submit following documents for approval of Engineer-in-charge.
- a. Drawing in A-4 size, clearly showing the panel, routing of tube inside the panel, location and fixing arrangement of cylinder & system components.
- 98.06 All doors and holes in the enclosed/equipments should be closed or sealed to maintain the tightness of enclosure.

99.00 System Description:

99.10

- a) The detection tube shall be fixed with cylinder valve at top of cylinder. The tube shall be pressurized with dry nitrogen. In case of reach of pre-determined temperature (100-120oC), the tube shall rupture gas shall be released from tube over the protected area.
- b) The pressure switch shall be provided for necessary indication of discharge of gas.
- c) The Extinguishing Agent shall be stored in cylinder as liquefied compressed gas, super pressurized with dry nitrogen at 195 psi.
- d) The cylinder shall be equipped with brass valve, pressure gauge (to monitor agent pressure) and isolation valve for maintenance purposes. The cylinder bracket shall be of steel construction with quick release clamp.
- e) The detection tube shall be installed throughout the compartments of panel. The location and spacing of tube shall be above the hazard, to be protected.
- f) In case of fire, the tube shall rupture at a point. The rupture of tube shall result in formation of discharge point and release the agent in uniform pattern.
- g) With system activation, a signal should be generated via Audio Visual Alarm installed at convenient location as per Engineer-in-Charge.

99.20 System Components:

The bidder shall provide an under taking from Principle Manufacturer of CE marked product they intent to install, that manufacturer will fully support the bidder for this specific project.

- a) Cylinder of steel construction with standard red epoxy paint finish. Cylinders shall be accompanied by original manufacturers test certificate confirming the contents of the cylinder.

- b) The cylinders shall be from reputed Manufacturers only. Cylinders shall be super pressurized with dry nitrogen to an operating pressure and temperature as per manufacturer recommendations.
- c) Each cylinder shall have pressure gauge and low pressure switch to provide visual and electrical supervision of the cylinder pressure. The low pressure switch shall be wired to the Audio Visual Alarm to provide audible and visual trouble alarm in the event of drop of pressure. The pressure gauge shall be color coded to provide an easy, visual indication of cylinder pressure.
- d) Furnish a welded steel bracket with each cylinder assembly for holding the cylinders in a saddle with a front bracket piece that secures the cylinders.
- e) Cylinder shall be provided with a certificate provided by the company who charge with the FK-5-1-12 gas mixture. The certificate shall be secured around the cylinder with chain fastener.
- f) The Detection Tube, CE marked to be Red Colour and pressurized at 195 Bar. The Detection Tube to rupture between (100-120°C).
- g) The Pressure Switch should be CE Marked having NO/NC contact.

99.30 Extinguishing Agent

FK-5-1-12 (Dedecafluoro-2-Methylpentan-3 One - CF₂CF₂C (O) CF (CF₃)₂

- (a) The agent shall not contain any Hydrofluorocarbons (HFC).
- (b) The ozone depletion potential should be zero.
- (c) The Global warming potential should be equal to or less than 1.
- (d) The Extinguishing Agent should be UL Listed/ FM approved.
- (e) The extinguishing agent should be filled in an UL Listed or FM approved filling station.

99.40 Installation

- a) The system shall be installed on basis of approved drawing.
- b) The installation / final connections shall carry out in direct supervision of representative of Manufacturer/authorized distributors.
- c) Cylinder shall be located so that they are not subjected to mechanical, chemical or other damage.
- d) All system components shall be capable of withstanding heat of fire and severe weather conditions.
- e) Detection Tube to be properly secured inside the panel by Clips/Tie etc.
- f) The Detection Tube outside the panel should be protected in flexible conduit.

- g) Inspection certificate should be pasted on cylinder clearly marking next due date of inspection.

99.50 Approved Make: Siemens / Sevo Flex/FireTrex/ Tyco

100.00 HAND APPLIANCES

100.10 SCOPE OF WORK

100.10.1 Work under the section shall consist of furnishing all labour, material, appliances and equipments necessary and required to install fire extinguishing hand appliances.

100.10.2 Without restricting to the generality of the foregoing the work shall consist of the following:

Installation of fully charged and tested fire extinguishing hand appliances CO₂, Foam, Dry chemical powder type as required by these specifications and drawings.

100.20 GENERAL REQUIREMENTS

100.20.1 Fire extinguishers shall conform to the following Indian Standard Specifications and shall be with ISI approved stamp as revised and amended upto date: -

- a) Water gas type I.S. 940
- b) Dry powder type I.S. 2171-1962
- c) Mechanical Foam I.S. 10204
- d) ABC I.S. 13849

100.20.2 Fire extinguishers shall be installed as per Indian Standard "Code of practice for selection, installation and maintenance of portable first aid appliances "I.S. 2190-1962".

100.20.3 Hand appliances shall be installed in readily accessible locations with the appliance brackets fixed to wall by suitable anchor fasteners.

100.20.4 Each appliance shall be provided with an inspection card indicating the date of inspection, testing, change of charge and other relevant data.

100.20.5 All appliances shall be fixed in a true workman like manner truly vertical and at correct locations.

100.20.6 The contractor has to obtain approval of Fire Department for all fire fighting installations.

STANDARDS AND CODES

1. IS 1648 Code of practice for fire safety of building (general) fire fighting equipment and maintenance.
2. IS 3844 Code of practice for installation of internal fire hydrant in multistorey buildings
3. IS 2217 Recommendations for providing first aid and fire fighting arrangement in public buildings.
4. IS 2190 Code of practice for selection, installation and maintenance of portable first aid fire appliances.
5. Part IV, fire fighting National building code
6. IS 5290 External fire hydrants
7. IS 5290 Internal landing valves
8. IS 904 2 & 3 way suction collecting heads
9. IS 884 First aid hose reel
10. IS 5132 High pressure rubber pipe
11. IS 1537 C.I. Double flanged pipes
12. IS 1538 C.I. Double flanged fittings
13. IS 780 C.I. Sluice valves and Gunmetal valves
14. IS 934 Specifications for portable chemical fire extinguisher soda acid type.
15. IS 2873 Specifications for fire extinguisher of Carbon-di-oxide.

11.0 TECHNICAL SPECIFICATIONS OF SOLAR WATER HEATING SYSTEMS

The detailed technical specifications of solar water heating systems, its equipment, components and installation etc. are indicated hereunder:

1.	SYSTEMS CAPACITY	As specified
2	NO of SYSTEMS	As specified
2.	SYSTEM TEMP. OUTPUT	60°C year average basis on clear sunny days
3.	SOLAR COLLECTORS Type Make Applicable IS No. Quantity of Solar collectors Absorption area	Selectively coated (Cu-cu type) ISI marked Make BHEL/TATA BP /EMMVEE SOLAR SYTEMS Pvt. Ltd/ inra Solar IS:12933 As per requirements 2.0 Sqm(MIN)

4.	COLLECTOR/TANK SUPPORT FRAME	MS Angle 35x35x5mm/40X40X4mm minimum adequate for 150 km/hr wind pressure
5.	HOT WATER STORAGE TANKS (INSULATED) Quantity Capacity Material Insulating material Insulating material Density Insulation thickness Waterproof covering Cladding material	1 No. each As per site requirements 304 Stainless Steel (min 3 mm) Rockwool/Glass wool 48 kg/cu.m 100mm (Min.) polythene lining Aluminum 22 swg (0.71 mm thick)
7.	Distribution PIPINGS (Extra payable as per actual measurements) CPVCI/Composite Pipe Pipe fittings System Internal piping size Insulating material Insulation thickness covering Weatherproof coating /Cladding material	ISI marked ISI marked As per site requirements Imported foam pipe section 9mm/10mm thick Fiber Tissue lining Imported resin /aluminium sheet 28 SWG
8	PUMPS	As per requirements JHONSAN/ Kirloskar
9.	TEMPERTURE GAUGE Quantity Type Range End connection Make	1 No. each for each system Dial gauge 0-120C ½" BSP H Guru
10.	STRAINER Material Type Mesh	Cast Iron Y-type Horizontal Brass
11	ELECTRICAL BACK-UP	As PER REQUIRED Heater ISI Marked
12	HEAT EXCHANGER Material Type Surface area	Stainless Steel 304 Cage As per site requirements
13	OPERATION GUARANTEE	One year
14	ALLIED CIVIL & ELECTRICAL WORKS	Complete for making the system operational/functional in all respects including wiring upto nearby distribution board.

Manufacturers or their authorized distributors/specialized firms of solar water heating system of BHEL /TATA BP solar system/ EMMVEE SOLAR SYTEMS Pvt. Ltd/ Inter solar make. Distributors will be required to produce documents in support of their authorization from the manufacturer. The work shall be carried out by trained authored staff of the company.

Collector specifications: The collectors shall be of Cu-Cu type with Absorber area of 2.0 sq. mtrs. The absorber riser-tubes shall be made of high-grade copper & welded to the copper fins with the State of the Art ULTRASONIC WELDING process to ensure superior conductivity of heat & long life of absorber plate. The absorber plate shall be selectively coated with a very special NALSUN coating for efficient absorption of heat from the Sun-rays. The efficiency of the collectors has been specified as $FR (Ta) = 0.72$, $FROL = 3.62 \text{ W/Sq. mtr/ } ^\circ\text{C}$. The outer dimensions of the collector box shall be 2080 mm x 1070 mm x 100 mm with Frame made out of Extruded aluminum sections of 16 SWG specifications (powder coated yellow). The insulating material in the collectors would be 50mm (bottom) and 25mm (sides) Rock-wool with thermal conductivity of 0.029W/mk and density 48kg/sq. cm. The top glass would be toughened clear glass of thickness 4.0mm, with 88% transitivity and be of a reputed make like ATUL. The **Collector stands** would be made of 40X40X4mm (min) thick MS angles with enamel paint covering. The Grommet & Glass beading shall be made out of High quality EPDM rubber for long life. All hardware used shall be of SS-304 or Zinc Plated steel. The solar collector shall be arrange on roof in such a way so that the shadow of the collectors/ parapet etc can be avoided. The outer sides shall be having a Powder Coated finish in Yellow colour. The collector should have very high Absorbitivity of $> 0.95 \%$ & Emissivity $< 0.2 \%$. Anti-Condensation breather outlet shall be incorporated at rear bottom of collector to drain out condensed moisture if any. This prevents the inner glass surface from Fogging.

Tank specifications: The Insulated Hot Water Tank shall be of the Vertically oriented cylindrical type made out of SS-304. It shall be duly insulated with 100mm thick glass-wool insulation with thermal conductivity of 0.028 to.033 W/mk and density 48 kg/cu.m. This will be covered with Aluminium cladding of thickness #22 SWG along with chicken mesh and thin polythene sheet. There shall be a built in Heat Exchanger of multiple tube type made of SS-304 to transfer the heat to the water in the tank. This closed loop system shall be provided with a make up tank. Also provided shall be a sacrificial anode to prevent Galvanic Corrosion. Electrical backup of as required with SS/Cu Thermostat (range 30-80°C, 15A/250 VAC) shall also be provided.

The hot water from solar heater in case supply to water heater (geyser) the additional heating arrangement by electricity in the hot water storage tank is not required.

LIST OF APPROVED MAKES: PLUMBING WORKS

Sl.No	Material	Relevant IS Code	MANUFACTURERS
1	Vitreous China Sanitary ware	2556	<i>Kohler, Roca, American Standards, TOTO, Falcon</i>
2	Stainless Steel Sink		Jayna, Neelkanth, Nirali, Selam Steel
3	Plastic Seat Cover		<i>Kohler, Roca, American Standards, TOTO, Falcon</i>
4	Geyser		Racold, Usha Lexus,
4	C.P. Fittings Mixer/Pillar taps Washers, C.P. brass accessories ,CP Angle Valve, Bibcocks, CP waste	1795/4291/4827	<i>Kohler, Roca, American Standards, TOTO,</i>
5	Centrifugally /Sand cast iron pipes & fittings	3989/1729	Neco, BIC, SKF, HEPCO
6	G.I. Pipes	1239 Part I	Jindal-Hissar, Tata, Prakash-Surya
7	G.I. Fittings	1239 Part I	Unik, K.S., Zoloto,
8	Gunmetal Valves/ Pressure Release valve	778	Zoloto, Leader, Castle, Sant
10	Brass stop & Bib Cock	781	<i>Kohler, Roca, American Standards, TOTO, Falcon</i>
11	Ball valve with floats	1703	Zoloto, Leader, Sant, Othelo
12	Stoneware pipes & Gully Traps	651	IS Marked pipes, as approved by Engineer
13	R.C.C. pipes	458	IS Marked pipes, as approved by Engineer
14	C.I. Manhole Covers	1726	SKF, Neco, BIC, HEPCO
15	Water Tank		Sintex,
16	Mirror		Atul, Modi guard, Asahi, Saint Gobain
17	Hand drier		Kopal, Euronics, Utech
18	Insulation of Hot water pipes		Vidoflex Insulation, Superlon, Thermafex, Kaiflexkaimenn
20	PVC Rain Water Pipes.		Supreme, Prince, Finolex,
21	D.I pipes		Jindal, Tata, Electrosteel,
22	Sluice valve / NRV		Kilburn, Zoloto, Leader, L&T, Castle
23	Water supply pumps		Crompton (CG), GRUNDFOS, KSB, Mather & Platt, Kirloskar
24	DI Manhole Cover		SKF,NECO,BIC
25	Submersible pumps		GRUNDFOS, KSB, Mather & Platt, Kirloskar
26	PVC/UPVC pipes & fittings		Finolex , Prince, Supreme
27	Chlorinator		Siemens, Watcon, Ion exchange, oxybee,
28	HDPE Solution tank		WATCON, ION EXCHANGE, Water Supply Specialist P (Ltd), Pollucon Technology

29	Infrared Sensor operated Faucets/Urinals		<i>Kohler, Roca, American Standards, TOTO, Falcon</i>
30	Gratings, Strainers, Cleanouts etc		Neer Brand (Sage Metals),ACO
31	Level controller		<i>21st Century/ Advance Auto/ Shridhan international/ Minilec/ radar/ Femac/ Switzer</i>
32	Drainage Pumps		Grundfos, KSB, Mather & Platt, Kirloskar
33	Water / Sewage Treatment Plant		Geo Miler & Co, Ion-Exchange, Pollucon Technologies, Thermax,
34	Decorative bath room fittings		<i>Kohler, Roca, American Standards, TOTO, Falcon</i>
35	R.O System		Ion-Exchange, Pentair, Pollucon Technologies, Thermax,
36	PE-AL-PE		Kitec, Jindal, PRINCE
37	HDPE pipes and fittings	IS:14333 (1996)	Oriplast, So-Soon, Finolex, AKG
38	CPVC pipe, fittings and Solvent		Astral, Finolex, Aerocon (C.K.Birla),
39	Solar Panel		Maharshi Solar, Inter solar, EMMVEE SOLAR SYTEMS
40	Copper Pipe		Raj Co., Maxflow, Viega
41	Copper Fittings		Raj Co., Maxflow, Viega
42	Lab drainage		Viega, Duraline, So-Soon,
43	Lab Fittings		Viega, Duraline, So-Soon,
44	Vitreous China IWC, Lab Sink,	2556	<i>Parryware, Hindware, Kohler, Roca, American Standards, TOTO, Falcon</i>
45	SS pipe(EN-10312) & press type fitting		Viega, Jindal
46	Oxilyte (Mixed Oxident)		Oxybee Solutions, I2M Technologies, Faith Innovations
47	Hubless cast iron pipes & fittings	IS:15905	Neco, HEPCO, Saint-Gobain.

Note :

- Equivalent make of any item may be added with price adjustment with the approval of Engineer.
- Wherever makes have not been specified for certain items, the same shall be as per BIS and as per approval of Engineer.

LIST OF APPROVED MAKES : FIRE FIGHTING WORKS

Sl.No	Material	Relevant Code	ISI	MANUFACTURERS
1	G.I./M.S. Heavy class pipe	1239/3589		Jindal-Hissar, Tata, Surya- Prakash
2	Gate Air Valve			Leader, Zoloto, Castle
3	Butterfly valves	13095		Audco, KSB, C & R, Zoloto, Castle
4	Portable Fire Extinguisher	2171		Minimax, Safex, Ceasefire, Newage, Safe guard
5	First aid Fire hose reels		884	Minimax, Safex, Ceasefire, Newage, Safe guard,
6	Fire hose pipes	636		Newage, Minimax, Safex, Ceasefire,
7	Fire Hydrant valves	5290		Minimax, Newage, Safex, Ceasefire, Safe guard
8	Sprinkler Heads			
A	Pendent type	IS		Tyco, Viking, HD, Grinnel, Getech
B	Side wall type	IS		Tyco, Viking, HD, Grinnel, Getech
C	Sprinkler Side wall extended through	IS		Tyco, Viking, HD, Grinnel, Getech
9	Sluice and non return/ check valve foot valve strainer	IS		I.V.C., Kilburn, Zoloto, castle, KSB
10	Thermoplastic fire hose pipe	1258		Minimax, safex, Newage, , Safe guard
11	Rubber hose 12/20mm dia			Dunlop, Good year, Jyoti Eversafe, Getech
12	Reinforced rubber lined/canvas			Newage, Jayshree, Safe guard
13	Standby battery lead acid			Exide, Standard, Amco
14	Horizontal centrifugal/Fire pumps			Mather& platt(WILO), GRUNDFOS, Kirloskar
15	Diesel engine			Cummins, Ashok Leyland, Caterpillar, Kirloskar
16	Electric motors			GEC, Siemens, NGEF, ABB, Crompton, Kirloskar
17	Electrical switch gear & starters			As per Electrical Works
18	Cables			As per Electrical Works
19	Flow meter			Scientific Equipment (P) Ltd. Hyderabad ,System Sensor / CPWD
20	Suction strainer			Leader, ZOLOTO, AUDCO, Castle
21	Vibration eliminator connectors			Resistoflex , Kanwal, D.wren
22	Single phase			L & T, GEC, SIEMENS

	preventor		
23	G.I. Fittings	1239 Part I	Unik, K.S., Zoloto, R
24	Yard Hydrant Stand Post, 4 way suction		Eversafe, Minimax, Newage, Safe guard
25	DI pipes		Jindal, TATA, Electrosteel,
26	Pipe coat material (Pipe protection)		<i>Pypkote Integrated water proofing co. Madras/ coaltek Rustech products (P) Ltd. Syndcate Enclave, Dabri/Makphall</i>
27	Fire Man's Axe		<i>Safeguard/safex/Newage/Gunnebo, Getech</i>
28	Pressure guage		<i>IS:C3624 (cl-1) H.GURU/Fiebig/BRC/HD</i>
29	Flow switch		<i>Potter/Safex system sensor/Jhonson control/Rapid flow</i>
30	Pressure switch		<i>Indfoss/switzer, Equivalent make approval of Engineer</i>
31	Fire suppression system		<i>Trex /Seimens / UTC, SVS Buildwel (p) ltd , Equivalent make approval of Engineer</i>

Note :

- Equivalent make of any item may be added with price adjustment with the approval of Engineer.
- Wherever makes have not been specified for certain items, the same shall be as per BIS and as per approval of Engineer

GENERAL SCOPE OF WORK

The scope of work shall cover internal and external electrical works for **Construction of Hospital Block, Medical College & Residential Block, Nahan & Chamba Himachal Pradesh**. The scope of work covers electrical equipments as per BOQ. Also, supply, installation, testing and commissioning of electrical works of the project including the following main items/systems:

:

- i. H.T. Sub-station including VCB panel, Transformers, bus ducts, HT cables etc
- ii. Main LT , Capacitor panels (APFC), Rising mains, MV Panels.
- iii. DG sets including AMF panels etc.
- iv. MCB Distribution Boards.
- v. UPS
- vi. 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.
- vii. 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.
- viii. Addressable Fire Detection & Alarm System consisting of Main Fire Control & Indicator Panel, Smoke & Heat Detectors, Manual Call Points Hooter etc. including conduiting/wiring & cabling complete.
- ix. Conduiting and wiring for cable TV.
- x. Conduiting for computer networking.
- xi. Public Address System.
- xii. Nurse Call System.
- xiii. Lightning protection system consisting of lightning arrestor, finial, horizontal and vertical strips, test joints, earth electrodes etc.
- xiv. Lifts,
- xv. LT Cabling.
- xvi. Earthing, safety equipments and misc items required for electrical installation complete in all respect.
- xvii. Outdoor lighting
- xviii. CCTV.
- xix. Any other items/ works required for the completion of electrical work.
- xx. Enhancement/Sanctioning Electrical Load from State Electricity Board.
- xxi. Submission of GA drawings of electrical equipments and getting approvals from Client/HSCC/Owner before manufacturing/fabrication.
- xxii. Obtaining approvals from Chief Electrical Inspectors, Local Electricity Supply Authority, Telecom Department, and any other statutory authorities for the complete scope.
- xxiii. 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.
- xxiv. Contractor has to submit the working drawing of internal & external electrification based on our tender drawings for the approval of HSCC Electrical Engineer before commencement of work.
- xxv. Contractor has to take the approval of DB schedule/drawing of each DB from HSCC.

- xxvi. If, 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)- 2013
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	IS 694

including 1100V.

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)	ONAN Transformer	IS 1180
C1)	Energy Conservation Building code	(Latest)

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

CPWD/ IS specification, BOQ, drawings, Technical specifications

H.T. SUBSTATION

3.0 11 KV VACUUM CIRCUIT BREAKER PANEL BOARD

3.1 GENERAL:

Vacuum Circuit Breaker shall be incorporated in H.T. Panel wherever specified. VCB's shall conform to IEC 298 and 694 IS 3427, BS 5227 and VDE 0670, part 6 as well as the regulations mentioned therein. VCB's shall be suitable for operation on 11kV, 3 phase, 50Hz, AC supply. Vacuum Bottle of VCB should be of same make as of VCB. Life of CB shall confine to M2E2. Panel shall be internal Arc tested as per IEC/ IS Standards.

- ▶ Major civil work such as foundations, trenches, etc will be paid as per civil works.
- ▶ Minor civil work like cutting and making good all damages caused during installation and restoring the same to their original finish will be inclusive in the price.

3.1.2 TYPE AND CONSTRUCTION:

The metal clad panel shall be fully extensible and compartmentalized to give.

- a. Circuit Breaker Compartment
- b. Busbar Compartment
- c. CT and Cable Compartment

- 3.2.1 The compartments shall be safe to touch and compartments thus formed shall be dust proof & vermin proof. A separate metering chamber for fixing the necessary instrumentation metering and protective equipment shall be provided panel on the front.
- 3.2.2 The VCB shall consist of three air insulated poles incorporating mechanism of interrupters. The body of interrupters shall be made of nickel chromium steel supported on insulators made out of metalised aluminum oxide. The contacts shall be of chromium copper and butt shaped.
- 3.2.3 Vacuum circuit breaker shall be mounted on truck or a carriage mechanism. In case of truck mechanism, the breaker shall be on a trolley while in a carriage mechanism, shall be separate door and it shall be possible to perform all operations with front door closed. The draw out carriage shall have two positions for the circuit breaker viz isolated/test & service position. Bus bars shall be insulated type made of high conductivity copper supported on cast epoxy monobloc designed to withstand full short circuit currents and shall be provided all along the length of the H.T. board.
- 3.2.4 It shall be horizontal isolation, horizontal draw out type, fully interlocked, with dust and vermin proof construction, suitable for indoor instillation. The panel shall be supplied with the manufacturer's test certificates.
- 3.2.5 Certificates with date of manufacture and shall be complete in all respects as per details in the schedule of quantities. The steel work should have undergone a rigorous rust proofing process comprising alkaline degreasing, descaling in dilute sulphuric acid and recognized phosphate process and shall then be given power coating (Electrostatic) paint of manufacturer's standard shade.

- 3.2.6 The switchgear constructions shall be such that breaker operation and internal explosions do not endanger the operating personnel, and the front of the panel shall be specially designed to withstand these. Pressure relief flaps shall be provided for safely venting out gases produced inside the high voltage compartment, bus bar compartment and termination compartment. These flaps shall be vented upwards and cannot be opened from outside. These relief flaps shall be of such construction as not to permit ingress of dust/water in harmful quantities under normal working conditions. Enclosure shall be constructed with sheet steel of at least 2.0mm thickness. It shall have a rigid, smooth, leveled, flawless finish.
- 3.2.7 Voltage transformer of burden not less than 100VA and of proper ratio as specified shall be provided. the accuracy class for the VT shall be 0.5 as per is 3156 part 1 to III for incomer and class I for outgoing panels. The PT shall be of cast epoxy resin construction. It shall be fixed/withdraw able type. HRC fuses circuit Breaker shall be provided on both HV and LV side. Adequate space at the rear of the panel shall be provided for the termination of power & control cables. The panel shall be provided with suitable terminating arrangement for the termination of cables .Burden of PT should match with the requirement of client.
- 3.2.8 The making contact arms (upper & lower) of the circuit breaker shall be encased in polypropylene tubes. Penetration type bushings shall be provided in the busbars & cable compartment for the fixed contacts.
- 3.2.9 Safety shutters shall be provided to cover up the fixed high voltage contacts on busbar and cable sides when the carriage is moved to Isolated/Disconnected position. The shutters shall move automatically with the movement of the draw out carriage. It shall, however, be possible to open the shutters of busbars side and cable side individually.
- 3.2.10 Mechanically operated circuit breaker auxiliary switches of minimum 5 NO + 5 NC ways, shall be provided for control and indication purposes. Control wiring shall be done by 1.5 sq. mm; 1.1kV grade stranded copper PVC insulated cable. All control fuses shall be HRC link type.
- 3.2.11 Terminal blocks shall be clamp type suitable for connection of only 2 wires per terminal and shall be 650 V grade. The L.T. control circuit shall be routine tested to withstand 1.5kV for one minute.
- 3.2.12 Busbar compartment shall be provided at the rear. Electrolytic copper busbars shall be of rectangular cross section and insulated. Busbars shall be supported properly by cast epoxy resin insulators so as to withstand thermal and dynamic stresses during system short circuits. Busbars shall be provided with necessary color coding for phases indication. The busbars shall be designed to withstand a temperature rise of 60 deg. C above and ambient temperature of 45 deg. C.

3.3 BUSBAR AND REGULATORS

- 3.3.1 All busbars and jumper connections shall be of electrolytic copper conforming to relevant IS standards. They shall be adequately supported on epoxy insulators to withstand electrical and mechanical stresses due to specified short circuit currents. Busbar cross section shall be uniform throughout the length of switch board.

3.3.2 Contact surface at all joints shall be properly cleaned and No-oxide grease applied to ensure an efficient and trouble free connections. All bolted joints shall have necessary washers for maintaining adequate contact pressure. All connection hardware shall have high corrosion resistance.

3.3.3 Busbar insulators shall be of track-resistance, high strength, and non-hygroscopic, non-combustible type & shall be suitable to withstand stresses due to over voltages and short circuit current. Busbar shall be supported on the insulator such that the conductor expansion and contraction are allowed without straining the insulators. The temperatures of the busbars and all other equipments, when carrying the rated of relevant Indian Standards, duly considering the specified ambient temperature.

3.3.4 EARTHING AND PROTECTIVE EARTHING

Copper earthing bus shall be provided. It shall be bolted/ welded to the framework of each panel. The earth bus shall have sufficient cross time fault currents to earth without exceeding the allowable temperature rise. Suitable arrangement shall be provided at each end of the earth for bolting. Earthing conductors and earth bus shall run inside at the back of the panel for entire length. Facilities shall be provided for integral earthing of busbars & feeder circuit. Earthing rod consisting of 16 Sq.mm. stranded/flexible copper cable 15 Mtr. long and connectors shall be supplied. Cost of this earthing rod is deemed to be included in the cost of VCB Panel.

3.3.5 METERING AND PROTECTION

The VCB Panel Board shall be provided with epoxy resin current transformers for metering and protection. The protection CT's shall be of accuracy class 5P 10 of 2705- part -III- 1992. The metering CTs shall conform to the metering ratio and accuracy class 0.5 of IS 2705-1992 for the incomer and class I for the outgoing panels. Ammeter and voltmeter to be installed on panel shall be digital type. Voltmeter transformer of burden not less than 100VA shall be 0.5 as per IS 3156 part -1 to part III for incomer and class I for outgoing panels. The PT shall be fixed /withdraw able type. HRC fuses/ MCB shall be provided on both HV and LV side. All meters shall be 96mm square pattern, flush mounting type necessary selector switches. Necessary lamps of low voltage type with built in resistors shall be provided (maximum wattage 2.5watt. Burden of CT should match with the requirement of the client. Fault Level of CT should be equal to fault of HT Circuit Breaker for 1sec.

3.3.6 OPERATING MECHANISM

3.3.6.1 Vacuum Circuit Breaker shall be equipped with motorized spring charge. These operating mechanisms shall be of the stored energy type. In the closed state of the breaker, the energy stored in the springs shall be suitable for O-C-O duty.

3.3.6.2 Interlocking and Safety Arrangement

3.3.6.3 Vacuum Circuit Breaker shall be provided with the following safety and interlocking arrangements:

- i. The draw out carriage cannot be moved from either test/disconnected to service position or vice versa, when the circuit breaker is 'On'.

- ii. The circuit breaker cannot be switched 'ON' when the carriage is in any position between test & service position.
- iii. The front door of the panel cannot be opened when the breaker is in service position or in an intermediated position.
- iv. The low voltage plug & socket cannot be disconnected in any position except test/isolated position.
- v. The door cannot be closed unless the LV plug has been fitted.
- vi. It shall be possible to mechanically close and trip the circuit breaker through push buttons with the circuit breaker in service position and the door closed.
- vii. Individual explosion vents shall be provided for breaker, busbar, cable chambers on the top of the panel to let out the gases under pressure generated during an unlikely event of a fault inside the panel.
- viii. Circuit Breaker & sheet metal enclosure shall be fully earthed.
- ix. Self locking shutters shall be provided which close automatically and shall be interlocked with the movement of the draw out carriage mechanism.

3.3.7 RATING:

The rating of the vacuum circuit breaker shall be as per the drawings and schedule of quantities. The rated/breaking capacity of the breaker shall be 350 MVA (18.37 KA RMS) at 11 kV. The rated making capacity shall be as per the relevant standards.

3.3.8 ACCESSORIES:

3.3.8.1 Circuit Breakers shall be provided with the following accessories.

- i. Auxiliary Switch with minimum 5 NO+ 5 NC auxiliary contacts.
- ii. Tripping Coil
- iii. Mechanical Operation Counter
- iv. Spring Charging Handle

3.3.9 ADDITIONAL ACCESSORIES

3.3.9.1 The loose items to be supplied with the 11kV VCB Panel Board shall comprise of the following:

- a. Instruction Book.
- b. Maintenance Manual.
- c. Reaching in/out handle.
- d. Handle for spring charging mechanism.

- e. Foundation bolts.
- f. Busbar Earthing & Circuit Earthing Trolley.

3.3.10 Mounting

3.3.10.1 Vacuum Circuit Breakers shall be mounted as per manufacturer's standard practice.

3.3.11 Auxiliary Supply

- a. The tripping shall be at 24 Volt D.C. through a power pack unit or Battery Charger or as given in BOQ.
- b. Space heater indication & other auxiliary supply requirement shall be at 230 V AC. Necessary termination arrangements complete with isolating switch, control fuse & link shall be provided at one place in the panel for receiving the purchaser's cable.

3.3.12 TESTS

3.3.12.1 Factory Tests

The circuit breakers panel shall be subjected to routine tests at manufacturer's works in accordance with the details specified in the relevant IS specifications. These shall however necessarily comprise of the following.

- a. Power frequency voltage test on the main power circuit.
 - b. Verification of the correct wiring/Functional Test.
 - c. Dielectric test at 1.5kV on the control circuit. Apart from above, the vendor shall submit the routine test certificates for the following equipment.
 - i. Circuit Breakers
 - ii. Current Transformers
 - iii. Voltage Transformers
- The vendor shall submit the type test certificate for following along with the offer.
- a. Temperature rise test.
 - b. Impulse & power frequency voltage test
 - c. Short time current test on circuit breaker.

3.3.13 Site Test

3.3.13.1 General

1. Verification for completion of equipment, physical damage/deformities.
2. Alignment of panel, interconnection of busbars & tightness of bolts & connection etc.
3. Interconnection of panel earth busbar with plant earthing grid.
4. Inter panel wiring between transport sections.
5. Cleanliness of insulators and general Cleanliness of panel to remove traces of dust, water etc.

3.3.13.2 Circuit Breaker & Panel

1. Check for free movement of circuit breaker, lubrication of moving part & other parts as per manufacturers manual.
2. Manual/Electrical operations of the breaker and Functional test as per drawings.
3. Meggar before the Hi Pot test.
4. H.T. Test - Hi Pot test (Power frequency withstand test for one minute at 28kV RMS). At site Hi Pot test is carried out at 80% of 28kV RMS value.
5. Meggar after the Hi Pot test.
6. CT/PT ratio/polarity primary injection test.
7. Secondary injection test on relays to practical characteristics.

3.4 HT CABLES

3.4.1 Construction

All H.T cables shall be of 11kv grade XLPE earthed insulated & PVC sheathed flat steel wires (strips) armored electrical purity aluminum conductor cables shall be manufactured & tested in accordance with IS Specification.

3.4.2 TERMINATION JOINTS

Terminal joints shall be carried out as per IS specifications. Heat shrink cable termination kit shall be used for terminations.

3.4.3 INSTALLATION OF CABLES

Cable laying shall be carried out as per CPWD specifications.

3.4.4 CABLE TRAY

Cable tray is manufactured at Indian Standard Specification. laying is done as per IS & cpwd specification.

3.4.5 EARTHING

Earthing specified in BOQ is done as per IS & CPWD specification.

4.0 11 KV TRANSFORMERS

GENERAL

The transformer shall be double wound core type with low loss, non ageing, high permeability, Prime Grade, CRGO with M4 grade or better , perfectly insulated and clamped to minimized noise and vibrations.

- ▶ Major civil work such as foundations, trenches, etc will be paid as per civil works.
- ▶ Minor civil work like cutting and making good all damages caused during installation and restoring the same to their original finish will be inclusive in the price.

4.01 (OLTC TYPE)

Transformer shall be outdoor duty type. The transformer shall be fabricated as per IS 1180 (part-1 & part-2) specification amended up to date and having voltage ratio as 11kV/0.433kV. **The Transformer loss will be as per IS 1180 Amended up to Date.**

SPECIFICATION

STANDARD:-

Unless otherwise stated below, transformer & transformer oil shall conform to IS 1180 & 335 respectively.

SYSTEM OF SUPPLY:- KV 3 phase, 50 Hz system

NO LOAD RATIO:- 11000/433 volts

KVA RATING:- Transformer shall be suitable for continuous rating as stated in BOQ.

TYPE:- Out door

WINDING:- The transformer shall be copper wound.

CORE:-The magnetic core shall be made up of cold rolled grain oriented low loss steel stampings.

COOLING:- Natural oil cooling by means of pressed/round tubes around transformer tank (ONAN)

FREQUENCY:- 50Hz plus minus 3%

RATED VOLTAGE:-Transformer shall operate at its rated KVA at any voltage plus minus 10% of rated voltage of that particular tap.

VECTOR GROUP:- Corresponding to the vector symbol Dyn-11

CONNECTIONS

H.V side of transformer shall be provided with suitable size cable box for 3 core XLPE cable. Indoor heat shrinkable termination kit shall be used for termination of HV Cable.MV side of transformer shall be suitable for bus duct connection arrangement.

TAPPING

ON load tap changing arrangement on 11kv side. The range for circuit taps, which shall be provided on H.V. side, shall be plus 5% & minus 15% in steps of 1.25%

TEMPERATURE RISE

The transformer shall conform to the requirements of temperature rise specified in IS: 2026(PartII) 1977.Continuously rated for full load, temp. rise not to exceed 50 degree C by thermometer in oil (55degree C by resistance)

INSULATION LEVELS

The insulation levels shall be in accordance with IS 2076(Part III) 1977.

TERMINAL MARKINGS, TAPPING & CONNECTIONS

The terminal marking, tapings & connections shall be in accordance with IS 2026(Part1V) 1977.

REQUIREMENTS WITH REGARDS TO ABILITY TO WITHSTAND SHORT CIRCUIT.

As per IS 1180

IMPEDANCE VOLTAGE

As per IS 1180

ON LOAD TAP CHANGING SWITCH

On load tap changer with RTCC panel and AVR

PARALLEL OPERATION

Transformer shall be suitable for parallel operation with similar unit of same rates.

GENERAL REQUIREMENTS OF TRANSFORMERS

Transformer shall be suitable for operating at rated capacity continuously at any of the taps under ambient conditions and with the voltage and frequency variations indicated without exceeding permissible temperature rise and without any detrimental effect to any part.

Transformer shall be designed to be loaded as per IS:6600.

On Load tap changer shall be provided in the transformer with RTCC panel. The range of OLTC will be -15% to +5% in the steps of 1.25% as per BOQ.

All windings shall have uniform insulation resistance to earth.

Disconnecting chamber shall be air filled. Suitable cable end box shall be provided for termination of cables. Gland plate for single core cables shall be non-magnetic.

Transformer shall be able to withstand electrodynamic and thermal stresses due to terminal short circuit of the secondary, assuming the primary side is being fed from an infinite bus. All leads and windings in cores shall be properly supported. Short circuits withstand and duration shall be 2 secs. As per IS: 1180

Short circuit test results for similar transformers shall be furnished.

There shall be a marshalling box for gathering all alarm signals. All alarm shall be wired up to terminal strip provided in marshalling box. 20% spare terminals shall be provided. Armoured cable of 2.5 sqmm cu shall be provided along with suitable size glands for terminating these contacts in marshalling box.

Guides shall be provided to facilitate tanking and untanking of the core with the coil assembly. The details of anchoring of core and coils assembly of tank shall be furnished.

Radiators shall be provided on the tank to facilitate cooling. These shall be detachable type and shall be provided with isolating valves at ends, drain plugs and air release plug. Radiators of 1.2 mm thickness seamless steel tubing or pressed sheet steel.

Means for lifting and jacking of transformer shall be provided.

Class-A insulating material specified in IS:1271 shall be used. Paper insulation shall be new and free from punctures. Wood insulation, wherever used, shall be well seasoned and treated.

The mineral oil shall comply with IS: 335. 10% extra oil in seal tins/ drums shall be supplied.

All valves shall be of globe type. Valve body of carbon steel and trim of 135 cr. Steel.

Oil temp. Indicator for measuring top oil temp. Shall comprise 150mm dial type thermometer pocket and capillary tube jacketed with PVC sleeve. Thermo-meter shall have 2 sets of contacts, one for alarm and the other for trip, and set points can be set by hand. Contacts shall be wired up to marshalling box.

Buchholz relay shall be provided as per IS: 3637. It shall be double float type with two sets of contacts for alarm and trip with facility for testing by injection of air by hand pump and with cock for draining and venting of air. Relay shall be provided with shut off valves on conservator side as well as on tank side.

Alarm and trip contacts shall be suitable for 1A 230 AC.

A marshalling box shall be provided to accommodate all auxiliary devices except those which are to be located directly on transformer. It shall be of dust, weather and vermin proof type of sheet steel 2mm thick and shall have sufficient space for ease of cabling. 20%extra terminals shall be provided.

All steel surfaces exposed shall be treated with suitable anti –rust, anti –corrosive paints

Bushing insulator shall be rated for max. System voltage and shall be as per IS. Bushing shall be enclosed in terminal box and shall be detachable from outside the tank. Separate neutral bushing shall be provided for earthing the neutral. When LT cable box is provided, a neutral bushing shall be brought out for solid earthing.

Transformers shall have same percentage impedance & other characteristics with foundation plan parallel operation as per IS: 10028

FITTINGS

The following accessories and fittings shall be provided with the transformer

- i. **LIFTING LUGS:** The arrangement of lifting the active part of the transformer along with the cover of the tank by means of lifting lugs without disturbing the connections. Also complete transformer lifting lugs shall be provided.
- ii. **ROLLERS:** The transformer to be provided with 4 Nos. rollers fitted on cross channels to facilitate the movement of transformer.
- iii. **OIL CONSERVATOR:** The transformer to be provided with a conservator with welded end plates. It is to be bolted to the cover and can be dismantled for purposes of transport. It has to be provided with oil gauge with marking for minimum level and an oil filling hole with a cap which can be used for filtering of oil. For draining purposes a plug is to provide. A connection pipe between the conservator and tank is to be provided, which projects inside the conservator.
- iv. **AIR RELEASE VALVE:** An air release valve shall be provided on top of the tank cover to facilitate of the entrapped air while filling of oil.
- v. **BREATHER:** The transformer shall be provided with an indicating dehydrating silica gel breather of sufficient capacity.
- vi. **DRAIN VALVE WITH PLUG:** The transformer to be provided with drain valve with plug at the bottom of the tank.
- vii. **DIAGRM WITH RATING PLATE:** One diagram and rating plate indicating the details of transformer connection diagram vector group tap changing diagram etc.
- viii. **THERMOMETER:** Dial type thermometer (150mm dia) with maximum set pointer 75 degree C electrical contacts for electrical contacts for electrical alarm at high temp.
- ix. **EXPLOSION VENT:** Explosion vent or pressure relief device shall be provided of sufficient size of rapid release of any pressure that may be generated within the tank and which might result in damage in the equipment. The device shall operate at a static pressure less than the hydraulic test pressure for transformer tank.
- x. **FILTER VALVE:** Filter valve on the top of the tank.
- xi. **BUCHOLTZ:** Oil actuated relay equipment shall conform to IS 3637-1966(amended up to date) and shall be double float type having contacts which close following oil surge or under incipient fault condition. Bucholtz relay shall have contacts for alarm / trip.
- xii. **WINDING TEMPERATURE INDICATOR :**
- xiii. Winding temperature indicator with electrical contact for alarm/ trip

- xiv. OIL TEMPERATURE INDICATOR: Oil temp. Indicator with alarm & trip contacts.
- xv. MARSHALLING BOX: the transformer shall be provided with suitable size marshalling box to terminate the control cables of thermometer and bucholtz relay.
- xvi. CONTROL CABLING: all control cables required from Marshalling box to H.T panel board for Trip/alarm of winding temp. Indicator, oil temp indicator, Buchholz relay etc. shall be provided and deemed to be included in the rate of transformer equipments.
- xvii. TRANSFORMER OIL: First filling of oil.
- xviii. EARTHING: Two separate earthing terminals are to be provided at the sides of the tank on both the sides for earthing.
- xix. ON LOAD TAP CHANGER; High speed resistor type OLTC shall be provided along with RTCC and AVR.

SOAK PIT

Soak pit for oil filled transformer shall be made as per IS 10028 (Part II) 1981 with up to dated amendments. Sump shall be formed in the transformer room and shall be connected to soak pit outside the transformer room with a pipe. All the civil works required for the soak pit shall be done by the contractor and the cost shall be deemed to be included in quoted rates of the transformer item.

INSTRUMENTATION MANUAL

The successful bidder shall submit three copies of manual of complete instructions for the installations, operations, maintenance and repair, circuit diagrams, foundations and trenching details shall be provided with the transformer.

SHOP DRAWINGS

The selected supplier shall prepare and furnish shop drawings for the approval by the consultant/client before commencing fabrications/ manufacture of the equipment. Shop drawing shall be based on the requirement laid down in the specifications. The manufacture of the equipment shall be commencing only after the shop drawings have been approved in writing by the consultant. Transformer shall be manufactured conforming to specification of Local supply authority.

INSPECTION

- i) The transformer shall be inspected on arrival as per the inspection manual of the supplier
- ii) Shall be examined of any sign of damage and special attention shall be given to the following parts.

- Oil tank and cooling tubes
- Bushes cracks or broken
- Oil sight glass

INSTALLATION

- i) The transformer shall be installed as per transformer manual of the transformer supplier and conforming to Indian standards.

- ii) The transformer is to be erected on suitable size M.S channels embedded in the cement concrete flooring including providing & fixing the channel. The transformer supplied shall be lifted by all lifting lugs for the purpose of avoiding imbalance in transit.
- iii) The transformer wheels shall be locked by suitable locking arrangement to avoid accidental movement of the transformer.
- iv) The transformer cable end boxes shall be sealed to prevent absorption of moisture.
- v) The transformer natural earthing and body earthing shall confirm to Indian Standard.

FACTORY TEST

The transformer shall be subjected to test as laid down in IS 1180 at factory/manufacturing unit prior to dispatch of the transformer to the site.
All original test certificates shall be furnished.

TESTING AT SITE

Prior to commissioning of the transformer the following tests shall be performed

- i) Insulation resistance of the winding between phases and earth of H.V and M.V side.
- ii) Winding resistance of all the winding on all tap positions shall be taken.
- iii) The supplier gives sufficient advance information about the test schedule to enable the owner to appoint his representative.

HIGH SPEED RESISTOR ON LOAD TAP CHANGER

GENERAL

High speed resistor on load tap changer shall be provided with the transformer wherever specified. The high speed resistor OLTC shall be for rated voltage up to 11KV rating current of 100 Amp, 3phase, 17step conforming to Indian standard with AVR & RTCC panel.

TYPE AND CONSTRUCTION

OLTC shall be a compact unit for use with three phase distribution transformer. It shall be completely self contained and designed to bolt directly to a part flange on the transformer.

The assembly comprise of

1. Tank
2. Selector Switch
3. Driving Mechanism
4. Barrier Board
5. Local control Gear
6. Control cable Terminations
7. AVR & RTCC panel

TANK

The complete tap changer shall be housed in a single tank of welded sheet steel construction. The tank shall be divided into two separate compartments to house the selector switch, driving mechanism and Local control gear. Access to the compartments shall be made easy by means of

removable covers and a weather proof door. Anti- condensation heater shall be provided in the compartment which houses driving mechanism and control gear.

OPERATION MECHANISM

An impulse is received either from a remote control panel or from a local manual operation switch, which energises the appropriate raise/lower contactor to initiate a tap changer in the required direction. The contactor when energized seals itself via its own contact and the driving motor commences to run. At a predetermined point a directional sequence switch closes, taking over the handling duties of the contactor whose original hold circuit shall be isolated. At the completion of the tap changer the directional sequence switch opens and de- energizes the driving motor. The arrangement ensures that a short period initiating pulse shall be accepted by the control gear.

CONTROL CABLE TERMINATION

A detachable undrilled gland plate and the terminal station for all the external connections shall be provided in the driving mechanism compartment of the tap changer.

AUTOMATIC VOLTAGE REGULATOR

Solid state automatic voltage regulator shall be provided for the regulation of the secondary voltage of the power transformer with on load tap changer (OLTC). The band width control shall allow the dead band to be set in the terms of upper (LOWER VOLTS) and lower (RAISE VOLTS) voltage limit around a particular nominal value with a specified sensitivity. AVR shall be provided with time delay control to allow the regulator to respond only to voltage fluctuations lasting for period greater than a selected time delay. Where the voltage correction requires more than one tap change, the time delay shall be reinitiated before further tap changes. Regulations shall reset automatically after voltage correction. Solid state lamps (LED) shall be provided to indicate voltage outside the preset limit & control relay operation.

RTCC PANEL

RTCC panel shall be provided to operate OLTC from control room located in substation. RTCC shall be provided with main switch, a sequence selector switch. RTCC shall be provided with lower push button & raise push button, tap change in progress & complete. A.C supply ON/OFF lamp indicator & AVR relay operated operation indication. Cubical panel shall be totally enclosed, floor mounting and fabricated with a framed structure with rolled/folded sheet steel channel section of minimum 2mm thickness. All the sheet steel work forming the exterior of RTCC panel shall be smoothly finished and all steel work used in construction of RTCC panel shall undergo a rigorous metal treatment process consisting of effective cleaning by hot alkaline degreasing solution followed by the cold water rinsing, pickling in dilute sulphuric acid to remove scales and rust formation, a recognized phosphating process, passivating in deoxidize to retain & augment the effects of phosphating, drying with compressed air and dust free atmosphere, primer coating with two coats of highly corrosion resistant primer applied under strictly controlled conditions and finished coat of stoving

4.02 11 KV/0.433 KV TRANSFORMER (DRY TYPE TRANSFORMER)

4.02.01 GENERAL

Power transformer shall be dry type for indoor use having capacities indicated in the schedule. The supply is 11KV/433 volts, 50 Hz and 3 phase. All the transformers shall be with ON LOAD TAP CHANGER type or as specified in BOQ

The design manufacture and performance of transformer shall comply with all performance of equipment status, regulations and safety codes in the location where the transformers will be installed. Transformers shall conform to the latest applicable standards. **The Transformer loss will be as per ECBC Norms Amended up to Date. Transformer shall also meet all other norms / requirement of ECBC.**

4.02.02 CODES AND STANDARD

Transformers shall comply with the latest edition of Indian Standards No. IS 2026 Part I to Part V (Power Transformer) and IS11171 for Dry Type Transformer . In case the Provision of Indian Standards are not directly applicable to dry type Transformer , the provision of Latest IEC-726 and any other relevant IEC shall apply. Latest Standards as applicable shall be followed the Insulating materials, Bushing, Installation and Maintenance of the Transformer.

4.02.03 SERVICE CONDITION

Altitude	Less than 1000 meters.
Maximum Ambient Temperature	50 deg. C
Minimum Ambient Temperature	0 deg C
Relative Humidity	100 %
Installation	Corrosive, dusty, humid and tropical.

4.02.04 RATING AND TYPE

The Transformer shall have core type construction, 3 phase and shall be suitable for Indoor services under the climatic conditions prevailing at site. The Transformer shall be capable of withstanding thermal and mechanical effects of short circuit at terminals of any winding with full voltage maintained on other winding as per IS: 2026.

4.02.05 WINDING

The primary and secondary winding shall be of electrolyte copper conductors. The high and low voltage winding shall be totally encapsulated and should be cast under vaccum in moulds with fiber glass reinforce epoxy resin laminate. Both HV and LV winding of each phase shall be separately cast as arigid tubular coil with no mechanical and electrical connection between their co- axial arrangement. The Transformer shall be free of partial discharges at least upto 1.1 times the rated voltage.

The winding shall absorb no. moisture under the worst tropical conditions collection of moisture and dust over the winding shall not any way affect the insulation strength of the winding.

4.02.06 CORE

The transformer core shall be build upb with high non-aging low and high permeability CRGO Silicon steel lamination. CRGO sheet shall be coated with inorganic material or equivalent insulation to reduce eddy current to minimum. After shearing, the laminations shall be treated to remove all burrs and shall be annealed to remove all the residual stresses.

Coreframe work and clamps shall be arranged and tightened to securely hold lamination in order to prevent any settling or displacement in case of heavy shocks during transport, handling or short circuits. All the Iron parts except the core shall be galvanized and treated with high temperature resistance paint. Core Fastening shall be insulated to reduce losses and avoid spots. Transformer shall be designed to withstand 10 % overfluxing corresponding to rated voltage.

Suitable lugs shall be provided for lifting the complete core and coil assembly of the transformer.

4.02.07 INSULATION

Interturn and intercoil insulation shall be designed such that dielectric stress is uniformly distributed throughout the winding under all operating conditions. The winding shall be provided with Class 'F' Insulation.

4.02.08 TEMPERATURE RISE

The Temperature rise of the winding shall not exceed 90deg by resistance on continuous full load above maximum ambient temperature of 50 Deg C and in no case shall reach value that may damage the core itself or other adjacent part.

4.02.09 TAP CHANGING:

"ON LOAD" circuit tap changing with AVR arrangement on H.V side is to be provided. The tapping is to be provided for variation on high voltage side from + 5% to - 15% steps of 1.25% each. Automatically operated STEPLESS "ON LOAD Tap Changing Switch" having a position indicating lights & Locking device and complete with Automatic Voltage regulator and its Control panel shall be provided separately.

4.02.10 VECTOR GROUP:

Transformer shall have the vector group of Dyn 11.

4.02.11 IMPEDENCE

The desired impedance shall be as mentioned in the IS:2026.

4.02.12 CURRENT DENSITY

The Maximum Current density at any point in the winding shall not exceed 2.2 Amp. Per sq.mm at the rated full load, voltage and frequency.

4.02.13 FLUX DENSITY

The minimum flux density at any point in the winding shall not be less than 1.6 Tesla on the normal rated tap voltage and frequency.

4.02.14 COOLING

The Transformer shall be designed for natural cooling (AN)

4.02.15 ENCLOSURE

Transformer shall be provided with a sheet steel enclosure with adequate provision for ventilation. The degree of protection of enclosure shall be IP 21 for indoor installation and IP 33 for outdoor installations. The sheet steel thickness of enclosure shall be minimum 2mm.

4.02.16 CABLE TERMINATION

The low voltage side of the transformer shall be suitable to receive Aluminium Bus Duct of suitable capacities from the top of the Transformer. A suitable size of flange to be provided for connecting the overhead bus trunking in the LT Box.

H.T. sides of the transformers shall have cable end boxes to receive 3 C X 240 sq.mm desired size of 11KV cables.

All cable end boxes shall have bore holes to match the opening for each cable specified and shown in the single line diagram.

4.02.20 EARTHING

Two main earthing terminals shall be connected to the terminals provided for transformer.

4.02.21 FITTINGS AND ACCESSORIES

Rating and Terminal Marking Plate of the Transformer including the details of OFF circuit changing voltage of the links.

Earthing terminal with Lugs.

Transformer Neutral Earthing terminal.

Marshal Box with wiring and terminal and temperature scanner.

PT 100 type temperature scanner and its connection with marshal box.

Neutral CT 2000/1 Amp. And its connection with marshal box for 2000 KVA Transformer only.

Limit switch in all hinged door fix door and wiring till marshal box.

HV cable end box at primary.

LT bus Trunking box at secondary.

4 nos Plan bi- directional rollers.

Inspection windows shall be provided in the cover.

Lifting lugs for both the transformer and core shall be provided.

4.02.22 INSTALLATION OF TRANSFORMER

Installation of transformer shall be carried out in accordance with manufacturer's instructions and/or as directed by purchaser.

All power/control connections and mechanical joints shall be completed, checked and adjusted to ensure safety and satisfactory operation of the transformer.

Transformer shall not be placed on bare ground during unloading but it shall be placed on wooden sleepers. After placing on foundation, alignment, leveling etc. shall be carried out in best workman like manner.

For the power/control cabled projecting above the ground, the termination to cable box shall be run in GI conduits of suitable cross section and the same shall be supported properly and pipe ends shall be sealed with bitumen compound.

The cable box of detachable type of the transformer shall be supported properly so as to facilitate taking out of the transformer for repair without disturbing the cables.

4.02.23 TEST CERTIFICATES.

Test certificate shall be furnished in required number of copies for approval.

The routine, special and type test certificate of the transformer shall be furnished for approval before the delivery of the equipment from the factory.

The routine and type test certificates of miscellaneous components shall be furnished or approval.

4.02.24 ROUTINE TESTS

During manufacture and on completion the transformer shall be subjected but not limited to the following Routine Tests as laid down in the latest revision of the IS 11171 IEC - 726

- i) Applied voltage test
- ii) Induced voltage test
- iii) No-load loss and excitation current tests
- iv) Impedance voltage and load loss tests
- v) Resistance measurement
- vi) Ratio tests
- vii) Polarity and phase relation tests
- viii) Insulation resistance tests
- ix) Insulation power factor tests

4.02.25 TYPE TESTS

The type test certificates for the following type tests carried out on similar capacity rating shall be submitted along with the routine test certificates.

- i) Heat run test
- iii) Impulse test

4.02.26 FIELD TEST

After installation a site, the transformer shall be subjected to the following field test:

- i) Construction inspection
- iv) Ratio tests
- v) Polarity test
- vi) Tap change operation test.

4.02.27 ELECTRICAL & PERFORMANCE REQUIREMENT :

- a) Transformer shall operate without injurious heating at the rated KVA at any voltage within variation of +/- 10% of the rated voltage of that particular tap.
- b) Transformer shall be designed for 110% continuous over fluxing withstand capability.
- c) The neutral terminals of the winding with star connection shall be designed for the highest over current that can flow through the winding.
- d) Overloads shall be allowed within the conditions defined in the loading guide of the applicable standard. Under these conditions, no limitations by terminal bushings, tap changers or other auxiliary equipment shall apply.

- e) Temperature Rise for continuous full load application shall be guided by Maximum temperature rise clause of IS 2026. The temperature rise shall not exceed 45 degree C by thermometer in oil or 50 degree C for winding over an ambient of 45 degree C.
(Please note maximum ambient temperature shall be considered 50 degree C).

4.02.28 DRAWINGS AND O&M MANUALS:

4.02.29 Four copies of manual of complete instructions for the installation, operation, maintenance and repairs circuit diagrams, foundation and trenching details shall be provided with the transformers. List of spare parts shall also be indicated.

4.02.30 Two copies of the drawings incorporating the following particulars shall be submitted with the offer for preliminary study.

- a) GA drawing showing dimension, net weight and shipping weight, quantity of insulating oil etc.
- b) Crane requirements for assembly and dismantling of the transformer.
- c) Drawing indicating GA of cable box and its dimension for cable entry cut out requirements etc.

4.02.31 The drawings in (four sets) to be furnished by the supplier for approval after acceptance of his order shall include the following.

- a) GA showing front and side elevations and plan of transformer and all accessories and external features, detailed dimensions, crane lift for unloading, oil quantity, H.T./L.T. clearances etc.
- b) Drawings of Bus duct termination arrangement.
- c) HV cable box arrangement & disconnecting chamber GA drawings.
- d) Name plate and terminal making and connection diagram.
- e) Assembly of OLTC gear mechanism & details of mechanism parts, limits, contours of wearing parts, timing gear adjustments etc.

4.02.32 Reproducible copy of the above drawings for records

Dry-Type Transformers (ECBC Table 8.1)

Rating KVA losses	Max. Losses at	Max. Losses at	Total losses at	Total
	50% loading ¹	100% loading ¹	50% loading ¹	at rated
	Up to 22 kV		33 kV	
100	0.9	2.4	1.12	2.4
160	1.2	3.3	1.42	3.3
200	1.5	3.8	1.75	4

250	1.7	4.32	1.97	4.6
315	2	5.04	2.4	5.4
400	2.3	6.04	2.9	6.8
500	2.8	7.2	3.3	7.8
630	3.34	8.8	3.95	9.2
800	3.8	10.2	4.65	11.
100	4.5	12	5.3	12.
125	5.19	13.8	6.25	14.
160	6.32	16.	7.5	18
200	7.5	20	8.88	21.
250	9.25	24.7	10.7	26.

¹Total loss values given in above table are applicable for thermal classes E, B & F and have component of load loss at reference temperature according to clause 17 of IS 2026: Part 11. i.e., average winding temperature rise as given in column 2 of Table 8.2 plus 30°C. An increase of 7% on total for thermal class H is allowed.

Oil Filled Transformers (ECBC Table 8.2)

Rating KVA losses	Max. Losses at	Max. Losses at	Total losses at	Total
	50% loading ¹	100% loading ¹	50% loading ¹	at rated
	Up to 11 kV		33 kV class	
100	0.52	1.80	0.56	1.82
160	0.77	2.20	0.78	2.58
200	0.89	2.70	0.90	3.00
250	1.05	3.32	--	--
315	1.10	3.63	1.30	4.30
400	1.45	4.63	1.52	5.10
500	1.60	5.50	1.95	6.45
630	2.00	6.64	2.30	7.60
1000	3.00	9.80	3.45	11.35
1250	3.60	12.0	4.00	13.25
1600	4.50	15.0	4.85	16.00
2000	5.40	18.4	5.70	18.50
2500	6.50	22.5	7.05	23.00

¹Total loss values given in above table are applicable for thermal classes E, B & F and have component of load loss at reference temperature according to clause 17 of IS 2026: Part 11. i.e., average winding temperature rise as given in column 2 of Table 8.2 plus 30°C. An increase of 7% on total for thermal class H is allowed.

Measurement and Reporting of Transformer Losses

As per the Code

All measurement of losses shall be carried out by using calibrated digital meters of Class 0.5 or better accuracy and certified by the manufacturer. All transformers of capacity of 500kVA and above would be equipped with additional metering class current transformers (CTs) and potential transformers (PTs) additional to requirements of Utilities so that periodic loss monitoring study may be carried out.

5.00 CAPACITOR PANEL

5.01 SCOPE

Supply, installation, testing and commissioning of medium voltage capacitors and Automatic Power Factor Correction Panel (APFC) for improvement in power factor of electrical system. It will be connected to main LT panel. It shall improve power factor up to 0.98 lagging from initial power factor. Capacitor panel shall be provided with day/ night mode selector switch and double ratio C.Ts, for day/ night mode. Day/ night mode shall be selected based on estimated day / night load requirement. The panel shall include all the specified capacitor banks, switchgears, controller, filter reactors, control gears, busbars, meters, earthing, interconnections etc

5.02 RATING

Capacitor units as specified in the BOQ shall be used to form a bank of capacitors.

5.03 ENCLOSURE

The panel shall be indoor, floor mounted and free standing type with IP-42 degree of protection. It shall be completely made of CRCA sheet steel. The enclosure shall have sturdy support structure and shall be finished with powder coating in the approved colour shade. Suitable provisions shall be made in the panel for proper heat dissipation. Air aspiration louvers for heat dissipation shall be provided. The front portion shall house the switchgear and the rear portion shall house capacitors and series reactors (14%). The enclosure is to be suitably sized to accommodate all the components, providing necessary air clearance between live and non-live parts, providing necessary working clearance.

5.04 APFC Relay

Microprocessor based APFC relay, (intelligent VAR controller) of suitable steps as mentioned in the BOQ, shall sense the PF in the system and automatically switch ON/OFF the capacitor unit or bank to achieve the preset target PF. The controller shall have digital settings of parameters like PF, switching time delay, step limit etc, indication of PF, preset parameter, minimum threshold setting of 1% of CT current.

5.05 CAPACITORS

The capacitor shall generally conform to IS: 13585:1994 and IEC 60931:2002

General specification: three phase, delta connected, 50 Hz.

- i. Voltage: Must be designed to with stand system over voltage, increased voltage due to series reactor and harmonics. It should be rated for 525V for 14% detuned reactor. The KVAR of Capacitor banks should be increased proportionately for combination of Capacitor + reactor.
- ii. Capacitor type: The capacitor unit shall be Heavy Duty MPP resin filled, copper wound type. The dielectric should be made of polypropylene. Capacitor Impregnation shall be Oil Type. Capacitor should be fitted with safety device for each capacitor units. The capacitor should be low loss type (total losses should not exceed 0.45 W/ KVAR).
- iii. Temperature category: -25 degree C to 70 degree C.

- iv. Over voltage +10% (12h in 24 hours), +15% (30 minutes in 24 hours), +20% (5 minutes) and 30% for 1 minute as per clause 6.1 of IEC 60931
- v. Over current: $2.5x I_n$
- vi. Peak inrush current withstand: $400 x I_n$
- vii. Capacitor shall be provided with permanently connected discharge resistors so that residual voltage of capacitors is reduced to 50 volts or less within one minute after the capacitors are disconnected from the source of supply.
- viii. Each capacitor bank shall be provided with a terminal chamber and cable glands suitable for AYFY cable as specified.
- ix. Separate earthing terminal shall be provided for earth connection of each bank.

De-tuned Filter

- Detuned filter reactor shall be used along with power capacitors to mitigate harmonics, improve power factor and to avoid electrical resonance in LV electrical networks.
- The low voltage filter Copper reactor shall be series type having a three phase, iron core construction suitable for indoor use. The reactor shall be air cooled and the layout shall be in accordance with IEC 60076.
- The permitted tolerance of inductance shall be + 3% of rated inductance value.
- The limit of linearity of inductance of the filter reactor shall be as follows $1.8 * I_n$ with $L = 0.95 * L_N$.
- The reactor shall be fitted with a temperature sensitive micro-switch in the centre coil (normally open) for connection to trip circuits in case of high operating temperatures.

5.06 SWITCHGEAR & PROTECTION:

Incomer switchgear will be as specified in BOQ. Suitable rated Power Contactors or Special Capacitor duty contactor for each step shall be used and must be capable of capacitor switching duty. Busbars shall be suitably colour coded and must be mounted on appropriate insulator supports.

Power cable used shall have superior mechanical, electrical and thermal properties. Internal wiring between main bus bars, contactor, capacitor etc shall be made with 1100 volt grade PVC insulated FRLS copper conductor of appropriate size by using suitable copper crimping terminal ends etc suitable bus links for input supply cable termination shall be provided.

Control circuit shall be duly protected by using suitable rating MCB. An emergency stop push button shall be provided to trip thru entire system (22.5 mm dia, mushroom type, press to stop and turn to reset). 440 Volt caution board shall be provided on the panel.

5.07 TESTS AT MANUFACTURER'S WORKS:

All routine and type tests as per IS:2834 relevant to capacitor bank s as amended upto date shall be carried out at manufacturer's works and test certificates to be submitted to HSCC.

5.08 TESTS AT SITE:

Insulation resistance with 500 V DC Megger shall be carried out and test results should be recorded.

Residual voltage shall be measured after switching of the capacitors and the same shall not be more than 50 volts after one minute. Each discharge resister shall be tested for its working.

Drawings and Instruction manual:

5.09 INSTALLATION:

Capacitor bank shall be installed at least 30 CM away from the walls on suitable frame work of welded construction. The earth terminals provided on the body of capacitor bank shall be bonded to main capacitor panel earth bus with 2 nos 8 SWG copper or 6 SWG GI earth wire.

Contractor shall submit four copies of the following certified drawings:

- i. General arrangement of capacitor bank and control panel indicating main dimensions, type of mounting, location of various devices etc., including foundation details.
- ii. Schematic diagram for automatic sequential switching with terminals and ferrules numbers.
- iii. Wiring diagram of control panel indicating terminal blocks and various apparatus.
- iv. Final list of components of control panel.

Contractor shall also submit four sets of installation and maintenance manual

6.0 MAIN LT, MV & FLOOR PANELS

6.1 GENERAL

Main/Sub Distribution Panels shall be indoor type, metal clad, floor mounted, free standing, totally enclosed, extensible type, air insulated, cubicle type for use on 415 Volts, 3 phase, 50 cycles system.

6.2 CONSTRUCTION

Main/Sub Panels shall be:

- i. Of metal enclosed, indoor, floor mounted, free standing construction (unless otherwise specified) type.
- ii. Made up of the requisite vertical sections, which when coupled together shall form continuous dead front switchboards.
- iii. Provide dust and damp protection.
- iv. Be readily extensible on both sides by the addition of vertical sections after removal of the end covers in case of Main Panels.
- v. All panels shall be front access type.

Main/Sub Panels shall be constructed only of materials capable of withstanding the mechanical, electrical and thermal stresses, as the effects of humidity, which are likely to be encountered in normal service.

Each vertical section shall comprise of the following:

- i. A front-framed structure of rolled/folded sheet steel channel section, of minimum 2 mm thickness, rigidly bolted together. This structure shall house the components contributing to the major weight of the equipment, such as circuit breaker cassettes, moulded case circuit breaker, main horizontal busbars, vertical risers and other front mounted accessories. The structure shall be mounted on a rigid base frame of folded sheet steel of minimum 2 mm thickness and 100 mm height. The design shall ensure that the weight of the components is adequately supported without deformation or loss of alignment during transit or during operation.
- ii. A cable chamber housing the cable end connections, and power/control cable terminations. The design shall ensure generous availability of space for ease of installation and maintenance of cabling, and adequate safety for working in one vertical section without coming into accidental contact with live parts in an adjacent section.
- iii. A cover plate at the top of the vertical section, provided with a ventilating hood where necessary. Any aperture for ventilation shall be covered with a perforated sheet having less than 1 mm diameter perforations to prevent entry of vermin.

- iv. Front and rear doors fitted with dust excluding neoprene gaskets with fasteners designed to ensure proper compression of the gaskets. When covers are provided in place of doors, generous overlap shall be assured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust.

The height of the panels should not be more than 2400 mm for MV Panels. Operating handle of breaker in top most compartments shall not be higher than 1800 mm. The total depth of the panel should be adequate to cater to proper cabling space and should not be less than 350mm.

Doors and covers shall be of minimum 2mm thick sheet steel. Sheet steel shrouds and partitions shall be of minimum 1.6 mm thickness. All sheet panels shall be smoothly finished, leveled and free from flaws. The corners should be rounded. The apparatus and circuits in the power control centers (panels) shall be so arranged as to facilitate their operation and maintenance and at the same time to ensure the necessary degree of safety.

Apparatus forming part of the Main/Sub Panels shall have the following minimum clearances.

- i. Between phases - 32 mm
- ii. Between phases and neutral - 26 mm
- iii. Between phases and earth - 26 mm
- iv. Between neutral and earth - 26 mm

When, for any reason, the above clearances are not available, suitable insulation shall be provided. Clearances shall be maintained during normal service conditions.

Creepage distances shall comply with those specified in relevant standards.

All insulating material used in the construction of the equipment shall be of non-hygroscopic material, duly treated to withstand the effects of the high humidity, high temperature tropical ambient service conditions.

Functional units such as circuit breakers and moulded case circuit breakers shall be arranged in multi-tier formation, except that not more than two air circuit breakers shall be housed in a single vertical section. Cable entry for various feeders shall be from the rear. Panel shall be suitable for termination of bus duct for incoming breakers.

Metallic/insulated barriers shall be provided within vertical sections and between adjacent sections to ensure prevention of accidental contact with:

- i. Main busbars and vertical risers during operation, inspection or maintenance of functional units and front mounted accessories.
- ii. Cable termination of one functional unit, when working on those of adjacent unit/units.

All doors/covers providing access to live power equipment/ circuits shall be provided with tool operated fasteners to prevent unauthorized access.

Provision shall also be made for permanently earthing the frames and other metal parts of the switchgear by two independent connections.

6.3 METAL TREATMENT & FINISH

All steel work used in the construction of the Main/Sub Panels should have undergone a rigorous metal treatment process as follows:-

- i. Effective cleaning by hot alkaline degreasing solution followed by cold water rinsing to remove traces of alkaline solution.
- ii. Pickling in dilute sulphuric acid to remove oxide scales & rust formation, if any, followed by cold water rinsing to remove traces of acidic solution.
- iii. A recognized phosphating process to facilitate durable coating of the paint on the metal surfaces and also to prevent the spread of rusting in the event of the paint film being mechanically damaged. This again, shall be followed by hot water rinsing to remove traces of phosphate solution.
- iv. Passivating in de-oxalite solution to retain and augment the effects of phosphating.
- v. Drying with compressed air in a dust free atmosphere.
- vi. Panel shall be powder coated with epoxy based powder paint after the above process so as to render the material suitable for corrosive environment.
- vii. Paint shade shall be Pebble (light) grey, shade no RAL 7032 unless otherwise specified.

6.4 BUSBARS

The busbars shall be air insulated and made of high conductivity, high strength aluminum alloy complying with the requirement of IS-5082.

The busbars shall be suitable braced with non-hygroscopic SMC supports to provide a through fault withstand capacity of 25kA RMS symmetrical for one second. The neutral as well as the earth bar should be capable of withstanding the above level. Ridges shall be provided on the SMC supports to prevent tracking between adjacent busbars. Large clearances and Creepage distances shall be provided on the busbar system to minimize possibilities of fault.

The Main/Sub Panels shall be designed that the cables are not directly terminated on the terminals of breaker etc. but on cable termination links. Capacity of aluminum busbars shall be considered as 0.8 Amp per sqmm. of cross sectional area of the busbar. The main busbars shall have continuous current rating throughout the length of Panels. The cross section of neutral busbars shall be same as that of phase busbar for busbars of capacity up to 200Amp; for higher capacity the neutral busbar shall not be less than half (50%) the cross section of that the phase busbars. The busbar system shall consist of main horizontal busbar and auxiliary vertical busbars run in busbar alley/chamber on either side in which the circuit could be arranged/connected with front access.

Connections from the main busbars to functional circuit shall be arranged and supported to withstand without any damage or deformation the thermal and dynamic stresses due to short circuit currents. Busbars to be colour coded with PVC sleeves.

6.5 SWITCHGEARS

Refer subhead 7.00 – LT switchgears

6.6 CABLE TERMINATIONS

Cable entries and terminals shall be provided in the Main/Sub Distribution Panels to suit the number, type and size of aluminium conductor power cables and copper conductor control cable specified.

Provision shall be made for top or bottom entry of cables as required. A cable chamber 150 mm. high shall be provided at the bottom through out the length and depth of the MDB/SDB. Generous size of cabling chambers shall be provided, with the position of cable gland and terminals such that cables can be easily and safely terminated.

Barriers or shrouds shall be provided to permit safe working at the terminals of one circuit without accidentally touching that of another live circuit.

Cable risers shall be adequately supported to withstand the effects of rated short circuit currents without damage and without causing secondary faults.

6.7 LABELS

Labels shall be anodised aluminium with white engraving on black background shall be provided for each incoming and outgoing feeder of Main/Sub Distribution and all Panels.

6.8 TEST AT MANUFACTURES WORK

All routine tests specified in IS: 8623-1977 shall be carried out and test certificates submitted.

6.9 TESTING AND COMMISSIONING

Commissioning checks and tests shall be included all wiring checks and checking up of connections. Primary/secondary injection tests for the relays adjustment/setting shall be done before commissioning in addition to routine meggar test. Checks and tests shall include the following.

- a) Operation checks and lubrication of all moving parts.
- b) Interlocking function check.
- c) Insulation test: As per CPWD Specifications.
- d) Trip tests & protection gear test.

7.0 L.T. SWITCHGEARS

7.1 AIR CIRCUIT BREAKERS

7.1.1 GENERAL

Air circuit breakers shall be incorporated in Main Distribution Panels wherever specified. ACBs shall conform to IS 13947 (Part 2) & IEC 947 (2) in all respects. ACBs shall be suitable for operation on 415 volts, 3 phase, 50Hz, AC supply. Electrical/ Mechanical endurance of the ACB shall be as per IS/ IEC 60497.

7.1.2 TYPE AND CONSTRUCTION

Air Circuit Breakers shall be of enclosed pattern, dead front type with 'trip free' operating mechanism. It shall have microprocessor based electronic release. Air Circuit Breakers shall be EDO type (Electrically drawout type unless otherwise specified) with horizontal drawout carriage. The ACBs shall be strong and robust in construction with suitable arrangements for anchoring when in fully engaged or fully drawn-out positions. The carriage or cradle on which the breakers are mounted shall be robust design made of fabricated steel, supported on rollers. Cradle shall also comprise of main and secondary separable contacts and all draw out mechanism in a completely fig welded assembly. There shall be no dependence upon the switchboard frame for any critical alignment. The withdrawal arrangement shall be such as to allow smooth and easy movement.

All the current carrying parts of the circuit breakers shall be silver plated, suitable arcing contacts shall be provided to protect the main contacts. The contacts shall be of spring loaded design. The sequence of operation of the contacts shall be such that arcing contacts 'make before' and break after' the main contacts. Arcing contacts shall be provided with efficient arc chutes on each pole and these shall be such suitable for being lifted out for inspection of main as well as arcing contacts. The contact tips and arc chutes shall be suitable for ready replacement. Self aligning isolating contacts shall be provided. The design of the breaker shall be such that all the components are easily accessible to inspection, maintenance and replacement. Interphase barriers shall be provided to prevent flashover between phases.

7.1.3 OPERATING MECHANISM.

Air Circuit breaker shall be provided with a quick-make, trip free operating mechanism, the operating mechanism shall be 'strain-free' spring operated. The operating handle shall be in front of the panel type. The design shall be such that the circuit breaker compartment door need not be opened while moving the breaker from completely connected, through test, into the disconnected position. Electrical operated breakers shall have a motor wound spring charged closing mechanism. Breaker operation shall be independent of the motor, which shall be used solely for charging the closing spring. The operating mechanism shall be such that the breaker is at all times free to open immediately and the trip coil is energised. Mechanical operation indicator shall be provided to show open and closed position of breaker. Electrically operated breakers shall be additionally provided with mechanical indication to show charged and discharged condition of charging spring. 24 volt DC supply through battery backup for closing and opening for tripping circuit.

Means shall be provided for slow closing and opening of the breaker for maintenance purposes and for manual charging and closing of electrically operating breakers during emergencies.

7.1.4 INTERLOCKING AND SAFETY ARRANGEMENT

Air Circuit Breakers shall be provided the following safety and interlocking arrangements:

- i. It shall not be possible for breaker to be withdrawn when in "ON" position.
- ii. It shall not be possible for the breaker to be switched on until it is either in fully inserted position or for testing purposes it is in fully isolated position.
- iii. The breaker shall be capable of being racked into 'testing', 'isolated' and 'maintenance' positions and kept locked in any of these positions.
- iv. A safety catch to ensure that the movement of the breaker, as it is withdrawn is checked before it is completely out of the cubicle.
- v. The operating mechanism shall provide for racking the breaker into connected, test and disconnected positions without operating compartment door. When cubicle door shall be open position, the breaker can be pulled out to a fourth position, maintenance, where free access shall be possible to all parts of the breaker.

7.1.5 RATING

The rating of the circuit breaker shall be as per the drawings and schedule of quantities. Rated service breaking capacity (Ics) of the breakers shall be 50kA unless otherwise specified at 415 volts. The rated making capacity shall be as per the relevant standard.

7.1.6 ACCESSORIES

The breaker shall be equipped with electronic microprocessor based release to provide over current & earth fault protection. The breaker shall be fitted with following accessories for control, signal and interlocking.

- i. Auxillary contacts 6 NO + 6 NC, of rating 16Amp at 415 volts 50Hz.
- ii. Shunt release for tripping the breaker remotely and shall be suitable for 240 volt/415 volt 50Hz with range of operation from 10% to 130% of rated voltage.
- iii. Micro switches shall be mounted on the cradle of draw out breaker to indicate the position of the breaker on the cradle.
 - a. Kit for test/isolated indication.
 - b. Kit for service position indication.
 - c. Kit for shutter assembly.
- iv. Accessories for following interlocking schemes shall be provided.
 - a. Accessory kit for locking the breaker in isolated position. This kit is useful for interlocking scheme as well as keeping personnel and equipment safe.

- b. Door interlock kit: Panel or cubicle door cannot be opened with the ACB in Test or Service position.
- c. Lockable trip push button.

7.1.7 MOUNTING

Circuit Breakers shall be mounted as per manufacturers' standard practice.

7.1.8 TESTING

Testing of each circuit breaker shall be carried out at the works as per IS 2516 and the original test certificate shall be furnished in triplicate. The tests shall incorporate at least the following.

- i. Impulse withstand test.
- ii. Power frequency withstand test.
- iii. Short circuit test.
- iv. Temperature - rise test under rated conditions.

7.2 MOULDED CASE CIRCUIT BREAKERS.

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 for three phase 415 volts. MCCBs shall have microprocessor based over current and short circuit releases with adjustable current setting or Thermal Magnetic with variable current setting as per BOQ.

7.2.1 Technical Specifications

MCCB should be suitable for 100% isolation.

Electrical/ Mechanical endurance shall be as per IS/ IEC 60497.

Fault identification of O/L, S/C, E/F shall be indicated on panel door.

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 or specified as BOQ. 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 or specified as BOQ.

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 confirming 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.

7.2.2 FRAME SIZES

The MCCBs shall have the following frame sizes subject to meeting the fault level or as per manufacturer's standard practice.

- | | | | |
|----|------------------------|-------|-------------|
| 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. |

7.2.3 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.

7.2.4 BREAKING CAPACITY

Unless otherwise specified, rated service breaking capacity of the Moulded Case Circuit Breakers shall be minimum 35kA.

7.2.5 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.

7.3 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.

7.4 MEASURING INSTRUMENTS, METERING & PROTECTION

7.4.1 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.

7.4.2 DIGITAL AMMETERS

Ammeters shall be standard digital type or specified in BOQ the ammeters shall be 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.

7.4.3 DIGITAL VOLTMETERS

Voltmeters shall be standard digital type or specified in BOQ the ammeters shall be calibrated as per the latest edition of IS: 1248. 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.

7.4.4 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.

7.5 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.

8.0 DIESEL GENERATOR SETS

8.1 INTENT OF SPECIFICATION

8.1.1 This specification covers the design, manufacture, assembly, packing, dispatch, transportation supply, erection, testing, commissioning, performance and guarantee testing of Diesel Gen-Sets with Acoustic Enclosure, complete in all respects with all equipment, fitting and accessories for efficient and trouble free operation as specified here under.

8.2 SCOPE OF WORK:

TECHNICAL SPECIFICATIONS OF DG SETS & ASSOCIATED WORK

The Scope of work shall include under this specification design, manufacture, supply, loading, unloading, storage, installation, testing and commissioning of the Diesel engine alternator sets including labour, tools, tackles and plants, steel fabrication and items as prescribed below:

- ▶ Diesel engine alternator set complete with base frame and accessories.
- ▶ Engine mounted engine control integral panel duly wired up to terminal box for engine safeties with sensors and protection for inter facing with PLC/Microprocessor based relay.
- ▶ Fuel oil system including day service oil tank, piping, valves, filters etc. from engine to service day oil tank.
- ▶ Lube oil system with piping etc. (Pre-lube oil pump with controller if required).
- ▶ Cooling system with radiator, heavy duty suitable for 50⁰C operation complete with make up water tank.
- ▶ Exhaust emission shall meet EURO II norms without catalytic converter or online scrubber as required and residential silencer, exhaust piping with mineral wool insulation and aluminum cladding as called for.
- ▶ Steel fabricated structure/support/hanger including fixing, grouting and bolting etc.
- ▶ Painting of steel work.
- ▶ L.T. / Control cabling.

The bidder shall also indicate in his offer the time schedule for routine maintenance / overhauling operations necessary for continuous satisfactory operation of D.G Set.

The item rate shall remain valid for variation to any extent of the estimated quantities given in the Schedule of Quantities.

All equipment shall be of the class most suitable for working under the conditions specified and shall withstand the atmospheric conditions without deterioration.

Minor civil work is included in the contractor's scope of work. However, the responsibility of coordination with the civil and other contracting agencies ensuring completion of turnkey contract rests with the contractor and shall be certified.

Contractor shall co-ordinate with all other agencies working at site for interconnection and safety aspects.

Also the D.G. Supplier will furnish a combined guarantee minimum for one year from the date of successful commissioning for the entire equipment, In case there is any defect the free replacement of any part or in whole will be made immediately at not loss to Owner.

8.03 FEES & PERMITS

The contractor shall obtain all sanctions and permits required for the running of DG sets for all the relevant authorities. All actual fee payable in this regard will be reimbursed against receipt/documentary proof (evidence). On completion of the work, the supplier shall obtain N.O.C from concerned authorities including Chief Electrical Inspectorate, of state in original shall be delivered to the employer through Architect.

8.04 CODES & STANDARDS

The design, construction, manufacture, inspection, testing and performance shall comply with all the currently applicable statutes, safety codes, relevant Bureau of Indian Standard (BIS), British Standards (BS), International Electro Technical Commission (IEC) publication, NEMA & VDE standards amended upto date.

Some of the applicable standards are listed below :

BS- 5514/ISO 3046/DIN 6271	Reciprocating internal combustion engines
BS – 4613	Electrical performance of rotating electrical machine
BS – 4999/5000	Applicable parts of BS 4999/5000
IEC-34-1/IS-4722/VDE 0530	Specification for rotating electrical machines.
IS – 4889	Method of determination of efficiency of rotating electrical machinery.
IS – 6491	Degrees of protection provided by enclosures for rotating electrical machinery.
IS – 4729	Measurement and evaluation of vibration of rotating electrical machines.
AIEE – 606	Recommended specification for speed governing (1959) of internal combustion engine generator units.
IS – 2705	Current transformers.
IS – 1248	Electrical indicating instruments.
IEEE – 115	Test procedure for synchronous machine.

8.05 DESIGN

The design and workmanship shall be in accordance with the best engineering practices, to ensure satisfactory performance and service life. The equipment offered by the contractor shall be complete in all respects. Any material or accessories, which may not have been specifically mentioned, but which are usual and necessary for the satisfactory and trouble free operation and maintenance of the equipment shall be provided without any extra cost to the purchaser.

8.06 PERFORMANCE REQUIREMENT

The equipment shall be capable of delivering power continuously at the generator

Terminal, a net output not less than the specified value at 0.8-0.95 p.f. excluding auxiliary power (shall be included over and above), when operating under the site ambient conditions described in this specification. Gen Set should be capable of taking 100 % step load & it should be able to take full load in less than 25 sec. from start. (The set shall be suitable for prime duty).

The design parameters of the generator and excitation system shall be chosen that the set is stable while running at any load between no – load and full load and also during starting of motors. It should also have isosynchronous speed control with load sensing governing system suitable for parallel running of D.G. sets.

Engine should be heavy duty four strokes, turbo charged after cooler ‘V’ construction/in line electric start. Engine should have minimum lube oil change period 300 Hrs. Bidders are required to offer the Duplex filter system for lube oil and fuel oil in case of non compliance.

The set shall have vibration limit less than 250 microns (as per BS:4999 Part – 142)& noise level shall be (105-110 db (a) at 1 mtr) under all conditions of load. The set shall be dynamically balanced. The set shall be mounted directly on the inertia foundation or with foundation bolts/AVM pads etc. as required. The efficient residential silencer shall be provided with or without catalytic converter on-line scrubber & the set shall meet EURO-II norms for D.G Sets, for the exhaust. Air inlet shall also be provided.

The total harmonics contents should be less than 3% as per IS 4722/1969. The graph & calculation for harmonic distortion shall be submitted.

Contractor to specify and guarantee maintenance contract cost and to give an undertaking to take a comprehensive maintenance contract after expiry of warranty period for which price may be quoted.

The engine shall be stationary, compression ignition, totally enclosed, water cooled, 4 stroke direct injection, cold battery starting, turbo charged and low temperature with after cooled Radiator Cooled 1500 RPM in accordance to BS 5514 and IS: 10002 complete with all accessories.

The D.G. engine shall be suitable for black start & should be able to pick up 100% load within 25 seconds.

The DG engine & the batteries shall be designed to take up at least six starting attempts beyond which the system shall be protected by means of an over crank relay. Calculations for battery sizing and battery charger capacity shall be submitted for review of the consultants. The successful bidder will submit shop drawing of the equipments/accessories selected for this work for the approval of Consultant/Employer.

8.07 SERVICE INTERVAL AND OPERATION

The set shall be capable of running at full load for not less than 300 hrs continuously or as per manufactures recommendations. The change period both for the lube oil, lube oil filters shall be minimum 300 Hours of operations or as per manufactures recommendations.

The time to Top overhaul, major overhaul & maintenance schedules shall be specified by the bidders.

8.08 DIESEL ENGINE - CONSTRUCCION

Material of construction of major parts shall be as under or as per manufacturer design.

- ☞ M.S. base frame with anti-vibration mountings.
- ☞ Crankcase – Aluminium alloys.
- ☞ Crank shaft, connecting rods –Forged Alloy Steel.
- ☞ Pistion – AL alloy casting.
- ☞ Piston rings – Alloy Steel.
- ☞ Engine Block – Cast Iron
- ☞ Cylinder Liner – Cast Iron

All other material of construction shall be as per relevant standard/code and the copies of same shall be supplied free of cost to Consultant.

One common base frame shall be provided for mounting the engine and alternator complete with electric suspension between D.G set and foundation bolts/AVM pads, leveling lines etc. as required.

All externally mounted hardware shall be high tensile steel only.

The normal speed of the engine shall be 1500 RPM and the direction of rotation shall be clearly marked on the set.

The engine shall be fitted with an exhaust gas driven turbo charger of air / water cooled type complete with its own self contained lubricating system. The turbo-charger shall be positioned at the free end of the engine preferably

The engine shall be fitted with a charge air inter cooler of the air/water type. Air from the turbo-charger compressor passes through the inter cooled and then to the engine manifold. The inter cooler shall be of tubular construction or as per manufacturer design with aluminum bronze tubes, mild sheet steel and cast iron water headers.

Fuel injection and valves shall not require frequent adjustment while in service.

All filters like fuel, lubrication oil, by pass etc shall be provided in the engine and shall be dry, paper element type.

Starting system shall be 24V DC comprising of batteries, Voltage regulator and arrangement for initial charging of batteries.

Bed Plate

The bed plate shall be fabricated from M.S. channel. The welding shall be radio graphed, and the entire fabrication shall be stress relieved after welding. The bed plate shall have integral well ribbed diaphragms for supporting the main bearing housings.

Crank Case

The crank case shall be steel construction with heavy steel plates to form water compartments around the cylinder. To facilitate access for purpose of inspection, inspection ports shall be provided.

Lube-Oil Priming Pump

An A.C. motor driven intermittent operation lube-oil priming pump shall be provided. This shall also include necessary piping, fitting instruments etc. for lubrication system along with clock timers if required.

Crank Shaft

The crank shaft shall be made of high tensile strength steel forging, and shall have a suitable flange to which the flywheel shall be bolted.

The bearing journals and fillets shall be induction hardened; and fully balanced.

Main And Big End Bearings

The main and big end bearings shall be detachable shells of high grade bearing material, and shall be pre-finished.

Connecting Rods

The connecting rods shall be of high grade drop forged steel I - beam section, centre to centre length. The rods shall be rifle drilled for pressure lubrication of piston pin. The rod shall be tapered at piston pin end provided to reduce unit pressures. The piston pin of suitable diameter shall be full floating and made of tubular steel, and retained by a snap ring.

Cylinder Liners

The cylinder liners shall be replaceable wet liners, cast iron alloy, and provided with specially machined grooves in their bores to give an oil retaining surface. These liners shall be easily replaceable without re-boring the block.

Piston

The piston shall be made of forged aluminum alloy, cam ground and machined on outer surface. The piston shall be fitted with an oil scraper ring, and compression rings of hardened cast iron alloy. The piston shall be oil cooled.

Camshaft

The camshaft shall be of induction hardened steel alloy with gear drive, and one of this shall be provided for each block of cylinders.

Exhaust Manifold

The exhaust manifold shall be multi-branch, of insulated design utilizing Ni-resist casting.

Flywheel

The flywheel, which shall conform to requirements of NEMA/ASA/BS codes, shall be made of mild steel statically balanced after machining and shall have graduated markings around the periphery / markings for checking of the valves can also be located on the vibration damper. Barring slots shall be provided around the flywheel rim for hand-barring/ alternatively a suitable barring arrangement should be provided.

Governing System

The governor shall be Isochronous, electronic digital type with a steady state frequency variation of $\pm 0.25\%$. The transient performance shall comply with ISO 8528-5, Class G3 requirements.

It should be possible to adjust the over speed settings on the governor by means of digital signals Manual adjustments for over speed trip settings are not preferred.

8.09 HEAT EXCHANGER

The DG Set should be equipped with a Heat Exchanger for suitable operation.

8.10 ALARMS/TRIP (AUDIO AND VISUAL)

The following Alarm/Trip indications shall be provided as minimum with first stage as pre alarm & second stage as trip:

- ❖ High water temperature.
- ❖ Low lube oil pressure.
- ❖ Low fuel level.
- ❖ Low coolant level.
- ❖ Over crank
- ❖ Over speed

8.11 OTHER AUXILIARY EQUIPMENT/SERVICES

These shall be complete include the following:-

Silencer

Exhaust Silencer shall be residential type to reduce the noise level. Values for Pressure drop across the silencers to be indicated by the vendor.

Cooling

The engine shall be water cooled Radiator/heat exchanger type. Adequately designed for ambient conditions, 50 deg C.

8.12 DAY SERVICE FUEL TANK

Day service fuel tank shall be made of 2 mm thick MS sheet of 990 litres capacity for each set with all accessories such as oil level indicator, inlet pipe connection, outlet pipe connection, trough to collect spilt oil, air vent pipe with air filter, manhole with cover, low level and full level float valve arrangements with all fittings, interconnections between tanks and engine. The tank shall be provided with suitable calibration scale. The Fuel to be used for trials and acceptance tests shall be high speed diesel. First fill of 990 litres HSD per DG set required coolant and lube oil is included in the scope of this contract at no. extra cost.

8.13 PAINTING

The Contractor shall paint all exposed metal parts and equipment supplied by him. All sheet metal work shall undergo a process of phosphating, passivating and then sprayed with high corrosion resistant primer. The finishing treatment shall be of two coats of synthetic enamel paint of approved color. All piping shall be color coded.

8.14 ALTERNATOR

The alternator shall be brushless synchronous and suitable for 3 phase 415 Volts, 4 wire, 50 Hz, 0.8 p.f., 1500 RPM.

The alternator shall be suitable for coupling directly to the diesel engine It shall be Drip proof, screen protected as per IP 23. The alternator shall be single bearing type & self ventilating. The alternators shall be continuously rated and shall have class 'H' insulation with a temperature rise restricted to that of class F designed and built to withstand tropical conditions. It shall generally conform to BS: 5000 (part - 99) / standards listed above. The alternator shall be suitable for sustaining a 10% overload for 1 hour in any 12 hour period without injury. The terminal arrangement for alternator shall be suitable for Cable connections of adequate size to deliver the full load of the alternator.

The alternator shall also have a solid state type digital voltage regulator (D.V.R.) suitable for single running with control limits of 1% from no load to full load under normal load changes. It

shall be of static type and complete with cross current compensation. The regulator shall be provided with voltage adjusting potentiometer, and shall be complete with all alarm contacts, internal wiring, etc.

The Engine and Alternator shall be direct coupled and mounted on a common rigid fabricated steel base frame with suitable vibration isolation system.

EXCITOR

Self excited, self regulated and providing alternator output regulation at plus or minus 0.25%. The alternator shall be provided with a pilot-excited, permanent magnet-excited generator (PMG) for superior short circuit capabilities. Bidders to specify sustained short circuit current capabilities for up to 10 seconds.

The alternator shall be provided with sealed Barings to give minimum service life of 40,000 Hours. The Bidders to specify the maximum rating of the motor that can be started direct on line without any base load, with 50% base load, restricting the Voltage depth to 20%.

INSTRUMENTATION

Instrumentation shall be provided and mounted on the Generator Set to monitor the following:

- ❖ Engine Speed
- ❖ Oil Pressure
- ❖ Water Temperature.

A Gauge Board shall be provided with all the indicators grouped together. The generator shall be provided with a microprocessor-based controller with a facility for remote start, remote annunciation, auto synchronizing and remote communication capability through the telephone /GSM network. It should be possible to monitor the parameters of the engine and the alternator and display the status of the faults on the DG set if any and generate a complete report on the PC individually or on a network. The following minimum monitoring & protection is required for the alternators.

Alternator Monitoring

- ☞ Current. (I1, I2, I3)
- ☞ Frequency
- ☞ Voltage (L-L & L-N)
- ☞ KVA
- ☞ KVAR
- ☞ Power Factor
- ☞ Percentage alternator duty heavily i.e. actual load / KW rating.

The Generator shall be protected against the following electrical faults

- Overload and short circuit
- Ground fault
- Over current
- Over frequency
- Under frequency
- Under Voltage
- Over Voltage
- Reverse power protection.

It should be possible to read the data i.e. Parameters and Shutdown status locally on the D.G Set. All the above Parameters should be displayed on The Local Control Panel through appropriate meters and status on faults should be indicated through a facia annunciator. It should be possible to display all the functions as above on a personal computer.

8.15 EXHAUST SILENCER PIPING

The exhaust silencer piping system shall be of heavy duty MS pipes conforming to Class - B. Suitable length of flexible piping shall be used for connecting the exhaust piping to the engine as per the recommendations of the manufacturer. Exhaust pipe along with silencer inside the building shall be provided with mineral wool insulation with chicken mesh wrapping and 26 SWG aluminum cladding. All terminal connections and pipes joint shall be of welded construction. The terminals of sizes 2" and above shall be butt welded, and of sizes 1.5" and below shall be socket welded, complete with flanges, jointing and fasteners. This welding shall be done as per relevant ASME/ASA codes. The Contractor will have to indicate beforehand the welding procedure he proposes to use. After confirmation by the Project Manager the procedure which is finalised shall be strictly adhered to.

8.16 TESTS AT MANUFACTURER'S WORK

The following tests shall be performed at manufacture's works prior to packing and dispatch to site and test reports for the same shall be furnished.

On DG Set

- ▶ Maximum power load capacity.
- ▶ Maximum motor starting capacity
- ▶ Endurance test.
- ▶ Fuel consumption at full load, 50% load, 75% load and 25% load.
- ▶ Engine - Alternator cooling air flow
- ▶ Load acceptance Test

On the Alternator

- ▶ High voltage tests on stator and rotor windings.
- ▶ Insulation resistance of stator and rotor windings.
- ▶ Temperature rise test.
- ▶ Measurement of resistance of stator and rotor windings.
- ▶ Measurement of losses.
- ▶ Mechanical balance.
- ▶ Load rejection and over speed tests.
- ▶ Stator voltage and current tests.
- ▶ Stator phase sequence check.

All routine test as per IS/BS codes shall be conducted on alternator, exciter and AVR.DG Panel shall be part of main L.T. Panel, supplied by the Owner. However DG supplier shall do the coordination and provide all the inputs required for successful operation.

8.17 INSPECTION AND TESTING AT SITE

All pre-commissioning and commissioning test and checks shall be carried out at site. The Contractor shall be required to produce manufacturer's test certificate for the particular batch of materials supplied to him by the manufacturers. The test carried out shall be as per the relevant

standards. For examination and testing of materials and the works at site, the Contractor shall provide necessary testing and gauging equipment as required. All such testing and gauging equipment shall be tested for calibration at any approved laboratory as required by the Project Manager. The Contractor shall give notice well in advance to the Project Manager before commencement of any site testing. All materials like consumable stores, fuel oil grease, lubricating oil etc. required for the trails shall be arranged by the contractor. The Contractor shall make all necessary hook-ups to carry out tests at site and shall furnish necessary fuel. The complete installation should be initially started and checked out for operational compliance by manufacturer's representative.

8.18 TRIALS (AT SITE)

Preliminary Trials

After completion of erection of generating sets and before carrying out main trials, preliminary site trials shall be conducted in the presence of the Project Manager. Such trials shall include the checking and adjustments of all instrument relays, timers, interlocks and meters. Insulation resistance of stator, rotor and exciter windings shall be checked and reading recorded. A check shall be made for the satisfactory working of all auxiliary motors and their starting accessories supplied with the set.

Main Trials

The main trials shall include over 8 hours continuous run at full load. D.G. Panel shall be tested for automatic operation by injecting proper current and voltage by a separate source. The satisfactory working of automatic operation shall be tested and necessary adjustments shall be done for relays in the presence of the Project Manager and the results shall be recorded in the test sheet at 30 minutes intervals. Alternator efficiencies as determined in works test shall be used as the basis of calculation for fuel consumption rate. A tolerance of 5% shall be allowed on the fuel oil consumption to cover possible errors in measurement. Tests providing the satisfactory performance of all safety and operating controls shall be carried out. Governor trials shall be carried out as laid down in BS: 5514. Alternator insulation resistance and commutation check shall be as per BS: 5000. Starting time of sets shall be tested at least five times after sufficient time intervals to allow for cold start. On completion of tests, inspection doors shall be removed and running gears inspected and alignment checked. Any further reasonable trial as suggested by the Project Manager shall be carried out with no extra charges. All instruments, materials and labour required for carrying out the trials shall be provided by the Contractor. Test sheets of trials shall be forwarded in quadruplicate to PROJECT MANAGER.

8.19 TEST WITNESS

Tests shall be performed in the presence of Project Manager. The contractor shall give at least thirty (30) days advance notice of the date when the tests are proposed to be carried out.

8.20 PERFORMANCE REQUIREMENT

The D.G. set shall operate upto 110% of rated speed, without undue vibration and noise. The unit shall be capable of delivering rated output at 0.8 p.f. at the generator terminals (after derating of the engine due to site conditions).As soon as the set attains rated speed the transient voltage drop at the generator terminal shall not exceed 15% of rated value.

GURANTEED TECHNICAL PARTICULARS OF DG

1.1	ENGINE Rating i) Minimum Engine Rating ii) Altitude (m) iii) Air humidity iv) Air temperature (°C) v) Duty vi) Standard	Matching Less than 1000m above mean sea level 30% Min. 95% Max. Minimum 42 Maximum 50 Average 40 Prime Continuous rating duty at specific ambient air Temperature of 45°C BS 5514 and IS 3046
1.2	Overload capacity for one hour	10% over the continuous rating. In 12 hours continuous running.
1.3	GOVERNOR	Electronic Isochronous digital type
1.4	Starting i) Method ii) No. of auto starts iii) Selectivity	Electric 3 (three) Auto/Manual/Test
1.5	Cooling System i) Heat exchanger/Radiator	Yes
1.6	Exhaust System i) Silencer ii) Flexible connection iii) Scrubber	1 No or more as required Residential type. 1 No for each exhaust pipe near the engine. Nil.
1.7	Safety Controls Instruments i) Two-point thermostat ii) High water temperature iii) Low oil pressure iv) Fuel level low v) Oil Pressure gauge vi) Water temperature gauge vii) Hour counter	Audible & visible alarm Trip engine with trip indication Audible visible alarm Trip engine Audible & visible alarm Yes, required Yes, required Yes, required

1.8	Sundry fittings i) Vibration mounts	Yes, required with vibration, isolation efficiency up to 95% or more.
2.0	ALTERNATOR	
2.1	Rating at 40 Deg. C (ambient air Temp.) Continuons duty	Alternative - I 1400 KVA, (1200 KW), 10% over load for 1 hour in 12 hours
2.2	Minimum efficiency %	94.00
2.3	Enclosure	IP – 21 or better
2.4	Winding	Class H
2.5	Cooling	IC 01 IS-6362
2.6	Excitation System	Brush less exciter with rotating diode assembly
2.7	Over speed %	120
2.8	Transient response & Response voltage dip	Bidders to specify largest motor to be started on DOL with no base load & with 50% base load, TVD to be restricted to 20%.
2.9	Sustained short circuit	Bidders to specify maximum SC capability 10 seconds
2.10	Terminal Box	Suitable for Al / Cu Bus duct deliver the rated current.
3.0	FUEL OIL FACILITY	
3.1	Day tank (14 SWG steel)	990 litres complete with, over flow, drain, filter and gauge glass and level controller etc.
3.3	Piping	From day tank to engine set
4.0	COOLING	Heat exchanger/Radiator type
5.0	ACOUSTIC ENCLOSURE DETAILS	
	Structure	MS Press bent 2 mm
5.1	PANELS	
	Type	Steel Fabricated double wall insulated panels
	Panel Thickness	75 mm thick
	Outer Sheet	1.75 mm thick minimum CRC Sheet
	Inner Sheet	1.00 mm thick CRC Perforated Sheet
	Frame & Stiffener	2mm thick CRC Sheet

5.2	INSULATION	
	Type	Rock wool of reputed make.
	Thickness	75 mm thick
	Density	96 Kg/m ³
	Anti droning	HDPE Sheet
	Thickness	6mm thick
5.3	AIR CIRCULATION SYSTEM	
A	AIR Intake	
	Type	Axial Flow Fan
	Make	Techno Mac or Equivalent
	RPM	1440/2800
	Motor	KIRLOSKAR/SIMENS/ABB/Cummins Equivalent
B	Air Exhaust System	
	Type	Axial Flow Fan
	Make	Reputed Make
	Speed	1400/2800 RPM
	Motor	KIRLOSKAR or Equivalent
	Qty.	1 No. For Air Exhaust
5.4	SILENCER HOOD INTAKE	
	Type	Air Intake Hood
	Qty	2 Nos.
	Design	With Acoustic Splitter & Baffles Insulated Hood Cover
	FINISHING	Weather Proof “ POWDER COATED “
	Sound Reduction (min)	Insertion loss of 25 db(A) at one mtr.
5.5	Protection CT's for each DG set	
	3 nos of cast resin CT's requires at alternator side including the bus extension and the box for differential protection .	
	3 nos spare CT's to be supply by the vendor of the same specification a.	

Notes: Deviation if any, from the data sheet shall be specifically brought out by the tenderer and no extra payment will be made if any deviation .

8.21 COOLING TOWERS AND WATER CIRCULATING EQUIPMENT

8.21.1 GENERAL

The various items of the water circulating system shall be complete in all respect and comply with the specification given below. The total sound intensity with all fans in operation shall not practically exceed 65 db at the distance of 3 mtrs, from all around the cooling towers.

8.21.2 COOLING TOWERS (FRP CONSTRUCTION)

The cooling towers shall be of FRP, Vertical induced draft type complete with FRP basin FRP body, fan and motor assembly, fill media, distribution pipes etc.

8.21.3 GENERAL CONSTRUCTION

The body shall be made of FRP (Fiber glass reinforced plastic) section of equal segments, all bolted together. The surface on both inside and outside shall be smooth, for minimum air resistance. The fan deck 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 earth quake.

The water basin shall also be of F.R.P. Having an auxiliary suction tank, at the bottom. The basin shall be complete with connections for drain, overflow, makeup water, quick fill and float valve, plus hot dipped galvanized stainer.

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

The water diffusion deck shall of rigid PVC fill in Honeycomb design, arranged in a suitable pattern for ease of replacement. PVC fills shall be of high efficiency.

The colour of the cooling tower body shall be of the owner / architect choice.

8.21.4 WATER DISTRIBUTION SYSTEM

The hot water shall be distributed through a sprinkle system consisting of PVC sprinkler pipes, which shall be mounted on the top of the main supply stand pipe.

Each cooling tower shall hve twin header system coupled with gravity flow distribution system.

8.21.5 FAN ASEMBLY

The fan shall be of axial flow type with cast aluminum multiple blades of aerofil 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 4500m / minutes.

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.

The fan motors shall be totally enclosed fan cooled squirrel cage type confirming to I.P. 55 Protection for outdoor operation.

The fan guard shall be hot dipped galvanized with wire mesh screen to prevent bird nesting during idling period.

8.21.6 LADDER

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

8.21.7 PUMP SETS

The pump sets shall be mono block type with end suction and top discharge flanged connections directly mounted on the drippro of squirrel cage induction motors and suitable starter as specified.

The impeller shall be of Bronze, single entry shrouded design, and properly balanced.

Water seal shall be of mechanical type to minimized water leakage and should be easily serviceable in the field.

Motor and starter shall conform to relevant specifications and of rating given in ' schedule of quantities'.

8.21.8 MISCELLANEOUS

The following items to be provided:

Water pressure gauge at inlet and outlet of each pump complete with gauge cocks and connected tubing.(To be priced separately)

Vibration isolation pads for each pumps.

Drain line from each pumps upto drain pilt,(priced separately).

8.21.9 INSTALLATION AND TESTS

The cooling towers shall be mounted on the beam/ steel structure member, provided Contractor and shall be unconnected with the roof slab. All nuts / bolts etc. for mounting shall be provided by the Contractor.

On installation of the capacity of the cooling towers 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.

The pumps sets shall be mounted on cement concrete foundation which shall be provided by HVAC contractor including grouting nuts, bolts, channels etc. shall be provided by the contractor.

On installation the capacity of the pumps shall be checked by measuring water flow. Motor current and pressure difference at inlet and outlet. The reading shall be recorded to compare actual performance with the specified data.

Magnetic level switches shall be provided for low level alarm, in each cooling tower.

8.21.10 PIPE WORK

General:

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

Pipes

All pipes in sizes 200 shall M.S. E.R.W. tube (black steel) heavy class as per I.S. 1239-79, Part -1 with amendment-I of January '81. All pipes above 150 mm dia shall be minimum 6.4 mm thick.

Fittings:

The dimensions of the fittings shall conform to I.S. 1239/69 Part-II unless otherwise indicated, in the specifications.

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

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.

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.

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.

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 and discs of 6 mm thickness are to be welded on, with additional cross stiffeners from 50mm x 50mm M.S. Heavy angles, for sizes upto 350mm. All ends larger than 400 mm dia shall have dished ends.

Flanges.

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.

Flanges may be tack welded into position, but all final welding shall be done with joints dismounted. 3 mm thick gaskets shall be used with all flange joints. The gaskets shall be fibre reinforced rubber as approved by the Engineer-in-charge. Special adhesive compound shall be used between flanges of steam, air and gas lines.

Flanges shall be used as follows :-

Counter flanges for equipment having flange connections.

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.

All thread valves shall be provided with nipples and flanged pairs on both sides to permit flange connections, for removal of valves from main line for repair/replacement.

Valve :

Butterfly Valves

The butterfly valve shall consist of cast iron body preferably in two piece construction.

The discs shall consist of disc pivot and driving stem shall be in one piece centrally located.

The valve seat shall be synthetic material suitable for water duty. It shall line the whole body.

The discs should move in slides bearing o both ends with 'o' ring to prevent leakage.

The handle should have arrangement for locking in any set position.

All gate valves and check valves upto & including 65 mm dia shall be of gunmetal screwed type, conforming to class 2 of I.S. 778. and shall be with I.S.I marking and certification.

All gate valves and check valves upto 80 mm dia and above shall be of cast iron flanged type, conforming to class 2 of I.S. 780/69 (for sizes upto 350 mm) and of I.S. 2906/69 (for sizes 350 mm and above) marking and certification.

All guage cocks shall be of gunmetal plug type, complete with siphon (brass chrome plated).

All drain valves shall be of gunmetal with a hose union connection of one hand.

All valves o the supply of fan coil units shall be of gunmetal ball type with integral water stainers, having (BSP) fpt inlet and flare type MPT outlet connection.

All valves on the return line of fan coil units shall be as in 5.6 but without integral water strainer.

Balancing Valves :

The balancing valves upto 80 mm dia shall be of gunmetal screwed type confirming to B.S. 5154 or equivalent specifications.

The valves shall be cast gunmetal ASTM B-62 and complete with non rising spindle. PTFE disc seal cast metal hand wheel.

The port opening shall permit precise regulation of flow rate, by accurately measuring the pressure drop across the port.

The valves shall be complete with two ports for connection to a mercuary manometer, to measure the pressure drop, as well as a drain port.

The spindle shall have shielded screw to set the flow at the desired level.

The valves shall be used wherever specified.

Strainers :

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.

The strainers shall have a perforated bronze sheet screen with 3 mm perforation and with a permanent magnet, to catch iron fillings.

Pot strainers shall be provided with flanged conection and 'Y' strainers shall be provided with flanged ends.

The strainers shall be designed to facilitate east removal of filter screen for ceaning without disconnection of pipe line.

Jointing

All pipes line shall be welded type.

Square cut plain ends will be welded for pipes upto and including 100 mm dia.

All pipes 125 mm dia or larger will be beveled by 35 deg before welding.

Miscellaneous :

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

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 airconditioning units. Pitch, 20 mm per meter wherever possible, but not less than 10 mm per meter.

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

Provide valves and capped connections for all low points in piping system, where necessary or required for draining system. Provide isolating valves & drain valves in all risers to permit repairs without interfering with the rest of the system.

Support piping independently of all equipment so that the equipment is not stressed by the piping weight or expansion. To facilitate the maintenance, repair and replacement.

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.

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.

Cut the pipes accurately according to measurements, established site & work into place without springing or forging.

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 (meters)		
15	1.25
20&25	2.00
32, 30, 50, &65	2.50
80, 100, &125	2.50
150&Above	3.00

Extra supports shall be provided at the bends and at heavy fittings like valves to avoid undue stresses on the pipes. Pipe hangers shall be fixed on walls and ceiling by means of metallic approved dash fasteners. Insulated piping shall be in such a manner as not to put undue pressure on the insulation, such as providing teak wood block between pipe and support.

Where pipes are to be buried under ground, they should be coated with one coat of bituminous paints. The top of the pipes shall not be less than 75 cm. From the ground level. Where this is not

practical permission of engineer-in-charge shall be obtained for burying pipes at lesser depth. The pipes shall be surrounded on all sides by sand cushion of not less than 15 cm. After the pipes have been laid and top sand cushion proved, the trench shall be refilled with the excavated soil, excess soil shall be removed from the site of work by the contractor.

Hangers & Supports:

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

All Hangers & supports shall be made of steel or other durable and non-combustible material, given two coats of primer red oxide and then painted with aluminium colour paint. Wood wire or perforated strap iron shall not be used as permanent hangers or supports.

Hangers shall be supported from structural steel, concrete inserts & pipe racks, as specifically approved. No hangers shall be secured to underside of light weight roof decking and light weight floor glass. Mechanical equipment shall be suspended midway between steel joists and panel points.

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

Sleeves :

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.

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

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

Expansion or Contraction :

The contractor shall provide for expansion and contraction of all piping installed by the use of swing connection and expansion loops.

Arrangement and alignment of Piping :

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.

The piping shall be installed in a uniform manner, parallel to or perpendicular to walls or ceiling, and all changes in directions shall be made with fittings. The horizontal piping shall be run at right angle and shall not run diagonally across rooms or other piping. Wherever possible all piping shall be arranged to provide maximum head room.

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

All piping shall be carefully installed to provide for proper alignment, slope and expansion

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

Anchors and supports shall be provided wherever necessary to prevent any misalignment of piping.

Small tubing gauges, controls or other equipment installed on any apparatus, shall not be coiled nor Excessive in length, but shall be neatly, carefully bent at all change in direction, secured in place and properly fastened to equipment at intervals to prevent sagging.

The piping shall be grouped wherever practical and shall be installed uniformly in straight parallel lines in either vertical or horizontal positions.

Testing:

In general, tests shall be applied to piping before connection of equipment and appliances. In no case shall the piping, appliance be subjects to pressures exceeding their test ratings.

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 blankoffs or flanges.

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 fitting shall be cleaned of all dirt, filling and debris.

All piping shall be tested yo 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 thw satisfaction of the engineer-in-charge, without any extra cost.

All the piping system shall be tested in the presence of the engineer-in-charge or their authorized representative. Advance notice of test dates shall be given all equipments, labour, materials required for inspection, and repairs during the test shall be provided by the contractor. A test shall be repeated till the entire systems are found to be satisfactory to the above authority. The tests shall be carried out for a part of work if required by engineer-in-charge in order to avoid hindrance in the work of the insulation contractor.

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.

Miscellaneous piping, tests with air at 10.5kg/sq.cm for a minimum of 24 hours without drop in pressure.

The contractor shall make sure that proper noiseless circulation is 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.

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 contractor' properties, shall be borne by the contractor.

Painting:

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

All pipes, which are not to be insulated, shall then be given one coat of finish paint, of a type and colour, as per ISI code.

8.21.11 EXHAUST SILENCER PIPING

The exhaust silencer piping system shall be of heavy duty MS pipes confirming to class B. Suitable length of flexible piping shall be used for connecting the exhaust piping to the engine as per the recommendation of the manufacturer. MS screws flanges and bends shall be used as per site requirements. Exhaust pipe inside the building shall be lagged with heat resistive glass wool of 48 kg / mtr cube and then cladded with Al. foil all along the pipe.

8.21.12 COOLING TOWER CAPACITIES

The cooling towers of adequate capacity to be installed at the terrace of the complex from where the common header of the cooling towers shall be brought down to the DG room in the basement. Soft water is required to be filled up in make up water tank for closed circuit cooling of engine. The contractor has to obtain the data from the Manufacturer for the requirement of the cooling tower capacity of the DG sets. The data for the Cummins engine is as followed:

DG Rating	Raw water Flow	Cooling Tower capacity	Recommened pipe size.
1500 KVA	1300 ltr / minute	150 TR	125mm
1010KVA	900 ltr / minute	100 TR	100mm dia.

The inlet temperature to the cooling tower shall be of 43.3 degree C.

The inlet temperature from cooling tower shall be of 32.3 degree C.

There shall be two common cooling tower for the DG sets. On the basis of data the size of common header and Pups size min two nos with third no. standby shall be designed. the common header shall have temperature meters and butterfly/ Non return valves as required. While designing the Header of DG set shall be taken from the manufacturer.

8.22 Synchronization System

8.22.01 The synchronization panel shall be complete in all respects for auto operation of D.G. Sets as specified in BOQ. The minimum requirement for D.G. set operation shall be as detailed below, however, the vendor shall indicate in details the additional features and facilities being offered by them.

8.22.02 The parallel operation of D.G. set in Synchronization mode shall be completely through Cummins Engine Controller PCC 3.3/GCU/PLC. If synchronization & load sharing facility is

inbuilt in engine controller require PLC for only load management facility. The PCCM shall be mounted on DG SETs outside the Building (the supplying and fixing of the PCCM is in the scope of Supplying and fixing of DG vendor Set). The PLC for the further operation shall be mounted on the Synchronizing panel with SLC 5/03 processor, kw transducer & suitable input /out put card, 8 channel analog card Power Monitors – IV . The wiring between the DG Sets, PCCM and Synchronizing Panel is in the scope of DG Vendor.

8.22.03 During the parallel operation, the system take care of the load sharing i.e. active and reactive both for all the D.G. sets. and issue soft commands for voltage / frequency raise / lower,

8.22.04 Depending upon the load requirements, the the system shall start / stop the D.G. sets.

8.22.05 Monitoring & logging of the electrical datas and events through existing P C. This will be achieved by using microprocessor based PC controller or equivalent networking kits & required hardware like GCM, modlon convertor ,communication cable.

8.22.06 Alarms and necessary remedial commands for D.G. and electrical system fault.

8.22.07 The following components shall be provided for each DG Set:

- a. Breaker control Switch except for DG Incomer.
- b. Automatic battery charger having inbuilt Trickle /boost facility selector switch for battery charger
- c. DC digital Ammeter and Voltmeter selector switch
- d. Auto/Manual selector switch for priming pump
- e. Breaker control switch (only for one number bus-coupler required)
- f. Indicating lamps (LED type) for following:
- g. R₁Y₁B, phase indication
- h. D.G breaker “ON”/”OFF” spring charged
- i. Neutral contactor “ON” /”OFF”
- j. Engine running
- k. Battery charger “ON”
- l. Control supply healthy
- m. Priming pump “ON” /”OFF”
- n. 8 window annunciator with alarm Accept/Test/Reset push buttons, Hooter.
- o. Temperature Scanners for RTD and BTD

- p. Beacon light
- q. Hour meter
- t. 5 Nos Under voltage relay for mains feeder “
- r. 5 Nos Over Voltage relay for mains feeder “
- s. Stand by Earth fault relay “
- t. Reverse power relay (reactive) “
- u. Trip circuit supervision relay “
- v. Master trip relay “
- w. 5 H.P, DOL starter for oil priming pumps for D G Set
- x. Power factor meter (Analog)
- y. Frequency meter (Digital)
- z. Ammeter (Digital)
- aa. Voltmeter (Digital)
- bb. KW and KVA meter (Digital)
- cc. Kwh meter (Digital)
- dd. D.C. Ammeter (digital)
- ee. D.C.Voltmeter (digital)
- ff. Breaker Control Switch for bus coupler
- gg. Battery Charger on / off switch with boost and trickle charger facility
- hh. Trickle / booster charger selector, switch
- ii. Push buttons (lot)
- jj. P. T
- kk. Aux. Contactor (lot)
- ll. transducers

8.22.08 Automatic Generator Sequencing

- a) Automatically start & stop gensets based on plant load or bus on process demand.
- b) Configurable plant bus demand start / stop levels and timers.
- c) On line engine priority sequence configurability from any synch. Unit or PC to equalize run time of all DG sets.

8.22.09 SYNCHRONISING PANEL

The technical specification and details of the microprocessor based PLC controller for the DG set synchronizing and load sharing shall be as follows:

The microprocessor based PLC panel shall be suitable for use with AVR and electronic speed governor to protect and monitor DG sets.

The PLC shall be provided with following features and audible alarm:

- Engine pre glow control
- Fuel solenoid control
- Engine starter control
- KVA controlled cool-down timer
- Speed monitoring
- Over speed protection
- Oil pressure monitoring, alarm and shutdown of the engine.
- Water temperature monitoring, alarm and shutdown of the engine
- Battery voltage monitoring
- Over speed monitoring and alarm.
- 3 attempt start failure alarm
- Under/Over Frequency
- Reserve Power (Inverse time delay)
- Loss of excitation
- Over current (inverse time delay)
- Loss of utility power detection
- Load surge
- Current unbalance
- Voltage unbalance
- Mains Protection (vector shift, df/dt ROCOL)
- True RMS power calculations accurate control
- Configurable loading/unloading ramp rates
- Isochronous load sharing of up to 4 units using percentage based load sharing
- Base load control for optimum fuel efficiency
- Import export control using a watt transducer
- Soft utility transfer function
- Digital signal processing to eliminate harmonic issues
- Adjustable phase window, Voltage and dwell time

- Safe dead bus closing logic internal to the control
- Synchronization across generator and mains breakers
- Multiple short re-closing with adjustable time delay
- Manual voltage and speed adjusts for manual synchronizing
- VAR sharing on isolated busses using percentage based reactive load sharing
- Power factor or VAR control when base loaded
- Externally adjustable VAR or PF set point levels.
- The DG set shall start and stop automatically based on plant bus demand.

The PLC system shall be provided with built in relays for protection of the following:

- Reverse Power
- Reverse KVAR
- Over current
- Under and over voltage
- Under and over frequency
- Synchronization check and earth fault relay.

The PLC system shall be suitable for load sharing by sensing active and reactive power.

The PLC system shall comprises of the following:

- Main processor unit
- Power module for power supply to the processor and the system
- Power monitor to monitor voltage, KVA, KVAR, KW, KWH, KVAH, KVARH.
- 16/32 channel Digital input module
- 16/32 channel Digital output module
- EEPROM for main processor unit
- Computer to PLC communication card with necessary cables.
- Window based operator interface Software Package
- Mounting chassis for the equipment

The microprocessor based main processor of the system shall be suitable for 128 digital I/P and 128 O/P and comprises of the following:

The main processor unit shall be suitable for operation on 24 Volts DC with integrated memory. The integrated Ram memory shall be 20 K Words for program, data and constants plus data memory and flash EP ROM of 16 K works for backup application program, communication card and real time clock.

4 Nos. discrete combination module (Input/output Module) shall be provided and the same shall be suitable for operation on 24 volts DC system. Combination module shall be with 16/32 inputs and 16/32 output channels as per the actual requirement.

- 1 No. 2 slot extension rack

- 1 No. Ram back up battery unit
- 8/4 Nos. digital input module
- 8/4 Nos. digital output module

The CPU display unit shall be suitable for 4 lines of 40 characters. The display shall be with back lit LCD. Clarity shall be not less than 5 x 7 pixels. The height of the characters shall be not less than 5 mm. The data entry shall be with the help of 24 function keys. In addition to this there shall be 10 service keys and 12 alphanumeric keys.

The system shall be provided with RS 232 communication port.

8.23 OPERATION AND COMMUNICATION

The PLC shall monitor the bus bar load continuously. In event of mains failure the PLC shall give signal to select and start the generator, which is closer to the load sensed during the last 60 seconds. In case the load at the time of main failure is more than the highest rating DG set, the PLC shall give command to start 2 Nos. DG sets to suit the load, synchronize the sets and give command to close the breaker on the main LV panel.

If load starts reducing the PLC shall give command to turn off the DG sets through cool down timer. On restoration of main power supply, the PLC shall check the voltage and frequency and if they are stabilized and within the permissible tolerances, the PLC shall give command to shut down the DG sets through cool down timer.

The control and monitoring of the cooling tower and fan and feed pump shall be done through PLC control system. Necessary control wiring between cooling tower, pumps and PLC panel shall be carried out within the scope of work.

8.24 SYNCHRONIZING MODULE

The synchronizing module shall be a microprocessor based intelligent unit, which shall monitor the electrical parameters and shall be able to communicate with the PLC control unit in the process of synchronizing and load management. The system shall be suitable for dynamic synchronization. The synchronizing module shall be suitable for programming and set the preferred difference between DG set and bus bar.

The synchronization module shall monitor and fulfill the following conditions before the system synchronizes the DG set to mains.

Feed back signal from the DG breaker on main LV panel that the breaker is in open condition.

- Bus bar voltage is present
- Generator voltage is present

The frequency regulator in the system shall start when the generator voltage and the bus bar voltage is over 50% of normal voltage. The voltage regulator in the system shall start when the frequency is within 90% of the normal system frequency.

The system shall close the breaker on the power panel without carrying out synchronization when all the below mentioned conditions are fulfilled.

Feedback signal from the DG breaker on main LV panel that the breaker is in closed condition.

- Bus bar voltage is present
- Generator voltage is present

The synchronizing module shall transmit all monitored electrical parameters to the PLC unit and the PLC unit shall start controlling the synchronization of the DG sets and its load management. The data logging, monitoring and controlling shall be through a PC based SCADA station.

9.00 BUS TRUNKING/ RISING MAINS

9.1 SCOPE

This section covers manufacture, supply, installation, resting and commissioning of sandwich insulated bus trunking, & rising mains, indoor/ outdoor type.

9.2 Supply voltage

415/ 440 Volt, 3 phase, 4 wire, 50 Hz AC supply.

9.3 Standards for compliance:

IS: 8623/ 1993 I & II and IEC 60439/ I & II.

9.4 Construction:

The enclosure will be made from 16 SWG GI/ CRCA sheet steel powder coated of approved shade. Bus bars would be of high conductivity aluminium in "Sandwich" construction and the conductors will be individually insulated with halogen free, fire retardant class-B or better insulation. No drilling of Bus bar is permitted. Length of the section will be limited to maximum three metre. Bus bar of one section will be connected to bus bar of adjacent section by uni-block joint system removable as separate sub-assembly, so that it can be inserted or removed without disturbing the adjacent sections.

9.4.1 Technical Parameters:

Bus trunking shall be designed to withstand short circuit current of 50 KA for one second.

Bus bar system should be designed for high temperatures withstand capability.

Insulation voltage 1.1 KV/1.0 KV or as per manufacturer Standard Practices

Bus trunking will be suitably chosen to give permissible voltage drop.

Plug in boxes

Plug in boxes will be of draw out type. Contacts will be of silver plated copper and spring loaded. Earth connection will be the first to make and last to break during insertion and with drawl. Plug in boxes will be made from 1.6 mm CRCA sheet steel powder coated. Inside the plug in Boxes MCCB with the fuses will be located as per requirements. The operating handle will be interlocked with plug in box cover so that MCCB can be operated only with the suitable cover in closed position. The plug in box will be interlocked with bus bar trunking so that it can not be inserted or removed with the plug in box lid open. MCCB will be of 4 pole type unless otherwise specified in BOQ. Short circuit breaking capacity of MCCB in PIB should be same as that of bus trunking i.e. 50 KA.

9.5 List of test to be carried out:

9.5.1 Routine tests:

- i. Verification of insulation resistance.
- ii. Inspection of assembly, interlocks, locks etc.
- iii. Dielectric test.

Copies of the following certificate should be submitted:

- i. Verification of temperature rise limits
- ii. Verification of di-electric properties.
- iii. Verification of short circuit strength.
- iv. Verification of degree of protection.
- v. Insulation resistance test with 500 volt megger. The insulation resistance shall be not less than 100 mega ohm.

10.0 INTERNAL ELECTRIFICATION OF BUILDING

10.1 SCOPE

As specified in subhead 1.00

10.2 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.

10.3 DISTRIBUTION BOARDS.

As a general practice only MCB type double door DB shall be used or as specified in BOQ.

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 minimum 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 outgoings) 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.

10.4 METALLIC CONDUIT WIRING SYSTEM.

10.4.1 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.

10.4.2 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.

10.4.3 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.

10.4.4 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.

10.4.5 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.

10.4.6 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.

10.4.7 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.

10.4.8 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.

10.4.9 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 3 pin type and 15 Amp socket shall be 5/6 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.

10.4.10 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.

10.4.11 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.

10.5 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 Cross-Sectional area of conductor in Sq.mm.	25mm		32mm		38mm		51mm		64mm	
	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.

10.5.1 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.

10.5.2 LOAD BALANCING

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

10.5.3 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.

10.5.4 CLASSIFICATION OF POINTS.

10.5.4.1 General

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

10.5.4.2 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).
- (m) Lamp holder (in the case of goose neck type wall bracket, batten holder and fittings which are not pre-wired)..

- n) Back Plate (in the case of stiff pendants).

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.

10.5.5. 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.

10.5.6 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 Linear basis from switchboard/15A power point to 5A point. Conduit of power SOCKET wiring can also be used for 5A socket outlet wiring, but both phase and neutral wires shall come directly from switchboard/power socketoutlet. 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 socket outlet 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 socket outlet wiring shall be done on basis under following two subheads:

- i) Directly from MCB-Distribution Board to the Socket Outlets
- ii) From One power socket outlet/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 linear 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.

10.5.7 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 - 2.5Sq.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

10.5.8 LIGHTING FIXTURE AND FANS

10.5.8.1 GENERAL

- a. Normally all light fixture will be LED type and shall be with driver etc, ready to use condition.

The Contractor shall supply and install lighting fixtures including but not limited to lamps, driver /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.

10.5.9 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.

10.5.10 LAMPS-GENERAL

LED will be used

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.

10.5.11 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.

10.5.12 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.

10.5.13 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

10.5.14 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.

11.00 TELEPHONE SYSTEM

11.01 Telephone point wiring

- (a) The point wiring shall be carried out with two 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 Diameter 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.

12.02 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.

12.0 EPABX SYSTEM

12.1.1 Scope:

This specification covers the design, manufacture, testing and supply of digital Electronic Private Automatic Branch Exchange (EPABX), Telephone Sets, MDF, Back-up Power supply system, Voice Mail System etc.

12.1.2 Code and Standards:

The telephone system and the components shall conform to the latest edition of the "The International Telegraph and Telephone Consultative Committee (CCITT)" and other Indian and International standards as applicable.

12.1.3 Site Condition:

All the equipments shall be designed and tropicalised to withstand the site conditions as specified in the schedule of quantities.

12.1.4 Technical Requirements

Calling line identification display on all extension (external line as well as intercom)

In built SMDR (Minimum 1500 calls)

In built USB port for programming on system /CPU

Memory backup based on SD card with at least 5 years duration

At least 2 in built ports for external music source connectivity

Power voltage Ac 100v-240v

In built interface for connecting optional External battery bank-36v(12vx3)

AUTO ATTENDENT-04 CHANNEL

In skin, of same brand as EPABX. Expandable to 08/12 channels

UPS Suitable for above configuration or optional External Battery bank-36 v(12x3)

System should be-

100% non –blocking Digital Hybrid IP PBX employing PCM/TDM principles

Based on universal Slot Architecture

Capable of supporting connection of additional Digital phone from another digital phone without need for any other adaptor or hardware

Supporting optional CLI on analogue P&T line

Supporting optional multiple 4 channel DISA cards

Supporting ISDN BRI (4line & 8 line) and PLI

Supporting optional IP Gateway/ Extension card

Supporting optional CTI card

Supporting Floating extension

Supporting major networking protocols such as FXO, FXS , E &M (8 channel), E1 & QSIG (PRI/ BRI)

Supporting Background music on Key Telephone

Supporting Background music on Key Telephone

Supporting 3 to * party conference supporting unattended conference.

Supporting 32 party broadcast feature

Supporting internal and external paging interface with different paging groups

Supporting multiple call hop forwarding facility

Supporting off hook Call Announcement on high end Digital Key phone

Supporting the facility of DISA, DDSA, external call forwarding, Trunk –to –Trunk Transfer and walking class of service

Supporting voice calling on intercom

Supporting Boss Secretary function

Supporting direct connectivity or Digital extension port

Supporting CTI

Supporting call budget management

Supporting CLI based routing

Supporting Mobile Integration

Absent message capability in – built

Speed Dial- At least 1000 on system and 10 per extension

Should have extension personal Identification Number (PIN)/ password- up to 10 digits per extension

Should give call log of at least 10 outgoing numbers and 100 incoming numbers per key phone extensions

Having Message/ Ringer Lamp on Digital phone (dual colour) to indicate the following distinct status on High Mid Key phone:

- i. Internal call
- ii. External Call
- iii. Message

12.1.5 Main Distribution Frame (MDF)

A Krone MDF mounted in sheet steel enclosure shall be supplied along with the exchange. I.P.M. shall be provided in the MDF for all junction lines and external one. All cables coming from field will be terminated on the MDF.

12.1.6 Operator's Console

The operator's console shall be digital, desk top type, compact in design and electronic based. Electronics switching shall be used to make various connections, cord connections shall not be accepted. The operator console should work on single pair. Status of all the analog extensions and digital extensions shall be indicated on LED display. Suitable Add on module shall be provided for this.

12.1.7 The console shall provide the following facilities:

- i) Answering an incoming call
Operator can answer an incoming call, whether from an internal extension or from External Junction line.
- ii) Call Waiting
An unattended call waiting for more than a predetermined time shall automatically go to standby operator.
- iii) Setting up External calls
It shall be possible for an operator to set up external calls.
- iv) Automatic Recall

Incoming calls will be automatically returned to the operator if the called extension does not answer within a predetermined time or called extension is busy.

13.0 ADDRESSABLE FIRE DETECTION AND ALARM SYSTEM

13.1 GENERAL

The Contractor shall supply and install the Addressable Fire Detection & Alarm System as per schedule of quantities are as herein specified. The system shall include Addressable Main Fire Alarm Control Panel, battery charger, batteries, addressable heat detectors, addressable smoke detectors, manual fire alarm station, fire alarm bells/hooters, response indicators, conduiting, wiring and all necessary accessories required to complete fire alarm system installation as per IS: 2189-1988. Equipment like control panel, smoke detector, heat detectors etc shall be UL approved or as specified in BOQ.

13.2 FEATURES

The system shall be general alarm electrically supervised type activation of manual fire alarm station or any of the automatic alarm initiating devices shall sound the general alarm bells on all floors and shall give indication on the control panel. The signal shall be continuous until the station from which it is originated is restored to normal and a reset button on the control unit is operated.

The system shall be electrically supervised against open and ground on both the stations and signal device wiring. Open and ground in the system shall cause a trouble bell to ring at the fire alarm control panel and a trouble lamp to light. It shall be possible to silence the bell but the lamp shall remain lit until the fault is rectified. In case of power failure the system shall automatically changeover to the battery standby.

13.3 CONDUITING & WIRING

Conduiting & Wiring for FDA system shall be carried out in M.S Conduit with copper conductor PVC insulated wires.

13.4 CONTROL PANEL

The fire control panel has to be addressable type.

The Main Fire Control Panel shall be constructed to sheet steel of red colour, and provided with windows for the alarm and trouble lights. All components shall be of the plug in type, for simple replacement and extension in the future. Control panel shall be wall mounting type conforming to IS 513-1986.

The number of loops is mentioned in B.O.Q. Each loop shall be able to support at least 128 any device addressable analog/digital (as the case may be) sensors and control module etc or as specified in BOQ. The control panel shall have alphanumeric display. The Main Fire control panel shall be provided with all necessary relays, resistors, fuses, transformers, rectifiers and all other components to assure full and proper functioning of the system. All relays shall conform to the relevant IS Standards. Control panel shall include power on lamps, system trouble lamps, audible trouble signal, trouble silence switch with ring back, alarm silence push button with repeat alarm capability, low battery indicator with reset, ground detection indicator, alarm reset, milli ammeter, supervised alarm lamps, zone "Open" test pushbutton, zone alarm test push button, end of line resistors etc.

Each zone shall be equipped with an auxiliary contact for control of a remote annunciation.

Main control panel shall include a power supply model to provide a filtered and regulated source of power to provide additional power wherever supplementary power is required within the system. It shall include an output fuse, key reset switch, provision for automatic transfer to standby power upon primary power failure.

Main control panel shall in addition have audible signal and lamp to indicate as failure of the charge of battery.

Two stages general Alarm shall be provided in which a continuous evacuation alarm is immediately given in zone of fire and its adjoining zones. In other zone intermittent alarm signal shall be provided as per IS 2189-1988.

Repeater Panel shall be of same specification as main control panel and shall have fire/fault indication with audio device.

13.5 CHARGER AND BATTERY

Unit shall comprise a ventilated cabinet supplied complete with charger, meters, high rate charge switch and lock and key in a sheet metal enclosure.

13.6 ELECTRONIC HOOTERS

Hooter shall be electronic solid-state speaker type having tone for fire, which shall be wailing. Hooter should be loop powered having an output of approximately 6 watt. The audible range shall be around 100m under normal condition. Cable for this in our system shall be 2 cores. The switching shall be provided on the control panel. The outer enclosure of the speaker shall be of MS sheet and shall be suitably oven baked and painted. The speaker shall be 4" heavy magnet type. All hooters shall be on one or more circuits.

13.7 MANUAL ALARM CALL POINT FOR SURROUNDINGS (ADDRESSABLE)

The manual call point shall be electrically compatible with the standard range of automatic detectors so that it can be connected directly into a supervised two-wire zone of the manufacturer's standard range of control units. The manual call point shall be of pleasant, streamlined and flat appearance permitting its use as flush and surface mounted unit. The manual call point shall consist of base plate, insert and cover. The push button shall have minimum one normally closed plus one normally open contacts. The push button shall not be shrouded and the same shall be projected out from the surface of the MS Box. The whole assembly of push button shall be enclosed in the 16 SWG MS Box except from the front side. The front side shall be sealed with breakable glass covering neoprene or equivalent gasket. The glass cover shall be fixed in such a way that the actuating push button is kept depressed (with NC contact open) so long as the glass cover is in contact. In case of fire, when the glass cover is broken to give the fire warning the push button shall be released due the spring action hence giving remote fire alarm through the NC contact. The breaking of the glass must release an alarm. All inscriptions, texts and marks must be on the manual call point front plate, not on the glass, so that the glass can easily be replaced anywhere. The alarm contacts shall be of self-cleaning design to prevent failure after a prolonged period of inactivity in unclean environments.

It shall be possible to test the call point without destroying the seal or removing the cover. The manual call point shall be equipped with a self-holding device to maintain the alarm condition until reset by an authorized person. The complete unit and the push button shall be painted signal Red. The internal surface of the MS enclosure of the box shall be painted white colour. The external painting shall be of synthetic enameled paint. Aluminium hammer shall be suspended on a hook fixed to the external MS enclosure by means of a non-corrodible easy breaking of the glass cover.

Manual alarm call point located on the outer walls of the building and/or exposed to weather conditions shall be weather proof type and satisfying the requirement of APB.

13.8 OPTICAL (PHOTOELECTRIC) TYPE SMOKE DETECTORS (ADDRESSABLE TYPE)

The optical type smoke detectors shall be based on light attenuation by smoke/ or light scattering by smoke particles. Smoke detectors shall have an inherently stable sensor with built-in automatic compensation for changes in ambient conditions. All electronic circuits must be solid-state devices and virtually hermetically sealed to prevent their operation from being impaired by dust, dirt or humidity. All circuitry must be protected against usual electrical transients and electromagnetic interference. Reversed polarity or faulty zone wiring shall not damage the detector. The detector shall have no moving parts or components subject to wear. The response sensitivity of each detector shall be factory set. A built-in barrier shall prevent entry of insects into the sensor. The detector shall be designed for fast and simple laboratory cleaning.

The detector shall be inserted into or removed from the base by a simple push-twist mechanism to facilitate exchange for cleaning and maintenance. The manufacturer shall produce and provide test equipment allowing to test and exchange smoke detectors upto 7m (23ft) above floor level. The detector shall connect to the control unit via a fully supervised two-wire circuit.

The detector shall be capable of being remotely tested from control panel.

13.9 HEAT DETECTOR (ADDRESSABLE TYPE)

Heat detector shall be combined rate of rise and fixed temperature type. Heat detectors shall consist of two independent thermistors, designed to automatically compensate virtually hermetically sealed to prevent their operation from being impaired by dust, dirt or humidity. All circuitry must be protected against usual electrical transients and protected against usual electrical transients and electromagnetic interference. Reversed polarity or faulty electromagnetic interference. Reversed polarity or faulty zone wiring shall not damage the detector. The detector shall have no moving parts or components subject to wear. It shall be possible to test the detector in the field. The response (activation) of a detector shall be clearly visible from the outside by a flashing light of sufficient brightness. The detector shall be installed into the base by a simple push-twist mechanism to facilitate exchange for cleaning and maintenance. The detector shall connect to the control unit via a fully supervised two-wire circuit.

The manufacturer shall produce and provide test equipment allowing to test and exchange rate-of rise/fixed temperature heat detectors up to 7m (23ft) above floor level.

13.10 PLUG-IN BASES

The smoke & heat detectors shall fit into a common type of standard base. Once a bases has been installed, it shall be possible to insert, remove and exchange different types of detectors by a simple push-twist movement. The standard base shall be equipped with crewels wiring terminals capable of securing wire sizes upto formation and weakening of contact pressure. The standard base shall be supplied with a sealing plate, preventing dirt, dust, condensation or water from the conduit reaching the wire terminals or the detector contact points. All standard bases shall be supplied with a removable dust cover to protect the contact area during installation and construction phase of the building. It must allow the check out and certification of the zone wiring before insertion of any detectors. The standard base shall feature a built-in mechanism, which allows mechanical locking of as installed detector head, thus preventing unauthorized removal or tempering while maintaining.

The detector contact points shall be designed to retain the detector safely and to ensure uninterrupted contact also when exposed to continuous severe vibration. All electronic components of base and modules must be solid state and virtually hermetically sealed to prevent their operation from being impaired by but, dirt or humidity. All circuitry must be protected against usual electrical transients and electromagnetic interference. Reversed polarity or faulty zone wiring shall not damage the detector. The standard base shall allow snap-on insertion of an (optional) electronic module, it shall be possible to turn a standard base part into an individually addressable detector base with its own unique identification address at the control unit. The standard base shall have a built in alarm indicator which is repeatable by connecting a simple 2 core wire to the base. No changes in the zone wiring shall e required to operate the additional alarm indicator. Removal and insertion of dust covers or detectors shall be feasible by a simple push twist movement, even if the locking device has been activates. Special base assemblies shall be available for use in air ducts and aspiration air-sampling system wherever required.

Contractor is required to submit samples and get approved from HSCC Electrical Engineer of all above mentioned items including Response Indicators, Hooters, manual call points.

14.0 CLOSED CIRCUIT TELEVISION SYSTEM

1. SCOPE :

The specification of Video Surveillance System covers technical specification and requirement of IP Video Surveillance Systems consisting of Indoor IP dome cameras, Indoor IP PTZ cameras, outdoor IP

P/T/Z dome cameras, Video Management Software, Recording servers, switches, colour monitor etc for surveillance of the facility from a centralized location.

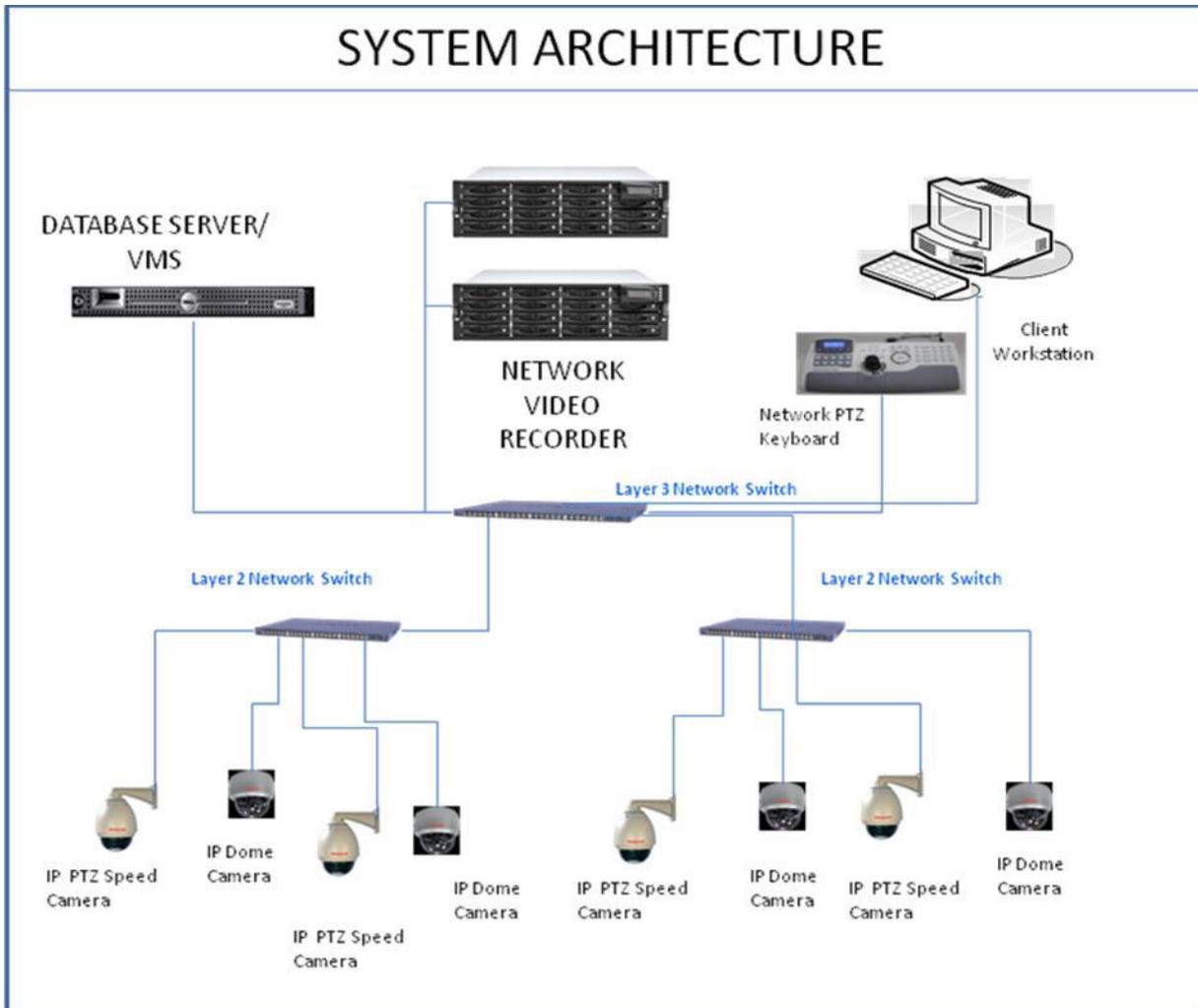
Video Surveillance System shall be an IP enabled system. The recording of the video shall be on an open architecture, non embedded based recorder server from reputed manufacturers like IBM/HP/Dell. The system shall be able to work on a fibre optic backbone network. The entire system shall be based on non proprietary open architecture where the Video Management software can work and integrate with any make of standard cameras and encoders, and IT hardware.

2. SYSTEM DESCRIPTION

- A. The Video Management Software should be a fully digital IP-based video surveillance system.
- B. The VMS should work with the latest compression technologies viz MPEG-4 and H.264 and should be capable to interface with IP cameras streaming both compressions.
- C. Video Surveillance System shall consist of outdoor IP Dome cameras, recording Servers and PC's and associated Ethernet cable, fiber cable, video cable, power cable, twisted pair cable etc. Bidder should consider all necessary network equipment and accessories to provide a LAN / WAN infrastructure dedicated for video surveillance on a fibre optic backbone network which should be not less than 1 Gbps speed.
- D. The software should provide a single GUI that monitors, records, and offers analysis functionality to deliver the timely, accurate information required for effectively responding to any challenge.
- E. The VMS shall have client station software. The client should offer multi-monitor options, and have drag and drop options and the ability to switch any particular camera onto any monitor through drag operation.
- F. It should be possible to set up a video wall from the software.
- G. Each camera shall have a video at 4CIF and 25 frames for viewing the videos during live as well as for recording purpose.

3. SYSTEM ARCHITECTURE

The following diagram explains the relationship of various system and integration components:



4. GENERAL REQUIREMENTS:

- I. Manufactured products shall have quality system compliance and shall be either UL or CE (EN) or FCC certified.
- II. The Video Management software, NVR, Joystick and Cameras should be of the same make.
- III. All software and firmware upgrades shall be free of cost. All the IP cameras shall be freely accessible and programmable from the control room.
- IV. Every control room of surveillance system shall be capable of getting connected to the optical or other communication backbone.
- V. The power supply available shall be 220 V / 50 Hz AC +/- 10%. All modules of the surveillance system should work using this power supply only with requisite converters, if required.
- VI. All the cameras and other modules of Video Surveillance System shall be modular in construction. In case of upgradation of such modules in future, it shall be possible to upgrade them without replacing the entire modules.

5. TECHNICAL REQUIREMENTS:

The Video Surveillance System shall consist of:

i) CAMERA SPECIFICATIONS

a. 1.3 MP Resolution Varifocal Indoor Dome should have following Features:

- 720P @ 60fps; 1.3M real-time @ 25fps
- H.264 (high profile / main profile / baseline) and MJPEG simultaneously
- Comprehensive I/O ports: MIC in, audio out, video out, DI, DO, RJ45, uSD
- Built in Power over Ethernet (PoE); Gigabit (1000Base-T) Ethernet
- Support various protocols: RTSP, UPnP, 3GPP, HTTPS, Samba
- Event trigger action: Send to NAS, send to FTP, send to Email, voice alert, go preset and tour, notify to
- ONVIF compliant

Specifications	
Analog / IP	IP
Type of Camera	Dome Camera
Effective Pixel	800 X 600
Image Device	1/3” Sony Exmor image sensor
Minimum Illumination	0.5 Lux at F1.4
IRIS	DC IRIS
S/N Ratio	50Db
Lens	3.3 - 12mm vari-focal lens
Alarm	1in/1 out

Audio Encoder	RTSP: G.711 64kbps, G.726 32kbps, AAC (option, by request)
Audio Streaming	One-way or two-way
Microphone	External microphone input
Video Encoder	H.264, MPEG4 and MJPEG simultaneously (Tri-encoders)
Video Profile	12-profile simultaneously H.264 high profile, main profile and baseline
Frame Rate	800x600, 720x576, 320x240 160x120 @ 25/30fps
Region of Interest	Max. 3 ROI. Editable range
Area of Interest	Max. 2 AOI. Editable range
IRIS Exposure Control	Auto mode / Outdoor mode / Manual mode Manual mode: 1/25 - 1/47,000 seconds
Image Setting	AE, AWB; 3D Noise reduction; Digital WDR; Color, brightness, sharpness, contrast, Hue; Mirror/Flip; Privacy Masks; Text, time and date overlay; Overlay image on video
Streaming	Simultaneously multi-profile streaming; Streaming over UDP, TCP, HTTP, or HTTPS; M-JPEG streaming over HTTP (server push); Controllable frame rate and bandwidth; Constant and variable bit rate (MPEG4 / H.264); Region of Interest (ROI)
On Screen Display	Text, time and date overlay; Editable OSD (bitmap format)
Supported Protocol	IPv4, IPv6, TCP, UDP, HTTP, HTTPS, SMTP, FTP, NTP, DNS, DDNS, DHCP, DIPS, ARP, Bonjour, UPnP, RTSP, RTP, RTCP, IGMP, PPPoE, Samba, ICMP, SNMP
Security	Password protection, IP address filtering, HTTPS encrypted data transmission, user access log
Ethernet	10/100/1000M auto negotiation
Access User	8 simultaneous unicast users
Network Interface	ONVIF
Local Storage	Micro SDHC Card Slot
Motion Detection	10-zone video motion detection with included or excluded options
Event Detection	Intelligent motion detection; audio detection; camera tampering
Audio Detection	Audio level 0 - 100
Camera Tampering	Camera dis-focus / move direction / mask
Alarm Events	File upload via FTP or email; File upload via Samba to NAS; Notification via email, HTTP, and TCP; External output activation; Audio alerting output; Micro SD card local storage
Video Buffer	Pre- and post- alarm buffering
Power Supply	12V DC/ 24 VAC
PoE	IEEE 802.3af
Operating Humidity	0% ~ 80% (non-condensing)
Operating Temperature	-10°C ~ 50°C
Browser	IE 8.0 or later
Connector	RJ-45 10Base-T/100Base-TX/1000Base-T; 12VDC power jack; 1 alarm input and 1 output; Audio out; External MIC input; Video out; Factory default reset; mSD card
Certification	CE, FCC

- b. **1.3 MP Resolution 25/20fps IP IR Illuminated Bullet Camera, H.264, PoE, DC12V/AC24V, ONVIF True Day/Night Box Camera should have following features:**

- 720P @ 60fps; 1.3M real-time @ 25fps
- H.264 (high profile / main profile / baseline) and MJPEG simultaneously
- Comprehensive I/O ports: MIC in, audio out, video out, DI, DO, RJ45, uSD
- Built in Power over Ethernet (PoE); Gigabit (1000Base-T) Ethernet
- Built in IR LED and ICR for day and night surveillance without color shift, controlled by photo sensor
- IP66 housing
- Support various protocols: RTSP, UPnP, 3GPP, HTTPS, Samba
- Event trigger action: Send to NAS, send to FTP, send to Email, voice alert, go preset and tour, notify to
- ONVIF compliant

Specifications	
Analog / IP	IP
Type of Camera	IR Bullet Camera
Effective Pixel	1280 X 1024
Lens	3.3-12mm
IR Distance	20Mtr
Image Device	1/3" Sony Exmor image sensor
Minimum Illumination	0.5 Lux at F1.4 and 0 Lux IR LED On
IRIS	DC IRIS & Auto IRIS
S/N Ratio	50Db
Alarm	1in/1 out
Audio Encoder	RTSP: G.711 64kbps, G.726 32kbps, AAC (option, by request)
Audio Streaming	One-way or two-way
Microphone	External microphone input
Video Encoder	H.264, MPEG4 and MJPEG simultaneously (Tri-encoders)
Video Profile Setting	12-profile simultaneously H.264 high profile, main profile and baseline
Frame Rate	800x600, 720x576, 320x240 160x120 @ 25/30fps
Region of Interest	Max. 3 ROI. Editable range
Area of Interest	Max. 2 AOI. Editable range
IRIS Exposure Control	Auto mode / Outdoor mode / Manual mode Manual mode: 1/25 - 1/47,000 seconds
Image Setting	AE, AWB; 3D Noise reduction; Digital WDR; Color, brightness, sharpness, contrast, Hue; Mirror/Flip; Privacy Masks; Text, time and date overlay; Overlay image on video
Streaming	Simultaneously multi-profile streaming; Streaming over UDP, TCP, HTTP, or HTTPS; M-JPEG streaming over HTTP (server push); Controllable frame rate and bandwidth; Constant and variable bit rate (MPEG4 / H.264); Region of Interest (ROI)
On Screen Display	Text, time and date overlay; Editable OSD (bitmap format)
Supported Protocol	IPv4, IPv6, TCP, UDP, HTTP, HTTPS, SMTP, FTP, NTP, DNS, DDNS, DHCP, DIPS, ARP, Bonjour, UPnP, RTSP, RTP, RTCP, IGMP, PPPoE, Samba, ICMP, SNMP
Security	Password protection, IP address filtering, HTTPS encrypted data

	transmission, user access log
Ethernet	10/100/1000M auto negotiation
Access User	8 simultaneous unicast users
Network Video Interface	ONVIF
Local Storage	Micro SDHC Card Slot
Motion Detection	10-zone video motion detection with included or excluded options
Event Detection	Intelligent motion detection; audio detection; camera tampering
Audio Detection	Audio level 0 - 100
Camera Tampering	Camera dis-focus / move direction / mask
Alarm Events	File upload via FTP or email; File upload via Samba to NAS; Notification via email, HTTP, and TCP; External output activation; Audio alerting output; Micro SD card local storage
Video Buffer	Pre- and post- alarm buffering
Power Supply	12V DC/ 24 VAC
PoE	IEEE 802.3af
Operating Humidity	0% ~ 80% (non-condensing)
Operating Temperature	-10°C ~ 50°C
Browser	IE 8.0 or later
Connector	RJ-45 10Base-T/100Base-TX/1000Base-T; 12VDC power jack; 1 alarm input and 1 output; Audio out; External MIC input; Video out; Factory default reset; mSD card
Certification	CE, FCC

c. 1.3 MP Resolution 25/20fps IP Box Camera, H.264, PoE, DC12V/AC24V, ONVIF True Day/Night Box Camera should have following features:

- 720P @ 60fps; 1.3M real-time @ 25fps
- H.264 (high profile / main profile / baseline) and MJPEG simultaneously
- Comprehensive I/O ports: MIC in, audio out, video out, DI, DO, RJ45, uSD
- Built in Power over Ethernet (PoE); Gigabit (1000Base-T) Ethernet
- Support various protocols: RTSP, UPnP, 3GPP, HTTPS, Samba
- Event trigger action: Send to NAS, send to FTP, send to Email, voice alert, go preset and tour, notify to
- ONVIF compliant

Specifications	
Analog / IP	IP
Type of Camera	BOX Camera
Effective Pixel	1280 X 1024
Image Device	1/3" Sony Exmor image sensor
Minimum Illumination	0.5 Lux at F1.4
IRIS	DC IRIS & Auto IRIS
S/N Ratio	50Db
Lens Mount	CS Mount

Alarm	1in/1 out
Audio Encoder	RTSP: G.711 64kbps, G.726 32kbps, AAC (option, by request)
Audio Streaming	One-way or two-way
Microphone	External microphone input
Video Encoder	H.264, MPEG4 and MJPEG simultaneously (Tri-encoders)
Video Profile Setting	12-profile simultaneously H.264 high profile, main profile and baseline
Frame Rate	800x600, 720x576, 320x240 160x120 @ 25/30fps
Region of Interest	Max. 3 ROI. Editable range
Area of Interest	Max. 2 AOI. Editable range
IRIS Exposure Control	Auto mode / Outdoor mode / Manual mode Manual mode: 1/25 - 1/47,000 seconds
Image Setting	AE, AWB; 3D Noise reduction; Digital WDR; Color, brightness, sharpness, contrast, Hue; Mirror/Flip; Privacy Masks; Text, time and date overlay; Overlay image on video
Streaming	Simultaneously multi-profile streaming; Streaming over UDP, TCP, HTTP, or HTTPS; M-JPEG streaming over HTTP (server push); Controllable frame rate and bandwidth; Constant and variable bit rate (MPEG4 / H.264); Region of Interest (ROI)
On Screen Display	Text, time and date overlay; Editable OSD (bitmap format)
Supported Protocol	IPv4, IPv6, TCP, UDP, HTTP, HTTPS, SMTP, FTP, NTP, DNS, DDNS, DHCP, DIPS, ARP, Bonjour, UPnP, RTSP, RTP, RTCP, IGMP, PPPoE, Samba, ICMP, SNMP
Security	Password protection, IP address filtering, HTTPS encrypted data transmission, user access log
Ethernet	10/100/1000M auto negotiation
Access User	8 simultaneous unicast users
Network Video Interface	ONVIF
Local Storage	Micro SDHC Card Slot
Motion Detection	10-zone video motion detection with included or excluded options
Event Detection	Intelligent motion detection; audio detection; camera tampering
Audio Detection	Audio level 0 - 100
Camera Tampering	Camera dis-focus / move direction / mask
Alarm Events	File upload via FTP or email; File upload via Samba to NAS; Notification via email, HTTP, and TCP; External output activation; Audio alerting output; Micro SD card local storage
Video Buffer	Pre- and post- alarm buffering
Power Supply	12V DC/ 24 VAC
PoE	IEEE 802.3af
Operating Humidity	0% ~ 80% (non-condensing)
Operating Temperature	-10°C ~ 50°C
Browser	IE 8.0 or later
Connector	RJ-45 10Base-T/100Base-TX/1000Base-T; 12VDC power jack; 1 alarm input and 1 output; Audio out; External MIC input; Video out; Factory default reset; mSD card
Certification	CE, FCC

LENS SPECIFICATIONS

The Varifocal Direct Drive Auto Iris Lens shall be 1/3-inch format for compatibility with the vast majority of CCD cameras, and must be a "CS" mount.

The Varifocal Direct Drive Auto Iris Lens shall be of an aspherical design, allowing the camera to view scenes in very low light situations.

To give the installer the flexibility of obtaining the exact field of view quickly and easily, the Varifocal Direct Drive Auto Iris Lens shall be available in focal ranges of 5-50mm.

The Varifocal Direct Drive Auto Iris Lens shall incorporate zoom and focus locking screws to ensure that the desired settings are not inadvertently changed. The focus locking screw shall be separate from the focusing ring, to allow for more precise focusing. The zoom locking screw shall be separate from the zooming ring, to allow for more precise zooming.

The Varifocal Direct Drive Auto Iris Lens shall be available with a long iris control cable versions to accommodate rear and side mount camera designs.

The Varifocal Direct Drive Auto Iris Lens must be terminated with an industry standard 4-pin connector for direct connection to all DC TYPE cameras.

MECHANICAL SPECIFICATIONS

The Varifocal Direct Drive Auto Iris Lens must have the following mechanical specifications:

1. Focal Length5-50mm
2. Mount..... CS

HOUSING / ENCLOSURE

Enclosure shall be such that it would cater the above mentioned camera with a varifocal lens of above dimensions as mentioned above as well as with the following specifications/features:

- Die-cast and extruded aluminum construction
- Total access design allows easy access to camera from all sides
- Integrated "Flex mount" adjustable mounting track
- 3/4", 1/2" and 1/4" cable entry glands
- Sunshield
- Outdoor installations
- Epoxy powder coated for corrosion resistance
- Dust-proof, IP66 weatherproof
- Dual positive locking clamps
- Reversible camera mounting tray elevate low profile cameras

Note – Housing for outdoor Box camera should be IP – 66.

d. 30X 25/20fps D1 IP PTZ, H.264, True Day/Night Indoor Ceiling Mount High Speed Dome Camera should have following features:

- 30x indoor optical zoom and 12x digital zoom
- On board camera storage – Micro SDHC card support
- 30 fps (25 fps PAL) interlace scan
- Wide Dynamic Range
- ONVIF compatible

- Supports both dynamic and static IP addresses
- Wide range of mounting options available (1.5" NPT)
- Supports Electronic Image Stabiliser (EIS)
- 650 TVL Horizontal resolution
- High preset speed up to 400 °/sec
- Selectable compression formats
- Choice of 24 VAC/PoE power inputs
Indoor : both 24 VAC/PoE+ power inputs
Outdoor : 24 VAC only

Specifications	
Analog / IP	IP
Type of Camera	High Speed Dome PTZ Camera
Video Format	PAL
Image Device	1/4" Sony CCD
Minimum Illumination	0.08 lux (Colour), 0.005 lux (B/W) @ F1.6 30IRE. Max. Aperture Ratio: F1.6 (Wide), F4.5 (Tele)
Electronic Shutter	1~1/10,000 Sec
Signal-to-Noise Ratio	> 50dB(AGC Close)
BLC	BLC ON/OFF
Video Compression	H.264, Motion JPEG simultaneously
Video Stream	Dual streaming: H.264 and MJPEG Controllable frame rate and bandwidth Constant or variable bit rate
Video Resolution	D1: NTSC 720x480/PAL 720x576 CIF: NTSC 352x240/PAL 352x288
Frame Rate	Up to 25fps @D1
Protocols	IPv4/v6, TCP/IP, UDP, RTP, RTSP, HTTP, HTTPS, ICMP, FTP, SMTP, DHCP, PPPoE, UPnP, IGMP, SNMP, IEEE 802.1x, QoS, ONVIF
Lens	f=3.4mm~102mm
IRIS Control	Auto Manual
Day/Night: IR Cut Filter	On/ Off
Vector Scan Groups	6
Auto Gain Control	On
S/N Ratio	> 50dB(AGC Close)
Preset Tours	8
Auto Tour	4
Mimic Tour	8
Pan Angle	360° Rotation Capability
Tilt Angle	-10° 190°
Pan Speed	Manual pan Speed 0.5° to 200°/s
Tilt Speed	Manual tilt Speed 0.5° to 84°/s
Preset Speed	400°/Sec
Accuracy	0.225°

Preset Positions	256
Privacy Mask	16
Proportional Pan and Tilt	On/Off (Pan and tilt speed proportional to zoom ratio)
Auto Scan	ON/OFF
Image Freeze	ON/OFF
White Balance	Manual/Auto/Indoor/Outdoor/ATW
Wide Dynamic Range	ON/OFF
Zoom	30x Optical Zoom, 12x Digital Zoom
Protocol	Pelco D/P
Alarm	4 Input/ 1 Output
Micro SD	Support Required
Video Buffer	Pre- and post- alarm buffering
Protection Class	IP66 Rating, weather and vandal proof
Ethernet	10/100M auto negotiation
Housing	Indoor Ceiling Mount
Certificate	CE, FCC/ UL

e. 37X 25/20fps D1 IP PTZ, H.264, True Day/Night Outdoor Weatherproof High Speed Dome IR camera with Beam length 100 meter , Camera should have following features:

- 37x outdoor optical zoom and 12x digital zoom
- On board camera storage – Micro SDHC card support
- 30 fps (25 fps PAL) interlace scan
- Wide Dynamic Range
- ONVIF compatible
- Supports both dynamic and static IP addresses
- Wide range of mounting options available (1.5" NPT)
- Supports Electronic Image Stabiliser (EIS)
- High preset speed up to 400 °/sec
- Selectable compression formats
- Choice of 24 VAC/PoE power inputs
Indoor : both 24 VAC/PoE+ power inputs
Outdoor : 24 VAC only

Specifications	
Analog / IP	IP
Type of Camera	High Speed Dome PTZ Camera
Video Format	PAL
Image Device	1/4" SONY 960H Ex-view HAD CCD II
Minimum Illumination	0.08 lux (Colour), 0.005 lux (B/W) @ F1.6 30IRE. Max. Aperture Ratio: F1.6 (Wide), F4.5 (Tele)
Electronic Shutter	1~1/10,000 Sec
Signal-to-Noise Ratio	> 50dB(AGC Close)
BLC	BLC ON/OFF

Video Compression	H.264, Motion JPEG simultaneously
Video Stream	Dual streaming: H.264 and MJPEG Controllable frame rate and bandwidth Constant or variable bit rate
Video Resolution	D1: NTSC 720x480/PAL 720x576 CIF: NTSC 352x240/PAL 352x288
Frame Rate	Up to 25fps @D1
Protocols	IPv4/v6, TCP/IP, UDP, RTP, RTSP, HTTP, HTTPS, ICMP, FTP, SMTP, DHCP, PPPoE, UPnP, IGMP, SNMP, IEEE 802.1x, QoS, ONVIF
Lens	f=3.5mm~129.5mm
IRIS Control	Auto Manual
Day/Night: IR Cut Filter	On/ Off
Vector Scan Groups	6
Auto Gain Control	On
S/N Ratio	> 50dB(AGC Close)
Preset Tours	8
Auto Tour	4
Mimic Tour	8
Pan Angle	360° Rotation Capability
Tilt Angle	-10° 190°
Pan Speed	Manual pan Speed 0.5° to 200°/s
Tilt Speed	Manual tilt Speed 0.5° to 84°/s
Preset Speed	400°/Sec
Accuracy	0.225°
Preset Positions	256
Privacy Mask	16
Proportional Pan and Tilt	On/Off (Pan and tilt speed proportional to zoom ratio)
Auto Scan	ON/OFF
Image Freeze	ON/OFF
White Balance	Manual/Auto/Indoor/Outdoor/ATW
Wide Dynamic Range	ON/OFF
Zoom	37x Optical Zoom,
Protocol	Pelco D/P
Alarm	4 Input/ 1 Output
Micro SD	Support Required
Video Buffer	Pre- and post- alarm buffering
Protection Class	IP66 Rating, weather and vandal proof
Ethernet	10/100M auto negotiation
Housing	Indoor Ceiling Mount
Certificate	CE, FCC/ UL

ii) PC Work Station For Clients Stations:

1.1 The PC shall be able to provide high graphics display and with DVD-Drive 52 x, PS/2 mouse and keyboard.

1.2 PC Work Station shall be of minimum configuration:

- Processor: Intel ® i5 750 2.66 GHz
- System Memory (RAM): 4 GB
- Optical Drive: DVD-R
- Floppy Drive: 3.5 inch 1.44 MB
- Hard Disk Drives: 250G, Ensure 20G available space
- Network Interface Card (NIC): Dual or compatible pair of NICs, with each port having 1 Gbps capacity.
- Human Interface: 102-key keyboard and a mouse pointing device
- Graphics Adapter: NVIDIA 1GB Independent Graphic Card
- Operating System: Original software CDs and startup installation diskettes for:
 - Windows® 7 Professional 64-bit (WOW64mode) OR Windows® 7 Professional 32-bit
 - .Net Framework 4.0
 - Windows Media Player Version 9 or 10
 - McAfee VirusScan 7.1.0, McAfee VirusScan 8, or Symantec Antivirus V10

iii) Network Video Recorder:

Utmost Efficiency

- Quick and effective event notification, verification and resolution
- High profile H.264 to make the best use of network and storage resources
- Optimized network resources usage with levels of video service, multicast and dual streaming
- Quick playback or backward play historical video at 8x, 16x, 32x, 64x speed

Powerful Emergency Response and Integration Capability

- Quickly locate emergencies with GIS E-Map
- Preprogramming to quick response to various emergency
- Powerful management system to link video and intrusion devices for actions when emergency happens

High Reliability

- Stable in operation 24/7/365
- Sandbox technology to ensure core service stability, thus no service crash will happen even when specified device adapters crash.

Simple Operation

- keyboard for full control of live view and PTZ
- Unified client operation interface to ease users' every access in need
- Integrate seamlessly with IP Video / Intrusion / Access sub-system, easy to operate with one single, unified, feature-rich GUI.

Quick Deployment

- ONVIF global standardization support, interoperability between IP-based physical security products
- Capability to search devices automatically in network.
- System configuration one click to finish with default configuration
- Windows 7/XP-P support in clients, Windows server 2008/2003 support in server

FEATURES

Video Management

- Shall Manage up to 128 video channels from IP cameras and video encoders to display on up to 5 clients
- Manage video streaming from IP cameras and video encoders to NVR
- Record searching by time, camera number, event, devices or complex conditions
- Virtual matrix operation with CCTV keyboards or remote control
- Record and playback by various compression devices including MPEG-4, H.264 and MJPEG video streams along with audio
- Accelerate investigation with agile replay controls: play & pause & shuttle
- Snapshot video image for immediate actions
- Configurable tours and patrols on workstation monitors or video walls
- 128 channels D1 resolution in full frame recording simultaneously
- Internal storage for 16/32TB, external storage options up to
- Support HD and Megapixel Camera; and decoder for video wall display

Event Management

- Events classified by types and security levels for easy searching
- Events to be managed according to resolution status ensuring proper handling
- Different security level event notifications can be easily identified with different colors

E-Map System

- Accurate event allocation on the map with video verification
- Navigate complex sites to get video live view when suspicious events occur
- Support BMP, JPEG and AutoCAD format map import
- Multi-layer map support

User Management

- Access to system resources – individually controlled per user or user group
- Manage user privileges one at a time or through common profiles
- Display user customized interface upon user login
- Allow or deny camera viewing by user or user group
- Every action from log-in to camera control to event export can be audited and reported enabling high level security operation

System Configuration and Maintenance

- Maintain database of all system functions for report out by request including devices error, alarms, and user actions
- Monitoring system health status indication, trigger alarm / information notification for initiative diagnosis and maintenance

Specifications	
Operation System	Windows Server 2003 Std
CPU	Intel Xeon Processor E5504
Memory	4 GB DDR3 ECC SDRAM
System Hard Disk	500GB, 3.5", 7.2Krpm, SATA III
Network	2 Gigabit NICs
LCD Display Panel	ENC Status
Storage Disk Interface	16 x 3.5" Swappable Trays

Hot Swappable Disk	Yes
RAID Levels	RAID 0, 1, 5, 6, 10, 50 and 60
RAID Management	Support Multi RAID Levels and Stripe Size
RAID Feature	Support 128MB 667 DDRII cache memory; Support Hot spare and automatic hot rebuild; Allow online capacity expansion within the enclosure; Local audible event notification alarm
Power Supply	AC 90V ~ 264V Full range, 47Hz ~ 63Hz
Operating Temperature	10°C ~ 40°C
Relative Humidity	10% ~ 85% Non-condensing
Certification	CE, FCC

vi) Digital Keyboard with Joystick:

1. It should be a fully programmable keyboard controller with LCD screen.
2. It should have following features:
 - A. The Joystick should have interactive / intuitive buttons & Status display LCD.
 - B. It should be fully programmable with customized menus.
 - C. Integral back-lit LCD touch screen.
 - D. Ergonomic design with padded wrist rest.
 - E. Variable-speed joystick with integral zoom control.
 - F. Multiple interface options (RS-232, RS-485 and TCP/IP).
 - G. Two jog/shuttle controls.
 - H. Dedicated keys for commonly used functions.
 - I. Dynamic menu selection.
 - J. All programming should be stored in flash memory.
3. It should comply with the following specifications:
 - Input Voltage: 10-16VDC
 - Power: 10 Watts
 - Control: Elastomeric push-button switches, 320x240 graphics LCD with touch-screen-Proportional 3-axis joystick, 2 Jog/Shuttle switches, and LCD
 - Pan/Tilt Functions: Rate-proportional pan left, pan right, tilt up, tilt down
 - Lens Functions: Zoom in, zoom out, focus near, focus far, iris open, and iris close
 - Control Ports: COM1 - RJ-12 connector (RS-485 only) COM2 - RJ-12 connector (RS-485) or 10BaseT Ethernet RJ-12 connector (RS-232) COM3 - DB-9 connector (RS-232 only)
 - Keyboard Port: 6-pin mini-DIN for QWERTY keyboard
 - Communication Speeds: 9600 to 38.4K baud
 - Control Output Modes : RS-232, RS-485 or TCP/IP
 - Operating Distances: 4000' (1219 m) maximum w/ RS-485 and 32 devices 50' (12.7 m) maximum w/ RS
 - Ambient Temperature: 32°F to 122°F (0°C - 50°C)
 - Ambient Humidity: 0% to 95% (non-condensing)

IP platform will support five clients.

vii) LAYER -2 MANAGEABLE SWITCH

- Number of ports: 24 Nos. 10/ 1000 base-TX RJ45 ports 2 Combo 1000 base T/ SFP with 1 No single mode 1000 base Fiber LX duplex port module.
- Switch: Fabric 8.8 Gbps
- Packet forwarding: 6.6 Mbps
- Transmission Method: Store and forward
- MAC Address Table: 8 K entries per device
- MAC Address learning: Dynamic entries: automatic update, static entries: user defined
- Packet Buffer Memory: 16 Mbytes per device
- Power Supply: AC 230 V @ 50 Hz

vii) LAYER -3 MANAGEABLE SWITCH

- Number of ports: 24 No 10/ 1000 base-TX RJ45 ports 2 Combo 1000 base T/ SFP with 1 No single mode 1000 base Fiber LX duplex port module to connect L2 switch uplink and NVR box
- Switch Fabric: 48 Gbps
- Packet forwarding: 35 Mbps
- Transmission Method: Store and forward
- MAC Address Table: 16 K entries per device
- Packet Buffer Memory: 16 Mbytes per device
- Power Supply: AC 230 V @ 50 Hz

viii) CABLES

S. No.	Connectivity	Cable Type	Connector
1	Camera to L2 Switch	UTP CAT 6	RJ45
2	L2 Switch to L3 Switch in control room	Single Mode Fiber/ UTP CAT 6	SC/ RJ45
3	L3 Switch to Video Wall Switches	UTP CAT 6	RJ45
4	From L3 switches to NVR/ NAS Box	UTP CAT 6	RJ45
5	From power source to PTZ camera	3x1.5 sq mm PVC Insulated power cable	

ix) INSTALLATION OF UTP CABLE

- a) Cables should be dressed and terminated in accordance with the manufacturer's recommendations and/ or best industry practices.
- b) Pair untwist at the termination should not exceed one-half an inch.
- c) Bend radius of the cable in the termination area should not be less than 4 times the outside diameter of the cable.

- d) The cable jacket should be maintained as close as possible to the termination point.
- e) Cables should be neatly bundled and dressed to their respective panels or blocks. Each panel or block should be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- f) The distance between UTP data cable and any power cable should be more than 4 inches.
- g) Each cable should be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view should not be acceptable.
- h) Cables should be installed in continuous lengths from origin to destination (no splices).
- i) Horizontal distribution cables should be bundled into groups of not greater than 40 cables. Cable bundle quantities in excess of 40 cables may cause deformation of the bottom cables within the bundle.
- j) Cables should not be attached to ceiling grid or lighting support wires.
- k) Any cable damaged or exceeding recommended installation parameters during installation should be replaced by the contractor prior to final acceptance at no cost.
- l) A self-adhesive label or PVC marker ferrules should identify the Cables. A cable label should be applied to the cable behind the faceplate on a section of cable that can be accessed by removing the cover plate. Similar label or marker ferrules should also be placed on a section of the cable near to the patch panel termination.
- m) Pulling tension on 4-pair UTP cables should not exceed 25-pounds for a single cable or cable bundle. The pathway should be adequately sized so as not to exceed the 80% cross-section fill of cables. The pathway should be securely installed in the facility.

- n) Care should be taken when pulling cables into trucking to avoid damage due to snagging. Trucking partitions should be used to separate the data cables from power, and bridges should be used where data cables have to cross the mains.

x) POWER WIRING SYSTEM

Rigid PVC (heavy duty) Conduit Wiring System as per IS: 9537.

xi) MATERIALS

Conduits

- (i) All rigid conduit pipes shall be of PVC and be ISI marked. The wall thickness shall be not less than 1.6 mm for conduit upto 32 mm dia and less than 2 mm for conduits above 32 mm dia.
- (ii) The maximum number of PVC insulated cables conforming to ISI: 694-1990 that can be drawn in one conduit as per standard norms. Conduit sizes shall be selected accordingly in each room.
- (iii) No conduit less than 20 mm in diameter shall be used. Flexible conduits will only be permitted for interconnections between switchgear, DB's and conduit terminations in wall. All flexible conduits used in the system should be Halogen free, flame retardant and self extinguishing polyamide conduits.

Conduit Accessories

- The conduit wiring system shall be complete in all respects, including their accessories.
- All conduit accessories shall be of solvent cement plastering type and under no circumstances pin grip type of clamp grip type accessories shall be used.
- Bends, couplers, etc. shall be solid type in recessed type of works and may be solid or inspection type as required.
- Saddles for surface conduit work on wall shall not be less than 0.55 mm (24 gauge) for conduit up to 25 mm dia. and not less than 0.9 mm (20 gauge) for larger diameter.
- The minimum width and the thickness of clips used for fixing conduit to steel joints, and clamps shall be per standard norms.

Outlets

- The switch box or regulator box shall be made of metal on all sides, except on the front. In case of cast boxes, the wall thickness shall be at least 2 mm and in case of welded mild steel sheet boxes, the wall thickness shall not less than 1.2 mm (18 gauge) for boxes upto a size of 20 cm x 30 cm, and above this size 1.6 mm (16 gauge) thick MS boxes shall be used. The metallic boxes shall be duly painted with anticorrosive paint before erection.
- An earth terminal with stud and 2 metal washers shall be provided in each MS box for termination of protective conductors and for connection to socket outlet/ metallic body of fan regular etc.
- Clear depth of the box shall not be less than 60 mm, and this shall be increased suitably to accommodate mounting of fan regulators in flush pattern.

The fan regulators can also be mounted on the switch box covers, if so stipulated in the tender specifications, or if so directed by the Engineer-in-charge.

- Except where otherwise stated, 3 mm thick phenolic laminated sheets as per clause shall be fixed on the front with brass or cadmium plated iron screws as approved by the Engineer-incharge.

Wires

Wires shall comply the following features:

- PVC insulated with a rating of 105 deg. C bright annealed electrotype grade (99.9% pure) copper standard conductors multi drawn simultaneously (Unilay, twisted conductors) for uniformity of resistance, dimension and flexibility.

- Color coded as below:

Phase – R - Red

Phase – Y - Yellow

Phase – B - Blue

Neutral - Black

Earth – Green

Installation

- Common aspects for recessed and surface conduit works

Conduit joints

- The conduit work of each circuit or section shall be completed before the cables are drawn in.
- Conduit pipes shall be joined by means of couplers and accessories only.
- Cut ends of conduit pipes shall have no sharp edges, nor any burrs left to avoid damage to the insulation of conductors while pulling through such pipes.

Bends in conduit

- All necessary bends in the system, including diversion, shall be done either by neatly bending the pipes without cracking with a bending radius of not less than 7.5 cm, or alternatively by inserting suitable solid or inspection type normal bends, elbows or similar fittings, or by fixing cast iron inspection boxes, whichever is most suitable.
- No length of conduit shall have more than four bends from outlet to outlet.

Additional requirements for recessed conduit work.

i) Making

- a. The chase in the wall shall be neatly made, and of ample dimensions to permit the conduit to be fixed in the manner desired.
- b. In the case of buildings under construction, the conduit shall be buried in the wall before plastering, and shall be finished neatly after erection of conduit.

c. 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.

ii) Fixing conduits in chase

- a. The conduit pipe shall be fixed by means of staples hooks or by means of saddles, not more than 60 cm part, or any other approved means of fixing.
- b. All joints of conduits pipes shall be treated with some approved preservative compound to secure protection.

iii) Fixing conduits in RCC work

- a. The conduit pipe shall be laid in position and fixed to the steel reinforcement bard by steel binding wires before the concreting is done. The conduit pipes shall be fixed firmly to the steel reinforcement bars to avoid their dislocation during pouring of cement concrete and subsequent tamping of the same.
- b. Fixing of standard bends or elbow shall be avoided as far as practicable, and all curves shall be maintained by bending the conduit pipe itself with a long radius which will permit easy drawing in of conductors.
- c. Location of inspection/ junction boxes in RCC work should be identified by suitable means to avoid unnecessary chipping of the RCC slab subsequently to locate these boxes.

iv) Fixing inspection boxes

- a. Suitable inspection boxes o he minimum requirement shall be provided to permit inspection, and to facilitates replacement of wires, if necessary.
- b. These shall be mounted flush with the wall or ceiling concrete. Minimum 65 mm depth junction boxes shall be used in roof slabs and the depth of the boxes in other places shall be as per IS: 2667 – 1977.

v) Fixing switch boxes and accessories

Switch boxes shall be mounted flush with the wall. All outlets such as switches socket outlets, etc. shall be flush mounting type, unless otherwise specified in the Additional Specifications.

vi) Bunching of cables

- a. Cables shall be always be bunched so that the outgoing and return cables are drawn into the same conduit.
- b. In case of three phase loads, separate conduits shall be run for each phase from the distribution boards to the load points, or outlets as the case may be.

Note: The Camera, NVR, VMS and Joystick controller should be of same make

17.0 NURSE CALL SYSTEMS:

NURSE CALL SYSTEM

Nurse Call System shall be designed for patient in the Hospital to call for assistance in case of emergency and reduce the critical time for receiving medical attention by pressing a button which shall be located on the bed side of the patient

1 MAIN CONTROL PANEL

This panel is installed at main nurse station/Room. This panel indicates the Room No/Bed No from where patient needs some help and is calling for the nurse.

This Panel has various LEDs and one Switch, which has following functions

POWER ON LED: This LED is used to indicate the power. This LED will glow when power is ON.

ACK S/W Switch: The nurse to acknowledge the call uses this switch.

POWER FAULT LED: This LED is used to indicate the power fault if it occurs. For e.g. Fuse Blown, Mains Failure etc...

CPU FAULT LED: This LED is used to indicate the fault in CPU if it occurs.

Whenever any patient press the bed switch, a NURSE CALL LED for corresponding room/bed will indicate a call by the patient and a siren will alarm the nurse to get the attraction. Nurse can mute the siren by pressing the ACK S/W switch but indicator will be reset only from the bed switch, which has been located near the calling patient's bed, ensuring that nurse has visited the patient. When Nurse press the ACK S/W, the CALL ACCEPT LED for the corresponding call will also glow to indicate that call has been acknowledged.

1 PATIENTS ROOMS

The system shall have patient bed side Push button unit which shall consist of the following:

- i. Wired hand held with Patient bed side button set with a LED indicating lamp and Reset / call accept button with LED .
- ii. Push button for medical assistance required by the patient which when pressed the call acknowledge by Nurse then it shall start flashing light. Also, to indicate that a call has been made.
- iii. Reset push button which shall be operated by the nurse from the patient bed side unit after attending the patient , LED shall be off Flashing.

2 MAIN DISPLAY AT THE NURSE STATION

At each nursing station the Central Display Unit shall indicate all the patient; bed numbers in the form of LED light . When a patient shall press the "Nurse Call" button at the bed side from his/

her room, the respective LED light at the central display shall go ON and the associated red light shall start flashing at the Nursing Station display, at the entrance of patient's room/ ward and at the toilet entrance. audio alarm shall also start to attract attention of the Nursing Staff. .

All operations at the bed side shall be isolated low DC voltage and with very low current consumptions for the safety of the patient.

3 **BEDSIDE INDICATION AND CALL MODULE**

This shall consist of a recess wall mountable module having three color indications, input jack for connecting hand module, reset button.

4 **HAND MODULE**

The hand module shall have an extension cord for being used by the patient lying on the bed. This module shall have a provision for call and reset/ cancel.

5 **TOILET CALL MODULE**

Toilet call modules shall comprise of recess mountable modules having provisions for emergency call from the toilets and provision for reset.

6 **CORRIDOR INDICATION MODULE**

Corridor indication module shall be LED indication recess mountable plates to indicate the status of the patients calls to be fixed outside each room door/ward in the corridor.

8 **CONDUITING WIRING AND CABLING FOR NURSE CALL SYSTEM**

Providing and fixing in position the following 16 gauges MS conduits concealed or exposed as called for including all accessories i.e. Bends, junction boxes with cover plates of approved make and design

- 25 mm diameter conduit
- 20 mm diameter conduit

Supply laying, connecting and commissioning of power cable 3 pair x 1.5 sq. mm twisted copper tinned cable in existing conduit.

Supply laying, connecting and commissioning of communication cable 6 core x 0.5 sqmm.. for Bed switch Button.

Supply laying, connecting and commissioning of communication cable 2 core x 0.5 sqmm.. for LED Indicators.

Specifications of main Panel

1. Operating Voltage
 - ❖ 230 Volt 50 Hz AC
(+10%, -15% Voltage Tolerance)
2. Type
 - ❖ Microcontroller Based
3. Max PSU Rating
 - ❖ 2.5 Amps total, comprising:
 - Battery Charger: 0.7Amps
 - Internal and external Loads: 1.8Amps
4. Standby Batteries
 - 12 V sealed lead acid batteries
 - Minimum Capacity: 12 V 6Ah (Internally Fitted)
 - Maximum Capacity: 12 V 7Ah (Internally Fitted)
 - Maximum Capacity: 12 V 12Ah (Externally Fitted)
5. Power Supply
 - ❖ Input(s): 12 V AC(from integral mains transformer)
 - ❖ Output(s): 12V, +1.5 V and – 1.5 VDC
6. Dimensions (32 Bed Nurse Call System)
 - ❖ 425 mm(Width) X 275 mm(Height) X 85mm(Depth)
7. Weight
 - ❖ 4500 gram(app.)
8. Environmental Operating Limits
 - ❖ Temperature: 0°C to + 60°C(32°F to 120°F)
 - ❖ Humidity: 10% to 93% non-condensing
9. Construction
 - ❖ CRCA Sheet, Powder Coating
10. Cable Entry
 - ❖ 6 X 20mm(0.8”) knock-outs in top of cabinet
 - ❖ 6 X 20mm(0.8”) knock-outs in backside of cabinet
11. Internal Sounder
 - ❖ Intermittent speaker indicates a nurse call.
12. External Outputs
 - ❖ Corridor/Repeater Display

13. User Controls
 - ❖ Acknowledge Switch
14. Indicators
 - LED type general panel Status indicators:
 - ❖ NURSE CALL
 - ❖ CALL ACCEPT
 - ❖ CPU FAULT
 - ❖ POWER FAULT/POWER ON
15. Display (Yet not in application) (Optional)
 - ❖ 2 x 40 Character LCD alphanumeric display with back light

Technical Specification For Dome Light

1. Operating Voltage
 - ❖ 12 Volt DC
2. Max PSU Rating
 - 10 mAmp
3. Power Supply
 - ❖ Input(s): From Main Panel
4. Dimensions (32 Bed Nurse Call System)
 - ❖ 73 mm(Width) X 100 mm(Height) X 45mm(Depth)
5. Weight
 - ❖ 500 gram(app.)
6. Environmental Operating Limits
 - ❖ Temperature: 0°C to + 60°C(32°F to 120°F)
 - ❖ Humidity: 10% to 93% non-condensing
7. Construction
 - ❖ CRCA Sheet, Powder Coating
8. Cable Entry
 - ❖ 1 X 20mm(0.8”) knock-outs in top of cabinet
9. Internal Sounder
 - ❖ Buzzer(Optional)
10. Indicators
 - LED type general panel Status indicators:

- ❖ NURSE CALL
- ❖ CALL ACCEPT

Technical Specification For Bed Switch

1. Operating Voltage
 - ❖ 12 Volt DC
 2. Max PSU Rating
 - 10 mAmp
 3. Power Supply
 - ❖ Input(s): From Main Panel
 4. Dimensions (32 Bed Nurse Call System)
 - ❖ 140 mm(Width) X 55 mm(Height) X 65mm(Depth)
 5. Weight
 - ❖ 750 gram(app.)
 6. Environmental Operating Limits
 - ❖ Temperature: 0°C to + 60°C(32°F to 120°F)
 - ❖ Humidity: 10% to 93% non-condensing
 7. Construction
 - ❖ CRCA Sheet, Powder Coating
 8. Indicators
 - LED type general panel Status indicators:
- ❖ NURSE CALL
 - ❖ CALL ACCEPT
9. User Controls
 - ❖ Nurse Call
 - ❖ Reset Call
 - ❖ Bed Switch with Cord for Nurse Call

15.0 LIFT INSTALLATION

15.1 The scope of work shall cover design, supply delivery, installation, testing and commissioning of passenger lifts/bed lifts. The scope of work shall also include the following item of civil works.

- a) Necessary scaffolding temporary barricade in the hoistway required during the erection of the elevators.
- b) Minor building work comprising of cutting holes and making good the car and counterweight rail brackets, hall buttons and indicators including laying of sills in position.
- c) Steel items such as machine beams, bearing plates buffer support channels, sill angles and fascia plates etc.
- d) Suitable trap doors with steel chequered plate covers.
- e) Providing and install a suitable vertical iron ladder for access to the pit.
- f) Any other item required for successful completion and commissioning of lifts. (including the hoisting beam in the machine room)

15.2 The work shall be done in accordance with regulations of any local code and following ISI codes which govern the requirements of installations.

IS: 1860-1980 code of practice for installation, operation and maintenance of Electric Passenger and Goods Lifts.

IS: 3534-1976 Outline dimensions of Electric Lifts.

IS: 4666-1980 Specifications for Electric passenger and Goods Elevators.

Indian Electricity Act 1910.

Indian Electricity Rules, 1956.

Delhi Lifts Rules, 1942.

15.3 **SHOP DRAWINGS AND APPROVAL OF ELECTRICAL INSTALLATIONS :**

The selected tenderer shall prepare a furnish shop drawings for approval by The Client, such shop drawings shall be based on the Architectural drawings and requirements laid down in specifications, local laws and regulations etc.

The detailed drawings shall be submitted within one month of placement of order. The successful tenderer shall obtain the approval of electrical Inspector and other local authorities as per requirements before submitting the drawings to Client/ Engineer. The contractor shall not proceed with in installation work till the drawings are approved by the Engineer-in-Charge. Expenses incurred such as license fee etc. towards obtaining the approval of Electrical Inspector, local authority shall be reimbursed to the contractor as per actual on production of documentary proof.

Approval of contractor's drawings shall not absolve the contractor of any of his obligations to meet the requirements of specification under this contract

Five sets of completion drawings operation manual, maintenance manual, spare parts details shall be submitted to the Client/ Engineer after completion of work.

15.4 GUARANTEE

The tenderer shall guarantee the equipment against all defects of materials and workmanship for a period of one year from the date of commissioning of the equipment as certified by the owner. Any defects arising during the guarantee period shall be rectified and replaced by the tenderer, at his own expense, to the satisfaction of the owner.

15.5 PERMITS, INSPECTION & LICENSE FEE

The contractor shall arrange all necessary local, provincial or national government permit and shall make arrangements for inspection and tests required thereby. Expenses to be borne by purchaser.

15.6 MAINTENANCE

After the completion of the installation and handing over of each elevator by the elevator contractor, DLP for the equipment furnished shall be provided for a period of twelve (12) months. This service shall include regular examination of the installation by trained employees, and shall include all necessary adjustments, greasing oiling, cleaning supplies and genuine standard parts to keep the equipment in proper operation, except any parts made necessary by misuse, accident or neglect caused by other. Contractor shall provide 24 hours Emergency local call back service facility and shall furnish full details of such facilities available.

15.7 POWER SUPPLY

The apparatus shall be designed to operate on 415 + 10% - 20% Volts, 3 Phase, 4 wires, 50 Hz A.C. Supply for illumination signal equipment shall be 240 Volts single phase 50Hz A.C..

15.8 ELECTRICAL WIRING

The necessary A.C. supply of 3 Phase, 415 Volts 50 HZ shall be made available in the main control switch unit to be provided by the contractor in the machine room. All the electrical works beyond the main supply switch shall be carried out by the contractor i.e. supply and installations of panels for drive motors, switches and control complete with wiring as per system requirement and approval of the Engineer.

The wiring shall be carried out strictly in accordance with Indian Electricity Rules and Indian code of Practice for Electrical Wiring Installation IS-732-1963 System Voltage not exceeding 650 V). For works not covered under any of the above wiring rules, the 13th edition of Electrical Engineers (Condense) shall apply. The cable and conduits to be used shall be of suitable size and grade conforming to relevant IS specification. Wiring for LT switchboard to the motor terminal shall be with heavy duty 1.1 KV grade PVC insulated PVC sheathed, FRLS aluminium cable.

All the trailing cables used for control and safety device shall conform to IS: 4289-1967, Specifications for lifts cables. The trailing cable circuits for controls, safety devices, lighting and signaling shall be separate and distinct.

Power wiring between controller and main board to various landings shall be drawn in suitable size heavy gauge conduit stove enameled/painted conforming to I.S specifications.

The Voltage and frequency of the supply shall be subjected to variations permissible under Indian Electricity Acts and Rules.

15.9 PARTICULAR SPECIFICATIONS

- 15.9.1 TYPE : Bed Lifts/Passenger Lifts.
- 15.9.2 NO. OF ELEVATORS : As Per Bill of Quantities.
- 15.9.3 CAPACITY : As Per Bill of Quantities.
- 15.9.4 SPEED : As Per Bill of Quantities.
- 15.9.5 FLOORS SERVED/RISE : As Per Bill of Quantities.
- 15.9.6 STOP : As Per Bill of Quantities.
- 15.9.7 OPENINGS : (All Openings on same side).
As Per Bill of Quantities.
- 15.9.8 OPERATION : Duplex/Simplex Collective as per BOQ.
- 15.9.9 CAR FRAME:

The car frame, which supports the car platform and enclosures, shall be made of structural steel and equipped with suitable guides and a car safety device mounted underneath the car platform. The hoist ropes shall include adjustable self/ aligning hinges. The car shall be so mounted on the frame that vibration and noise transmitted to the passenger is minimized.

15.9.10 CAR SAFETY AND GOVERNER :

Suitable car safety to stop the car whenever excessive descending speed is attained shall be operated by a centrifugal speed governor connected to the governor through a continuous steel rope.

The governor shall be provided with self tensioning device to keep governor rope in proper tension even after rope stretch. Suitable means shall be supplied to cut off power from the motor and apply the brake on application of the safety.

15.9.11 COUNTER BALANCE :

A Suitable guided structural steel frame with appropriate filler weights of cast iron shall be furnished to promote smooth and economic operation.

15.9.12 TERMINAL AND FINAL LIMITS :

Terminal limit switches shall be provided to slow down and stop the car automatically at the terminal landings within permissible over travel and final limit switches shall be provided to automatically cut off the power and apply the brake, should the car travel beyond the permissible over travel. They shall act independently of the operating devices and buffers.

15.9.13 TERMINAL BUFFERS :

Heavy duty spring buffers shall be installed as a means of stopping the car and counterweight at the extreme limits of travel. Buffers in the pit shall be mounted on steel channels which shall extend between both the car and counterweight rails.

15.9.14 CONTROLLER :

A Controller shall be provided to control starting stopping and speed of the elevator motor and also be automatically able to apply the brake if any of the safety devices operate or if power fails from any cause. In case of power failure and again restore of power the lift shall land to next floor and shall not go to basement/lowest level. Suitable software/hardware or rescue device shall be provided.

15.9.15 REVERSE PHASE RELAY :

A reverse phase relay shall be provided on the controller which is designed to protect the lift equipment against phase reversal and phase failure.

15.9.16 GUIDES :

Machined steel tee guides shall be furnished for the car and counterweight. The guide rails should be of steel solid and shall have tongued and grooved joints. Sliding clips shall be used for fastening the guides to allow building settlement without distorting the guide rails. To keep down the noise level and to reduce wear and tear of the sections, only Nylon Ribs shall be used in the guide shoes, after smoothening of the rails. The flanges shall be machined for the fish plate mounting such that rail alignment at joints almost remain constant.

15.9.17 FOUNDATIONS :

The machine shall be placed directly above the hoistway upon the machine room slab provided by the Owner.

15.9.18 ROPES :

The elevator shall be provided with traction steel ropes. Steel wire rope having a tensile strength of not less than 12.5 Ton/cm² of good flexibility shall be used for lift. The lift rope shall conform to IS: 14665 – (Part-4- Sec-8):2001.

15.9.19 MACHINE :

The machine shall be of the single wrap traction type and shall include a motor, electromechanical brake, steel worm, bronze gear, steel sheave shaft and Farrow-Molybdenum sheave all compactly mounted on a single base or bed plate. The worm shaft shall be provided with ball bearings to take the end thrust and roller bearings shall be furnished for the sheave shaft to ensure alignment and long bearing life. The driving sheave shall be grooved to ensure sufficient traction and minimize rope wear. Shall be provided for all bearings and the worm gear.

15.9.20 BRAKE :

The direct current brake shall be spring applied and electrically released and designed to provide smooth stop under variable loads. The brake should be capable of operation automatically by various safety devices, current failure, and by normal stopping of car. It should be possible to release the brake manually, such releases requiring the permanent application of manual force so as to move the lift car in short sties. For this purpose one set of brake release equipment shall be supplied.

15.9.21 MOTOR :

The motor shall be suited to the service proposed and arranged for adequate lubrication. The motor shall be class F insulation and one (1) hour rated squirrel cage induction type having high starting torque. It shall also be provided with Thermistors embedded in the stator windings for the highest degree of thermal motor protection.

15.9.22 CONTROL

The control shall be variable voltage variable frequency A.C. variable voltage, closed loop control system using solid state devices and electronic speed pattern generator to command the motor from a velocity transducer and load compensation circuits for a comfortable ride.

In Normal operation, the electromagnetic brake shall only be applied when the lift has come to a complete standstill. The brake shall only be meant for holding the lift in position at every landing, providing stopping without any jerking effect.

Each controller cabinet containing memory equipment shall be properly shielded from the pollution.

MICROPROCESSOR

The control shall employ a microprocessor working on a program such that precision leveling and highly efficient handling of passengers for least possible waiting and reduced travel time is ensured. The microprocessor system should be designed to accept programming with minimum downtime. It should be able to monitor the state of input calls (such as car calls from COP and hall calls from hall fixtures) and output commands such as starting, decelerating and stopping the elevator. It should be able to generate floor location data, thereby, providing a reference position to establish the safety zones for door opening and closing, and also to initiate leveling slowdown.

15.9.23 DUPLEX COLLECTIVE OPERATION

The operation shall be duplex collective with/without attendant for each elevator and shall consist of the following:-

IN THE CAR

There shall be furnished a flush type attractively finished stainless steel panel which contains a series of luminous buttons numbered to correspond to the landings served, an emergency stop switch and an emergency call button connected to a bell which serves as an emergency signal.

AT HOISTWAY LANDINGS

There shall be provided an UP luminous push button and a DOWN luminous push button at each intermediate landing and a single button at the terminal landings.

The car shall not start unless the door is in the closed position and all hoistway doors are closed in the locked position.

If the car is idle and one or more car or landing buttons above the landing at which the car is standing are pressed, the car shall start in the UP direction and proceed to the highest landing for which any button is pressed and stops at intermediate landing for which a car button or up landing button is pressed sufficiently in advance of the car's arrival at such landings to permit these stops to be made. After each stop, the car shall proceed in the UP direction until it reaches the highest landing for which a call is registered. The car shall not stop on the UP trip at any landing in response to a DOWN call.

Similarly, if the car is idle and one or more car or landing buttons below the landing at which the car is standing are pressed, the car shall start in the DOWN direction, proceed to the lowest landing for which any button is pressed and stop at each intermediate landing for which a car button is pressed.

When the car is idle and a button for a landing above the car and a landing below the car are pressed, the car shall start towards the landing corresponding to the button pressed first. The call registered for the landing in the opposite direction from the car shall be answered after the car has responded to the farthest call in the direction established by the button pressed first.

A time relay shall hold the car for an adjustable interval of few seconds at the landings at which stops are made to enable passengers to enter or leave the car.

OPERATION WITH AN ATTENDANT

The regular car operating panel shall include buttons, switches, etc. for the collective-automatic control and shall also include.

A two-position key-operated switch marked to indicate ATT (attendant operation)

A buzzer: UP and DOWN direction light jewels and A non-stop button.

A car operating panel shall also include an UP and DOWN button.

When the key-switch is in the position of WITH ATTENDANT, the direction light and buzzer shall become operative and the UP and DOWN direction button in the regular car operating panel shall be made effective for the attendant operation.

When an attendant operation, the car and hoistway doors shall open automatically at each stop but the closing of the doors shall be subject to the UP or DOWN direction buttons. As a visual signal to the attendant, the UP and DOWN direction jewel shall illuminate upon registration of either car or landing calls to indicate the direction of the travel of the car. The attendant shall operate the elevator normally in the direction indicated by the direction jewel but, if desired, opposite direction travel may be realized by pressure of a car button for a landing in that direction from the car.

The pressure of a direction button shall cause the doors to close and the car to start in the direction desired, provided a call is registered for that direction. If pressure of the direction button is released before the car starts, the doors will re-open and car shall not travel. It shall so arrange the pressure on direction button can be released, once the car has started.

Continuous pressure of the nonstop button shall cause the car to by-pass all landing calls and respond only to registered car calls.

15.9.24 CAR ENCLOSURES :

The car enclosures shall be of sheet steel and shall be of an elegant design comprising of the following :

- a) Suspended ceiling with light diffuser Perspex ceiling and fluorescent light.
- b) Concealed pressure fan with grille in suspended ceiling. The lift shall have sensor so that the fan is operation only when if there is at least one person inside the lift.
- c) Ceiling steel painted white.
- d) Complete stainless steel car enclosure in plain finish for passenger and Bed Lifts
 - a) PVC flooring (with 3mm thick tiles of approved shade) for Bed Lifts
 - b) Mirror on one face (front face when we enter the car)

15.9.25 CAR DOOR

The car entrance shall be provided with stainless steel sliding doors in plain finish giving a clear opening of 1200mm wide by 2000mm high for bed lift. The lift car door shall have a fire resistance rating of one hour.

15.9.26 HOISTWAY DOORS :

At each landing, a center/ telescopic opening , stainless steel sliding door in plain finish giving a clear opening as per CPWD general specifications for electrical works –Part-III – Lifts & Escalators, shall be provided.

15.9.27 SIGNAL AND OPERATIVE FIXTURES :

The following signal and operative fixtures shall be provided for each lift in stainless steel face plates except in fireman's switch which shall have a glass face plate.

a) **CAR OPERATING PANEL**

There shall be one (1) No. panel in car, with hinged stainless steel face plate and shall comprise illuminated floor buttons, door open and emergency stop controls emergency call buttons, door open and emergency stop controls emergency call button, two position key operated switch, a Buzzer, UP and DOWN direction light panels, a non stop button, and an integral interphone. The jewels and accentuator shall be of modular construction, face plate mounted, rewired using snap on lugs.

b) **HALL BUTTONS AND HALL POSITION INDICATOR**

There shall be provided combined signal fixture (one riser) of compact design and of attractive hairline stainless steel face plate at the elevator entrance on each floor which for terminal landings shall have a single luminous push button and for intermediate landings shall have an UP luminous push button and a DOWN luminous push button. The jewels shall be of modular construction mounted on a stainless steel face plate. Whenever a button is pressed, the jewel shall light up to indicate registration of the call and shall remain enlightened till the car arrives.

c) **CAR POSITION INDICATOR IN CAR**

This shall be of compact design and of attractive hairline finish stainless steel face plate with easy to read digital display of the floors, indicating through which floor the elevator is passing or on which floor the elevator is stopped. This shall also incorporate illuminated arrows showing the direction of travel.

d) **BATTERY OPERATED ALARM BELL AND EMERGENCY LIGHT**

A solid state siren type alarm unit operated by 2 Nos. 9 volt rechargeable Nickel Cadmium batteries shall be provided which shall give a waxing and waning siren when alarm bell in the car is pressed momentarily.

An emergency light unit using a 9 volt dry battery power pack and incandescent lamp with stainless steel face plate shall be provided inside the car which shall operate automatically in the case of power failure.

e) **OVERLOAD WARNING**

Overload warning radars with audio-visual indication (visual indication shall show OVERLOADED) with stainless steel face plate shall be installed in the elevator car, so that when there is overload in the car the sign shall light up a flash indicating OVERLOADED and a buzzer shall operate during this period and the doors shall remain open until the overload is removed.

f) **FIREMAN'S SWITCH**

A toggle switch covered by a glass cover shall be provided on the ground floor for each elevator which shall permit a fireman to call the elevator to the ground floor by canceling all car and landing calls. The elevator shall then stop at the ground floor with the door open to permit the fireman to have exclusive use of the elevator without any interference from the landing calls.

g) INTERPHONE

Interphone shall have one master unit in each machine room, one master unit on the ground floor for each 1 (outside hoistway) and one slave unit in each elevator car.

15.9.28 ELECTRIC DOOR OPERATOR FOR CAR DOOR AND HOISTWAY DOOR :

An electric door operator for opening and closing the car door shall be provided. The opening of a car and hoistway doors shall be such that the doors shall start opening meant for so that by the time the elevator stops completely, the elevator and hoistway doors shall be fully open.

The equipment shall consist of a machine on the elevator car operating the car door when the car is stopping at a landing.

The car door and hoistway door shall be mechanically connected and shall move simultaneously in opening and closing.

The car and hoistway doors shall be power opened and closed and shall be checked in opening and closing with an oil cushioning mechanism built into the gear unit.

Each hoistway door shall be provided with an interlock which will prevent movement of the car away from the landing unit.

The doors are closed in the closed position as defined in the ISI codes.

An electric contact for the car door shall be provided which shall prevent car movement from the landing unless the door is in the closed position as defined in the ISI codes. The locking arrangement shall be so designed that the electrical circuit cannot be completed unless the doors are in the closed position and mechanical latching is effected.

Necessary switches shall be provided in the elevator machine room to control the operation of the doors.

The car and hoistway, doors shall open automatically as the car is stopping at a landing. The closing of the car and hoistway door must occur before the car can be started. Doors can be stopped and reversed during their closing motion.

15.9.29 DOOR HANGER AND TRACKS :

For the car and each landing door, sheave type two point suspension hangers complete with tracks shall be provided. Means shall be provided to prevent the door from jumping off the track and for vertical and lateral adjustment of doors.

Sheaves and rollers shall be of steel and shall include shielded ball bearing to retain grease lubrication. Adjustable ball bearings rollers shall be provided to take the upward thrust of the

doors. Tracks shall be of suitable steel section with smooth surface. The locking of the two leaf parting type doors should be positive.

15.9.30 SAFETY SHOE :

A safety shoe (one on each door panel) shall extend to the full height of and project beyond the front edge of the car door.

Should this shoe touch a person or an object while the car door is closing, the car and hoistway doors shall return to the open position. The doors shall remain open until the expiration of a pre-determined interval and then close automatically.

15.9.31 LANDING ENTRANCE MATERIALS :

These shall consist of headers, extruded aluminium sills and strut angles.

15.9.32 WIRING :

Complete wiring in the equipment.

15.9.33 AUTOMATIC RESCUE DEVICE :

Automatic Rescue Device to be provided for all the lifts with battery backup so that it can land to the nearest level in case of power failure. Automatic Rescue Device shall have suitable battery backup so that it can operate minimum seven times in a day provided the duration between usage is at least 30 minutes.

16.0 LT CABLES

16.1 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.

16.2 MATERIAL

The L.T. power cable shall be XLPE Cable 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: 7098: 1988 (Part-I) with up to date amendments.

16.3 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.

16.4 INSPECTION

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

16.5 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.

16.6 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.

16.7 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.

17.0 CABLE TRAY

17.1 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.

17.2 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.

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

17.4 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.

17.5 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.

17.6 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.

17.7 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.

17.8 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.

- 17.9 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.
- 17.10 The cable tray shall be bonded to the earth Terminal of the switch bonds at both ends.
- 17.11 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.

18.0 EARTHING

18.1 GENERAL

All the non-current metal parts neutral of transformers & DG set etc 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 IS 3043 amended up to Date.

18.2 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.

18.3 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.

18.4 Earthing System – specification

Earthing system should comply to the requirements specified below. Earthing system should offer a resistance less than 5 ohms throughout the year. In places where Soil resistivity is more, multiple earth electrodes are to be installed to get the required value. Length of the earthing rod also can be increased to achieve low and stable resistance value.

Solid rods are recommended as earth electrode than a pipe due to the fact that solid rods can be easily driven by hydraulic hammers. Deep driven rods provide more stable and less Earth Resistance. Doubling the length of the rod will reduce earth resistance up to 40 %, where as doubling the diameter will reduce the resistance by only 10 %, but may increase the cost by 4 times. Lower earth resistance can also be achieved by increasing the number of earth rods. E.g. 40 % reduction in earth resistance is possible if the rods are increased from 1 to 2. The minimum spacing between earth pits should be equal to the length of the rod. Increasing the spacing between earth pits also reduces the earth resistance significantly.

Need and importance of Earthing:

- Human and Personnel safety.
- Equipment protection.
- Provides low impedance path for fault currents.
- To ensure good quality power.
- Protection against lightning and transient currents, noise reductions, Limitation of EMI.

References:

IEC 60364: Low Voltage Electrical Installations-Part 5-54: Selection & Erection of Electrical equipment-Earthing arrangement & protective conductors.

IEC 62561: Lightning Protection system Components.

IEC 62305: Protection Against Lightning –Part 3: Protection of structures & life Hazards

UL 467: Grounding and Bonding Equipments

UL96: Lightning Protection System – Components

IS 2309: Code of practice for protection of buildings & allied structures from lightning

IS 3043: Code of practice for earthing.

Components of earthing system:

- Earth electrode
- Couplers and Connectors
- Inspection Chamber (Earth Pit)
- Earth enhancement material
- Connecting cable/tape/strip with accessories.

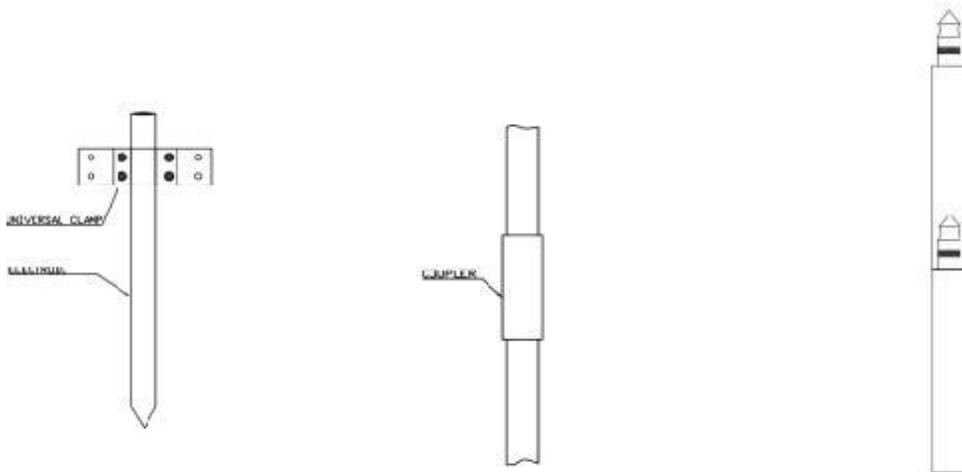
Earth Electrode:

Copper coated Solid steel Rods shall be made of high tensile low carbon steel rod, with molecular bonded with 99.9% electrolytic copper with minimum coating thickness of 250 microns. The minimum length of the earth rod shall be 3 meters which is either a single rod or smaller rods with couplers or similar arrangement. For dry areas, length of the rods can go up to 9 meters. The vendor should quote price of the rod in length of 3 meters. The rod as well as the couplers should satisfy the requirements as per the above-referred standards. For Lightning protection application rods should have a diameter of 14.2 mm or 17.2 mm. In order to carry fault current, earth rods used in Power networks should be of diameter 20 mm or 25 mm. In case of applications more than 3 meters, diameter of the rod should be 20 or 25 mm. These rods also should have facility to drive with an electric/hydraulic hammer.

Interconnecting Strips / Earthing Conductor: Copper coated steel strips / tapes should be used to interconnect different earthing rods as well as horizontal earthing (Ring earthing). These strips should have a coating thickness of minimum 70 microns and have minimum cross sectional area of 90 Sqmm. (Eg 30 X 3 strip)

Couplers / Connecting clamps:

Couplers for interconnecting rods should be made of Brass or any other copper alloy, which is resistant to corrosion. For rods with diameters larger than 20 mm self locking arrangements are preferable instead of couplers. Connectors for connecting Electrode with Earthing conductor/strip should be of Brass/copper alloy or copper coated steel. Fasteners should be made of Stainless steel. Size should be selected according to the electrode and earthing conductor dimensions. Different arrangements should be as per the below fig.



Inspection Chamber :

Should have an inner dimension of 250 mmX 250 mm X 250 mm made of FRP material. Flush Mounted, removable and lockable cover of the earth pit should be able to withstand 15KN. The area inside the inspection chamber should be such that, the UNIVERSAL CLAMP/EBB/Bus bar is not too deep inside the inspection chamber or projecting out of inspection chamber. The chamber should have facility for marking earth resistance and latest testing date by paint at the cover and previous recorded values inside the cover.

Earth Enhancement material:

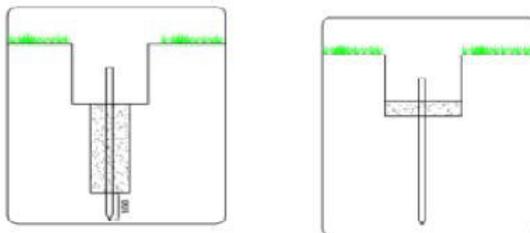
This is a conductive compound producing low resistance of an earth termination system. Earth enhancing compound shall be so designed and constructed that in normal use their performance is reliable and without danger to persons and the surroundings. The material shall be chemically inert to sub soil and shall not pollute the environment. It shall provide a stable environment in terms of physical and chemical properties and exhibit low resistivity. It shall not be corrosive to the earth electrode itself. The material should have a resistivity less than 50 Ohm meter

Installation:

Normal soil in Marsh land: Electrodes can be hand driven or hammered into earth for the required length.

Semi Hard Soil: Electrodes can be hammered electrically or hydraulically for the required length.

Hard Soil: Bore a hole with a minimum diameter of 100 MM with at a depth of up to 3 meters. Place the electrode at the centre of the hole in such a way that bottom 100 mm of the electrode is in bond with the mother soil. For deep driven rods with depth more than 3 meters, remaining length of the rod should be driven into the mother soil. (ref fig)Fill the hole with earth enhancement compound.



Inspection & maintenance:

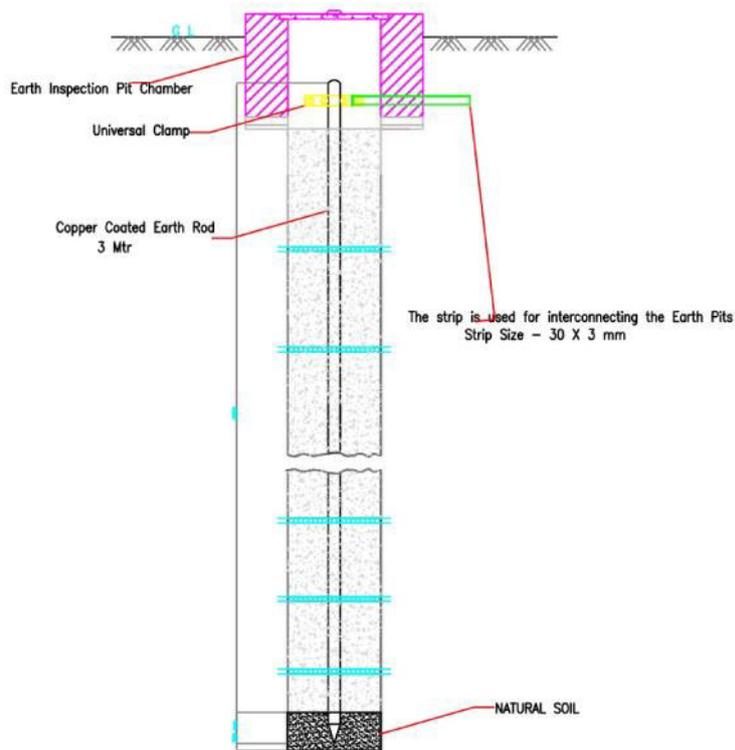
Maintenance of the earthing system has to be done at least once in 6 months, preferably before the monsoon period and a record should be maintained to verify earthing system conductors and components, electrical continuity, earth resistance value, re-fastening of components viz-nuts, bolts etc.

Drawing:

Layout of the complete earthing system with dimensions shall be submitted.

Warranty: Earthing system should provide stable resistance for a period of 18 months after installation as well as for full season. During this period monthly readings are to be recorded by the end user.

Earthing Arrangement



Note: we have to auger the soil up to 1mtr with 100 mm dia and fill up the pit with the 25 kg compound.

19.0 SAFETY EQUIPMENTS

19.1 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.

19.2 FIRST AID BOX

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

19.3 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.

19.4 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.

19.5 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.

19.6 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.

20.0 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.

21.0 UPS System

PART 1 - GENERAL

11.01 SUMMARY

- A. This specification describes a three-phase continuous duty, on-line, double conversion, solid-state uninterruptible power system, hereafter referred to as the UPS. The UPS shall operate in conjunction with the existing building electrical system to provide power conditioning, back-up and distribution for critical electrical loads. The UPS system shall consist of, as required by the project, the UPS module, battery racks, static or maintenance bypass, and other features as described in this specification.
- B. UPS level redundancy: All the UPS systems should operate in parallel redundant load sharing mode and all UPS systems should share the load equally. In case any UPS fails, the other UPS should take over 100% load instantaneously without break. Apart from above there are some UPS Units which are standalone units, all standalone UPS Should have static or maintenance bypass as inbuilt. Please refer BOQ for details on redundancy / standalone units.

11.02 UPS SYSTEM DESCRIPTION

- A. The System Components: it shall be consist of the following main components:
 - 1. Rectifier, Inverter, and Battery Charger.
 - 2. Battery string(s) in Battery Racks.
 - 3. Battery Breaker
 - 4. Battery to Battery Interconnects / Battery to UPS Connections.
- B. UPS: Each UPS shall operate as an on-line, fully automatic system in the following modes:
 - 1. Normal: Utilizing commercial AC power, the critical load shall be continuously supplied by the Inverter. The Inverter shall power the load while regulating both voltage and frequency. The Rectifier shall derive power from the commercial AC source and shall supply DC power to the Inverter. Simultaneously, the Battery Charger shall charge the battery.
 - 2. Battery: Upon failure of the commercial AC power, the critical load shall continue to be supplied by the Inverter, which shall obtain power from the batteries without any operator intervention. There shall be no interruption to the critical load upon failure or restoration of the commercial AC source.
 - 3. Recharge: Upon restoration of the AC source, the Charger shall recharge the batteries and simultaneously the Rectifier shall provide power to the Inverter. This shall be an automatic function and shall cause no interruption to the critical load.
 - 4. Bypass: If the UPS must be taken out of the Normal mode for overload, load fault, or internal failures, the static bypass switch shall automatically transfer the critical load to the commercial AC power. Return from Bypass mode to Normal

mode of operation shall be automatic. No-break transfer to and from Bypass mode shall be capable of being initiated manually from the front panel.

11.03 REFERENCES

- A. UL 1778 (Underwriters Laboratories) – Standard for Uninterruptible Power Supply Equipment.
- B. IEC 62040-1-1 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 1-1: General and safety requirements for UPS used in operator access areas.
- C. IEC 62040-1-2 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 1-2: General and safety requirements for UPS used in restricted access locations.
- D. IEC 62040-3 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 3: Method of specifying the performance and test requirements.
- E. NEMA PE-1 – (National Electrical Manufacturers Association) – Uninterruptible Power Systems standard.
- F. IEEE 587 (ANSI C62.41) Category A& B (International Electrical and Electronics Engineers) – Recommended practices on surge voltages in low voltage power circuits.

11.04 SUBMITTALS

- A. The UPS system shall be supplied with sufficient documentation, including the following manuals:
 - 1. Installation and Operation Manual: One copy of the installation and operation manual shall be furnished. It shall possess sufficient detail and clarity to enable the owner's technicians or representatives to install and operate the UPS equipment and accessories. The manual shall include the following major items:
 - a) UPS description
 - b) UPS site planning and unpacking
 - c) UPS installation
 - d) Optional accessory installation
 - e) UPS theory of operation
 - f) Operating procedures
 - g) System events
 - h) UPS maintenance
 - i) Performance and technical specifications
 - j) Wiring requirements and recommendations
 - k) Physical features and requirements

11.05 QUALIFICATIONS

- A. The UPS manufacturer shall have ISO 9001 certification for engineering/R&D, manufacturing facilities and service organization.

- B. The UPS manufacturer shall maintain a staffed 7x24x365 service availability for technical and emergency support.
- C. Field Engineering Support: The UPS manufacturer shall directly employ a field service department staffed by factory-trained field service engineers dedicated to startup, maintenance, and repair of UPS equipment. Third-party maintenance will not be accepted.
- D. Spare Parts Support: Parts supplies shall be located in the field to provide all emergency needs.

11.06 ENVIRONMENTAL REQUIREMENTS

- A. The UPS shall withstand any combination of the following external environmental conditions without operational degradation.
 - 1. Operating Temperature: 0 degrees C to + 40 degrees C without de-rating (excluding batteries).
 - 2. Storage Temperature: - 25 degrees C to + 50 degrees C.
 - 3. Relative Humidity (operating and storage): 95% maximum non-condensing.
 - 4. Elevation: Operational: 1000 meters maximum without de-rating.

11.07 SAFETY

CE & IEC 62040-1

11.08 UPS STANDARD FEATURES

The UPS configuration shall consist of the following standard components and features:

- A. Each UPS should consist of:
 - 1. Rectifier/Charger: Each rectifier/charger shall convert incoming AC power to regulated DC output for supplying the inverter and for charging the battery. The rectifier/charger shall be a high-frequency PWM design, using Insulated Gate Bipolar Transistors (IGBTs). The modular design of the UPS shall permit safe and fast removal and replacement of the rectifier/charger module. The rectifier/charger module shall also provide the following:
 - a) The rectifier shall be capable of drawing power from the utility with a power factor of 0.99 under nominal conditions.
 - b) The rectifier shall feature protection circuitry that prevents the IGBTs from sourcing current in excess of their published ratings.
 - 2. Inverter: Each inverter shall feature an IGBT pulse-width-modulation (PWM) design with high speed switching. The inverter shall also have the following features:
 - a) The inverter shall be capable of providing the specified quality output power while operating from any DC source voltage (rectifier or battery) within the specified DC operating range.
 - b) The modular design of the UPS shall permit safe and fast removal and replacement of the inverter module.

- c) The inverter shall feature protection circuitry that prevents the IGBTs from sourcing current in excess of their published ratings.
- B. **STATIC BYPASS:** The bypass shall serve as an alternative source of power for the critical load when an abnormal condition prevents operation in normal mode. The bypass shall consist of a fully rated, continuous duty, naturally commutated static switch for high-speed transfers. The bypass shall feature the following transfer and operational characteristics.
1. Transfers to bypass shall be automatically initiated for the following conditions:
 - a) Output overload period expired.
 - b) Critical bus voltage out of limits.
 - c) Internal over temperature period expired.
 - d) Total battery discharge.
 - e) UPS failure.
 2. Uninterrupted automatic re-transfer shall take place whenever the inverter is capable of assuming the critical load.
 3. Uninterrupted automatic re-transfers shall be inhibited for the following conditions:
 - a) When transfer to bypass is activated manually or remotely.
 - b) In the event of multiple transfers/re-transfer operations the control circuitry shall limit “cycling” to three (3) operations in any ten-minute period. The fourth transfer shall lock the critical load on the bypass source.
 - c) UPS failure.
 4. Uninterrupted manual transfers shall be initiated from the control panel. Uninterrupted manual transfers to bypass and from bypass shall be possible with the inverter logic. During manual transfers to bypass mode, the inverter must verify proper bypass operations before transferring the critical load to the bypass.
 5. All transfers to bypass shall be inhibited for the following conditions:
 - a) Bypass voltage out of limits (+/- 10% of nominal)
 - b) Bypass frequency out of limits (+/- 3 Hz, adjustable, factory set)
 - c) Bypass out of synchronization
 - d) Bypass phase rotation / installation error
 6. Static transfer time: No break, complete in less than 4ms.
 7. The bypass shall be manually energized using the control panel
- C. **Monitoring and control components:** The following components shall provide monitor and control capability:
1. Control panel with status indicators.
 2. Alarm and metering display.

3. Building alarm monitoring.
 4. Communication ports.
- D. Battery management system: The UPS shall contain a battery management system which has the following features:
1. The battery management system shall provide battery time remaining while operating in normal mode and battery mode. Battery time available information shall be displayed real-time, even under changing load conditions. Upon commissioning, battery runtime information shall be available.
- E. Wiring Terminals: The UPS module shall contain mechanical compression terminals for securing user wiring to the following locations:
1. Rectifier/charger input connections (3-wire plus ground)
 2. Bypass input connections (3-wire plus ground for 3-wire plus ground output configuration (415Vac), or 4-wire plus ground for 4-wire plus ground output configuration)
 3. DC link connections for battery cabinets (positive and negative).
 4. AC output connections (3 or 4 wires plus ground).

11.09 UPS SYSTEM OPTIONS AND ACCESSORIES

The UPS system shall consist of the following options and accessories as required:

- A. SNMP Network Adapter and UPS Power Monitoring Software (OPTIONAL): SNMP adapters shall provide a communications interface between the UPS module and SNMP-compatible network management systems. This capability shall allow the unit to be monitored remotely over an Ethernet network using a standard web browser.
- B. MODBUS CARD – Required with each UPS.
- C. Battery Rack: The battery rack shall house valve regulated, high-rate discharge, lead-acid batteries which provide energy to the support the critical load during a momentary loss of input power to the rectifier. The battery rack shall have the following features:
 1. Power wiring internal to each battery cabinet shall be using Nyvin cables.
 2. Each battery rack shall feature a DC rated circuit breaker (inbuilt or wall mount). The circuit breaker within the battery rack shall only provide protection to the battery string within that battery
 3. Power and Control wiring between the battery rack and the UPS
 4. BATTERY TYPE: 12V, VRLA SMF batteries
 5. Battery Back-up: As per BOQ

11.10 UNINTERRUPTIBLE POWER SUPPLY RATINGS AND OPERATING CHARACTERISTICS

A Each UPS Continuous Ratings.
Please refer BOQ for ratings.

A. Rectifier/charger input:

1. Nominal three phase input voltage: 415 VAC:
3-wire plus ground input
2. Operating input voltage range: + 10%, - 15% of average nominal input voltage without battery discharge.
3. For 50Hz systems, operating input frequency range shall be 45 to 55Hz.
4. Input power factor 0.99 lagging.
5. IGBT Based Technology
6. Normal input current limit: The UPS shall have the following programmable input current limit settings while operating in normal mode:
 - a) Rectifier/charger input current limit shall be adjustable from 100 to 115% of full-load input current.
 - b) Battery input current limit shall be adjustable from 10% to 15% of the UPS full load input current regardless of the actual load on the UPS.
7. On generator input current limit: The UPS shall have the following programmable input current limit settings while operating in normal mode on generator:
 - a) Rectifier/charger input current limit shall be adjustable from 100% to 115% of full-load input current.
 - b) Battery recharge input current limit shall be adjustable from 10% to 15% of the UPS full load input current regardless of the actual load on the UPS.
8. Input current total harmonic distortion (THD) shall be less than 5.0% @ 100% linear load condition.
9. Power walk-in: Ramp-up to full utility load adjustable from 3 seconds to 60 seconds.
10. Each UPS should be offered with Output Isolation Transformer, external to UPS. Isolation Transformer should be 1:1 Winding, H Insulation Class, Indoor Type, Air Cooled, Delta / Star Type.

B. Bypass input:

1. Synchronizing bypass voltage range shall be +/- 10% of average nominal input voltage.
2. Synchronizing bypass frequency range is centered on the nominal frequency.

3. Bypass and rectifier inputs can be supplied from out of phase sources if required.
4. Input surge withstand capability: The UPS shall be in compliance with IEEE 587 (ANSI C62.41), category A & B (6kV) **or better**

C. Rectifier/charger output:

1. Nominal DC voltage shall be as per vendor design.
2. Steady state voltage regulation shall be +/- 0.5%.
3. Voltage ripple shall be less than 0.5% (peak-to-peak).
4. Capacity: The rectifier/charger shall support a fully loaded inverter and recharge the battery to 90% of its full capacity within 10 times the discharge when input current limit is set at maximum.
5. Low line operation: The rectifier/charger shall be capable of sharing the DC load with the battery when the input voltage falls below the specified operation input voltage range, the on battery indicator shall enunciate operation in this mode.
6. DC sensing: Redundant DC voltage sensing methods shall be incorporated for providing battery over-voltage protection.
7. Battery charger characteristics: The UPS battery charging system shall have the following characteristics:
 - a) The charger shall be capable of being configured for several charge modes including:
 - (1) A charging mode that increases battery life by allowing the battery to rest, reducing positive plate corrosion
 - (2) A charging mode floating the battery at a set level, which can be adjusted via software, used for flooded cell applications
 - (a) Nominal Float Voltage: 2.25 V per cell.
 - (b) Equalizing Voltage: 2.38 V maximum per cell (adjustable).
 - (c) Automatic (time based) or manual (user initiated) equalization available
 - b) UPS will automatically adjust battery shutdown based upon loading and battery capacity.
 - (1) The UPS shall automatically adjust the final discharge voltage between 1.67 and 1.75 Volts per cell based on the existing load and the rate and length of discharge.
 - (2) The absolute minimum operational voltage is 1.67 V per cell (adjustable).
8. The UPS will automatically disconnect the battery system in case of full battery discharge followed by prolonged utility AC voltage failure. The time window before battery disconnection occurs shall be programmable for both time and voltage.

D. UPS output in normal mode

1. 415V, 3-phase, 3-wire or 4 wire plus ground. Output wiring configuration is based upon input wiring configuration for systems without internal transformers.
2. Steady-state voltage regulation (in inverter) shall be within +/- 1% average from nominal output voltage.
3. Transient voltage response shall be < +/- 5% from nominal voltage for 100% load step, full load re-transfers and full load drop on battery.
4. Transient voltage recovery shall be 25ms to within +/- 1% of steady state.
5. Linear load harmonic distortion capability: Output voltage THD of less than 3% for 100% linear load.
6. Non-linear load harmonic distortion capability: Output voltage THD of less than 5% for 100% non-linear load when tested using the non-linear load described in IEC 62040-3 connected line to neutral.
7. Manual output voltage adjustment shall be +/- 3% from nominal.
8. Line synchronization range shall be +/- 3Hz, adjustable to +/- 5Hz.
9. Frequency regulation shall be +/- 0.01Hz free running.
10. Frequency slew rate shall be 1 Hz/second maximum (adjustable).
11. Static transfer time: No break, completed in less than 4ms.
12. EMI Suppression: The UPS shall meet IEC 62040-2, EN50091 Class A restricted limits
13. Efficiency: The UPS efficiency in Online Mode should be
 >= 92% for UPS Rating <= 60 KVA
 >=94% for UPS Rating >60 KVA

11.11 MECHANICAL DESIGN

- A. Ventilation: The UPS shall be designed for forced-air cooling. Air inlets shall be on the front of the unit. Air outlets shall be on the top / back as per OEM.
- B. Cable entry: Standard cable entry for the UPS cabinet shall be through either the enclosure bottom or top. A dedicated wireway shall be provided within the UPS cabinet for routing user input and output wiring.
- C. Front access: All serviceable subassemblies shall be modular and capable of being replaced from the front of the UPS (front access only required). Side or rear access for installation, service, repair or maintenance of the UPS system shall not be required.

11.12 CONTROLS AND INDICATORS

- A. Microprocessor controlled circuitry: The UPS controls shall have the following design and operating characteristics:
 1. Fully automatic operation of the UPS shall be provided through the use of microprocessor controlled Digital Signal Processing. DSP shall eliminate

variances from component tolerance or drift, and provide consistent operational responses.

2. All operating and protection parameters shall be firmware controlled, thus eliminating a need for manual adjustments. The logic shall include system test capability to facilitate maintenance and troubleshooting. Printed circuit board replacement shall be possible without requiring calibration.
 3. Start-up and transfers shall be automatic functions.
- B. Digital Front Panel Display: The LCD shall display UPS status, metering, battery status, alarm/event queue, active alarms and UPS configurations. The front panel display shall show a system mimic diagram with an outlined power path, current operating mode and event logs.
- C. Control Panel Indicators: The UPS control panel shall provide the following monitoring functions with indicator LED's:
1. NORMAL: This shall indicate that the commercial AC utility or generator source is supplying power to the rectifier and the inverter is supporting the critical load. A text message shall indicate if the bypass line is not within tolerance.
 2. BYPASS: This shall indicate that the UPS has transferred the load to the bypass circuit.
 3. BATTERY: This shall indicate that the commercial AC utility or generator source has failed and the battery is supplying power to the inverter, which is supporting the load. A text message shall indicate if the battery charge is low or if the battery is installed but disconnected.
 4. ALARM: This shall indicate that the UPS detects an alarm condition, outlined in detail in the operator's manual.
- D. Control Panel Controls: The UPS control panel shall provide the following functions from front panel push buttons:
1. EVENTS: Displays the list of Active System Events and a historical log of system events. Historical logs shall include a detailed time stamped list.
 2. METERS: Displays performance meters for the system or critical load. When selected, the front display shall show individual screens of input parameters, output parameters or bypass parameters including; voltage, current and frequency. In addition, the battery display shall show runtime remaining.
 3. CONTROLS: Displays a System Controls screen. Allows selection of operating mode, normal, bypass, charger on/off and Power Module on/off.
 4. SETUP: Allows display contrast, date and time information serial communication port configuration and display of firmware revision numbers.
 5. RETURN: Confirms selection or returns to previous screen.

11.13 COMMUNICATIONS

- A. MODBUS Card (Mandatory) is required with each UPS for integration with Building Management System
- B. SNMP Card – (Optional) Should be available for monitoring UPS on LAN/WAN Network

11.14 UPS PROTECTION

- A. Rectifier/Charger and Bypass protection shall be provided through fusing.
- B. Battery protection shall be provided by molded-case circuit for an external battery bank.
- C. Electronic current limiting circuitry and fuses in the Inverter circuit shall provide output protection.
- D. To comply with agency safety requirements, the UPS shall not rely upon any disconnect devices outside of the UPS to isolate the battery rack from the UPS.

PART 3 - EXECUTION

21.15 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

21.15.01 COMMISSIONING

- A. The following procedures and tests shall be performed by Field Service personnel during the UPS startup "as minimum activities"
 - 1. Visual Inspection:
 - a) Visually inspect all equipment for signs of damage or foreign materials.
 - b) Observe the type of ventilation, the cleanliness of the room, the use of proper signs, and any other safety related factors.
 - 2. Mechanical Inspection:
 - a) Check all the power connections for tightness.
 - b) Check all the control wiring terminations and plugs for tightness or proper seating.
 - 3. Electrical Pre-check:
 - a) Check the DC bus for a possible short circuit.
 - b) Check input and Bypass power for proper voltages and phase rotation.
 - c) Check all lamp test functions.
 - 4. Initial UPS Startup:
 - a) Verify that all the alarms are in a "go" condition.

- b) Energize the UPS module and verify the proper DC, walkup, and AC phase on.
 - c) Check the DC link holding voltage, AC output voltages, and output waveforms.
 - d) Check the final DC link voltage and Inverter AC output. Adjust if required.
 - e) Check for the proper synchronization.
 - f) Check for the voltage difference between the Inverter output and the Bypass source.
5. Operational Training: Before leaving the site, the field service engineer shall familiarize responsible personnel with the operation of the UPS. The UPS equipment shall be available for demonstration of the modes of operation.

11.16 WARRANTY

All components of the UPS system shall be covered by a standard one-year warranty.

Manufacturer shall also include On-site user training, installation.

LIST OF APPROVED MAKES FOR ELCTRICAL SYSTEM

Contractor shall use the materials of approved make as indicated below unless specified in BOQ or as approved by the HSCC electrical incharge. The contractor shall ensure the correct selection of the approved make meeting the specifications and application duties. Before placing order for procurement, the sample of approved make shall be got verified for its suitability to the specification and application duty. However, HSCC electrical engineer (approving authority) reserves the right to opt for the best preferred listed make. The contractor shall quote the rates for the material and equipment as per the list of approved makes. In the event of the contractor wants to use alternate makes other than those stipulated for any reason , the contractor can send a proposal after ensuring that what he proposes at the least meets both the quality and safety standard of the stipulated makes, and the financial benefit that will accur to the client. He shall also stand full guarantee to his alternate proposal. The alternate makes can be used only after an approval accorded by the client/HSCC., whose decision will be final in this matter. Any financial implication incurred related with inspection will be borne by contractor.

Note- Approved Main LT Panel manufacture can use their Own Manufactured items for fabrication of panels. Authorized panel builders will not be accepted.

S.No.	ITEM	MAKE
1	11 KV VCB Panel Board/ RMU	Siemens/L&T/ABB/Schneider.
2	Transformer	ABB/GE/ Schneider/Alstom
3	Main LT Panel/ APFC panels /Main AC panel	Siemens/ L&T/ABB/Schneider/ SPC Electro Tech Limited/ Tricolite/Adlec
4	Additional make for APFC Panel	EPCOS
5	Synchronization Panel/AMF Panel	OEM of the DG set or above panel manufacturer as mentioned against s.no.-3
6	Diesel Engine:	Cummins/ Caterpillar/MTU/ Kirloskar oil Engine Ltd /Ashok Leyland/Perkins/Volvo Penta
7	Alternator:	Stamford/ AVK-SEGC/ Leroysoner, NGEF/ Crompton/ Kirloskar
8	Fastener	Hilti/ Fisher
9	Anti-vibration mounting:	Dunlop, Gerb, resistoflex
10	Bus Duct/Rising main	L&T/ABB/Siemens/Schneider/GE/Legrand/C&S
		<ul style="list-style-type: none">• Equivalent makes can be added with price adjustment with the prior approval of Engineer-in-charge

- | | | |
|-----|---|--|
| 11. | Battery: | Panasonic/Hitachi/Cummins/Exide |
| 12. | Automatic Battery Charger: | Max Power/ Voltstat/ |
| 13 | MV panels/Fire panel/AHU Panel | Tricolite/Adlec./Sterling & Wilson / Control & Switchgear/Jacksons Engineers (p) Ltd. /Milestone/ Nitya Electro Control Pvt. Ltd. /SPC Electro Tech Limited/ Risha Control engineers Pvt. Ltd./Neptune/ Zeta |
| 14. | ACB | L &T 'U' Power(Omega)/ Siemens 3WL/ ABB/ Schneider (NW- Master Pact)/GE- Entelliguard |
| 15. | Moulded Case Circuit Breaker | L &T – (D sine/DL) / Siemens-VA/ ABB-TMA/ Schneider (Compact NSX) |
| 16. | Power/auxiliary Contactors, timers, Relay, starters | ABB/ Schneider/ L&T/ Siemens |
| 17. | AMF Relay | wood ward/ Control & switchgear/ |
| 18. | SFU with HRC | L&T/ Siemens/ ABB/ Schneider/GE |
| 19. | Change over switches/Isolators | Schneider / Siemens/ABB/GE/L&T |
| 20. | Instruments (Analog & Digital) | Conzerve/ L&T/ AE/ Siemens/ Minilec/ Rishab/ Schneider/ABB |
| 21 | Timers | Legrand/ L&T/ Siemens/ ABB BCH |
| 22 | Cast resin current Transformers: | AE/ Kappa//L&T/ Rishab |
| 23 | Selector Switches: | L&T-Salzer/KAYCEE/ Siemens |
| 24 | Push button, Indicating Lamps LED: | L&T-Esbee/Siemens/Schinder/Veshno/RAAS/ Rishab |
| 25 | Auto manual changeover switches (3Way) | Kaycee/L&T/ Schnieder/Siemens |
- **Equivalent makes can be added with price adjustment with the prior approval of Engineer-in-charge**

26	MCB distribution Boards	L &T/Hager/Legrand/ Siemens/ Schneider/GE /Havells/ HPL/Philips/MDS
27	RCCB/MCB	L & T / Legrand-DX3/ Siemens / Schenider –Acti 9/GE/ Hager/HPL/Philips/Havells/MDS
28	HT/LT- XLPE cables	CCI/ Universal/Finolex/ Rallison
29	Copper Control cable	CCI/ Universal/Finolex/ Rallison
30	Compression Glands & Lugs	Comet/ Dowells
31	PVC Tape	Steel Grip or approved by HSCC
32	Cable Jointing kit	Raychem / 3M
33.	Cable Trays/ Raceways	OBO/ Legrand/ Cooper/BEC /Pilco Marketing and manufacturing Pvt.Ltd/Profab Engineers
34	Terminal Strips	Elmex/ Connectwell/ Technoplast
35	Light fitting	Philips / GE/ Crompton Greaves/
36	Fancy lights	Kesalec Schreder/ Decon/ and above light fixture against s.no.-35.
37	LED light fitting & Fixture	Philips / GE/ Crompton Greaves
38	Lamps	Philips/ GE/CG
39	MS conduit	BEC/ AKG/ Steel Kraft

- **Equivalent makes can be added with price adjustment with the prior approval of Engineer-in-charge**

40	PVC conduit	Supreme/Prince/Finolex/AKG
41	Conduit accessories MS & PVC	ISI marked
42	Solar Power system	TATA Power Solar, CEL, BHEL, BEL
43	Copper conductor PVC insulated wires, Co-axial , Telephone wires & cables	Finolex/ Havells/ L&T/ RR kabel/ Skytone / Rallison/Batra Henlay/ Bonton/
44	Additional make for telephone wire & cable	Delton
45	Modular Switches & sockets Outlets	Legrand-Myrius or Anti bacterial/L&T Oris/ Schneider -Livia / Philips -Sleek
46	Metal clad Socket outlets With boxes	L & T /Hager/ Siemens/ Schneider/ ABB/Legrand /HPL
47	Lighting protection	Erico/Galaxy electrode /Earth plus
48	UPS system	Schneider- MG , APC/ Eaton Power ware/ Emerson
49	High Mast poles	Crompton Greaves/ Bajaj /Philips
50	Electronic Ballast	Philips/ GE/Crompton
51	Ceiling fans	Crompton Greaves/ Orient/ Usha
52	PC with CPU and monitor etc	HP/ Compaq/Del
53	Auto Transfer switch	Cummins/Emerson/Panasonic
54	Public address system	Bosch/ Bose/ Honey well /Harman/
55	CCTV camera	Honeywell/ Pelco /Bosch/Sony/Axis
56	LCD/LED Monitor	Sony/Panasonic/Samsung/ Toshiba
57	Fire Detection System Addressable	Honeywell-Notifier /Edward/ /Bosch/ Siemens

- **Equivalent makes can be added with price adjustment with the prior approval of Engineer-in-charge**

58	FDA Conventional	a) Honeywell/Bosch or approved by HSCC
59	Portable fire extinguisher	Minimax/Ceasefire/
60	EPABX system	Avaya/ Siemens-unify/Alcatel/Cisco
61	Nurse Call bell system	Category A: Honeywell/Schreak/ Rauland Category B: Daksh, Omnitech and category A above
62	Capacitor	Epcos, Schenider, L&T, Ducati
63	APFC Relay	Epcos, L&T, Biluk, Ducati, Schneider
64	Occupancy Sensor	Philips/ Honeywell/ Schneider/Lutron/Legrand
65	Lifts/ Dumb Waiters/Escalators	Otis / Mitsubishi/ Scheindler
66	BMS, field devices etc	Honeywell-Trend/L&T-Atmos/Siemens/Schneider
67	Lighting Control	Lutron/ Philips/ ABB/ Schneider/ Legrand
68	Chemical Earthing	OBO Bettermann / Erico/Furse / Ingesco
69	Access Control System	Honeywell-Pro-3000/Schneider/Lenel/Cardex
70	Boom barrier	Magnetic/ Somfy/ RIB/FAAC
71	CAT 6 UTP, CAT 6A UTP/STP, Optical Fibre-cable	Molex/Systimax/Panduit
	<ul style="list-style-type: none"> • Equivalent makes can be added with price adjustment with the prior approval of Engineer-in-charge 	

END OF TECHNICAL SPECIFICATION

DETAILED SPECIFICATIONS

SYSTEM DESIGN DATA

1.0 GENERAL

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

2.0 LOCATION

1. Dr. Y. S. Parmar Government Medical College, **Nahan**, Himachal Pradesh.
2. Pt. Jawahar Lal Nehru Govt. Medical College, **Chamba**, Himachal Pradesh.

3.0 SCOPE OF WORK

- 3.1 The work proposed under this tender includes supply, installation, testing & commissioning of independent central air-conditioning systems, pressurisation and ventilation system for the proposed buildings namely Teaching and Hospital Block at Nahan & at Chamba (H.P.) 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 | : | 2 ACPH,
5ACPH for OT's. |
| b) | Window glazing | : | Single/double pane glass |
| c) | Lighting load | : | 1 - 1.5 W/ Sq. ft |
| d) | Occupancy | : | As per attached table |
| e) | Equipment load | : | As per attached Table |
| f) | Roof Insulation | : | The exposed roof of air-conditioned areas shall be insulated with rock wool or equivalent insulation by other agencies.

All non AC areas in corridors and lobbies where ducts are crossing/return being taken to have 50 mm thick insulated boxing. |
| g) | Electrical power supply: | : | 415v/3ph/50Hz, AC power supply |
| h) | Humidity control | : | Considered in OT, ICU only. |

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.
- 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.

4.3 (A) OUTSIDE AMBIENT CONDITIONS at NAHAN

Season	Dry Bulb temp	Wet Bulb temp.
SUMMER:	110 deg F DB	75 deg F WB
MONSOON:	95 deg F DB	80 deg F WB
WINTER:	45 deg F DB	41 deg F WB

4.3 (B) OUTSIDE AMBIENT CONDITIONS at CHAMBA

Season	Dry Bulb temp	Wet Bulb temp.
SUMMER:	105 deg F DB	75 deg F WB
MONSOON:	90 deg F DB	80 deg F WB
WINTER:	42 deg F DB	38 deg F WB

4.4 INSIDE CONDITIONS For OTs 70 deg F DB & RH 50%.

Other Areas 75 +/- 2 deg F DB & RH not exceeding 60%.

5.0 ESTIMATED LOAD

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

TABLE-I

HOSPITAL BLOCK (NAHAN)

SNO.	Space	Area (ft ²)	Occupancy (Nos.)	Equipment Load (KW)	Fresh Air (CFM)	Estimated Loads			
						Summer (TR)	Monsoon (TR)	Winter (KW)	CFM
	-2 FLOOR								
1	PACKING	463	3	0.25	162	3.01	2.58	-3.62	1180
2	STERILIZATION	549	4	1.00	192	4.20	3.53	-4.50	1694
	TOTAL -2F	1011	7	1.25	354	7.21	6.10	-8.13	2875
	GROUND FLOOR								
1	CASUALTY	1818	20	5.00	636	12.26	11.68	-7.17	4757
2	EMERGENCY OT	430	8	6.00	377	6.95	7.76	-0.96	3053
3	ICU	882	10	3.00	309	7.03	7.70	-3.14	3097
4	TSSU	204	1	0.50	72	1.55	1.34	-1.43	629
5	STERILE CR	689	3	0.00	241	3.24	3.08	-3.43	1169
6	DR LOUNGE	140	4	0.25	68	1.47	1.28	-1.38	567
7	CHANGE-M	97	1	0.00	34	0.44	0.44	-0.39	153
8	CHANGE-F	97	1	0.00	34	0.44	0.44	-0.39	153
9	CHANGE CR	334	2	0.00	117	1.76	1.62	-1.93	656
10	CTRL RM CCTV	118	1	0.75	41	1.21	1.05	-0.72	513
11	DR ROOM	194	2	0.25	68	1.15	1.07	-0.92	434
	TOTAL GF	5003	53	15.75	1996	37.51	37.47	-21.85	15179
	SIXTH FLOOR								
1	OT-1	430	8	6.00	430	8.13	9.05	-2.50	3610
2	OT-2	430	8	6.00	430	7.67	8.59	-1.87	3339
3	OT-3	430	8	6.00	430	7.67	8.59	-1.87	3339
4	OT-4	430	8	6.00	430	7.67	8.59	-1.87	3339
5	TSSU	204	1	0.50	82	1.40	1.32	-1.10	542

6	CORRIDOR-1	2227	10	0.25	891	9.83	10.18	-9.46	3306
7	BUFFER	204	2	0.25	82	0.88	1.00	-0.38	284
8	PREPARATION	204	2	0.25	82	0.88	1.00	-0.38	284
9	ANESTHESIA	204	2	0.25	82	0.88	1.00	-0.38	284
10	PRE OP	1151	12	2.00	461	6.10	7.10	-3.24	2135
11	POST OP	839	12	2.00	336	5.38	6.10	-2.84	1974
12	CORRIDOR-2	355	1	0.00	142	1.35	1.50	-1.17	427
13	DR LOUNGE	291	4	0.25	116	1.81	1.74	-1.43	658
14	OT STORE	204	1	0.00	82	0.68	0.81	-0.49	197
15	CORRIDOR-3	344	2	0.00	138	1.19	1.39	-0.87	347
16	NURSES CH-F	226	1	0.00	90	1.24	1.21	-1.17	451
17	NURSES CH-M	161	1	0.00	65	0.52	0.63	-0.35	145
18	DOCTORS CH-F	161	1	0.00	65	0.52	0.63	-0.35	145
19	DOCTORS CH-M	161	1	0.00	65	0.52	0.63	-0.35	145
20	CORRIDOR-4	194	1	0.00	77	0.98	0.94	-1.21	348
21	ICU & ICU LAB	5552	30	8.00	2221	32.54	37.39	-20.43	12884
22	CH & DUTY AREA	409	5	0.25	164	2.58	2.45	-2.31	950
	TOTAL 6F	14817	121	38.00	6960	100.43	111.88	-55.99	39135
	GRAND TOTAL NAHAN	20831	181	55.00	9310	145.15	155.45	-85.97	57188

TABLE-II

HOSPITAL BLOCK (CHAMBA)

HEAT LOAD SUMMARY NEW HOSPITAL BLOCK-CHAMBA								
Space	Area (ft ²)	Occupancy (Nos.)	Equipment Load (KW)	Fresh Air (CFM)	Estimated Loads			
					Summer (TR)	Monsoon (TR)	Winter (KW)	CFM
GROUND FLOOR								
OT	441	8	6.00	460	7.35	8.61	-2.86	2976
ICU	882	16	6.00	368	7.49	7.96	-1.59	3303

CORRIDOR	1259	5	0.00	525	6.08	5.89	-8.73	2167
OT CR	355	2	0.00	148	1.81	1.78	-2.43	651
CH-2	86	1	0.00	36	0.66	0.61	-0.86	263
CH-1	86	1	0.00	36	0.38	0.40	-0.43	124
STORE-1	108	1	0.00	45	0.46	0.48	-0.55	151
DOC-2	108	2	0.10	45	0.99	0.87	-1.25	405
DOC-1	108	2	0.10	45	0.55	0.57	-0.46	187
NURSE	129	2	0.10	54	0.64	0.66	-0.57	214
X-RAY	171	2	2.00	71	2.21	2.02	-1.00	975
ULTRASOUND	108	2	1.00	45	1.06	1.02	-0.27	440
TOTAL GF	3840	44	15.30	1876	29.67	30.88	-20.99	11856
FIRST FLOOR								
MRI	430	3	8.00	179	6.12	5.79	0.19	2752
CH-3	43	1	0.00	18	0.21	0.22	-0.20	69
CONSOLE-2	75	1	3.00	31	1.60	1.62	1.21	743
CSSD STERILE AR	1829	8	4.00	762	11.03	10.72	-11.12	4242
CSSD PACKING AR	1829	8	0.25	762	10.10	9.54	-14.41	3776
X-RAY	430	3	2.00	179	3.59	3.27	-2.97	1487
CH-1	43	1	0.00	18	0.21	0.22	-0.20	69
DARK RM	86	1	0.25	36	0.48	0.50	-0.30	176
CT SCAN	430	3	7.00	179	5.26	5.15	0.66	2323
CH-2	43	1	0.00	18	0.21	0.22	-0.20	69
CONSOLE-1	86	1	3.00	36	1.64	1.66	1.15	756
ULTRASOUND	215	2	1.00	90	1.84	1.65	-1.65	759
FLURPSCOPY	215	2	1.00	90	1.53	1.50	-0.95	607
UPS	215	1	4.00	90	3.05	2.86	-0.11	1376
WAITING,REG,CR	2087	50	0.75	870	14.04	12.95	-16.16	5167
TOTAL FF	8059	86	34.25	3358	60.94	57.88	-45.04	24373
SIXTH FLOOR								
OT-1	473	8	6.00	493	7.63	8.68	-3.30	3050
OT-2	398	8	6.00	415	6.73	7.62	-1.71	2736
OT-3	420	8	6.00	437	7.31	8.25	-2.68	3017

CR-1	1076	7	0.00	448	5.72	5.32	-8.35	2088
PRE OP	613	7	1.50	256	3.68	3.80	-2.27	1469
POST OP	699	8	1.50	291	5.09	4.81	-4.76	2188
CHANGE-1	129	1	0.00	54	0.54	0.57	-0.66	178
CHANGE-2	129	1	0.00	54	0.54	0.57	-0.66	178
CHANGE-3	129	1	0.00	54	0.86	0.81	-1.19	337
CR-2	194	2	0.00	81	1.06	1.07	-1.26	386
STAFF LOUNGE	237	4	0.15	99	1.35	1.31	-1.50	481
CR-3	377	3	0.00	157	1.59	1.66	-1.93	520
TSSU	194	2	1.00	81	1.26	1.30	-0.45	485
STORE-1	323	1	0.00	135	1.85	1.79	-2.59	705
OT CR	1291	7	0.00	538	5.99	5.92	-8.38	2084
CR-4	990	7	0.00	412	4.98	4.79	-6.79	1773
OT OFFICE-1	129	2	0.15	54	0.95	0.86	-1.07	372
OT STORE-1	129	1	0.00	54	0.54	0.57	-0.66	178
OT STORE-2	129	1	0.00	54	0.54	0.57	-0.66	178
OBSERV GALLERY	237	2	0.15	99	1.27	1.24	-1.54	460
OT OFFICE-2	237	2	0.15	99	1.27	1.24	-1.54	460
OT OFFICE-3	237	2	0.15	99	1.27	1.24	-1.54	460
OT OFFICE-4	237	2	0.15	99	1.27	1.24	-1.54	460
OT OFFICE-4	237	2	0.15	99	1.27	1.24	-1.54	460
STORE-2	237	1	0.00	99	1.46	1.27	-2.35	566
ICU	1205	10	3.00	502	8.61	8.28	-7.02	3720
TOTAL 6F	10685	100	26.05	5259	74.66	75.97	-67.92	28990
SEVENTH FLOOR								
OT	473	8	6.00	493	7.24	8.30	-2.35	2822
OT CR	1227	7	0.00	511	4.86	5.41	-5.23	1560
TSSU	194	2	1.00	81	1.38	1.41	-0.55	542
STORE-1	323	1	0.00	135	1.76	1.74	-2.38	659
CHANGE-1	129	1	0.00	54	0.47	0.55	-0.40	139
CHANGE-2	129	1	0.00	54	0.47	0.55	-0.40	139
LOUNGE	194	3	0.15	81	1.40	1.33	-1.58	545

CR-3	387	3	0.00	161	2.01	1.96	-2.60	722
POST OP	473	6	1.00	197	2.86	3.00	-1.73	1140
PRE OP	473	6	1.00	197	3.21	3.20	-2.43	1340
OBSERV GALLERY	603	6	0.15	251	3.30	3.36	-3.61	1199
CR-2	1076	7	0.00	448	5.07	5.17	-6.17	1764
OT OFFICE-2	237	2	0.15	99	0.93	1.08	-0.65	289
OT OFFICE-3	237	2	0.15	99	0.93	1.08	-0.65	289
OT OFFICE-4	237	2	0.15	99	0.93	1.08	-0.65	289
CR-1	990	7	0.00	412	4.38	4.65	-4.79	1475
OT OFFICE-1	129	2	0.15	54	0.87	0.84	-0.81	333
OT STORE-1	129	1	0.00	54	0.47	0.55	-0.40	139
OT STORE-2	129	1	0.00	54	0.47	0.55	-0.40	139
OT OFFICE-5	237	2	0.15	99	1.13	1.20	-1.06	389
OT OFFICE-6	237	2	0.15	99	1.13	1.20	-1.06	389
OT OFFICE-7	237	2	0.15	99	1.13	1.20	-1.06	389
OT OFFICE-8	237	2	0.15	99	1.13	1.20	-1.06	389
OT OFFICE-9	237	2	0.15	99	1.13	1.20	-1.06	389
STORE-2	237	1	0.00	99	1.32	1.24	-1.87	495
ICU	1205	10	3.00	502	7.73	7.95	-4.59	3215
TOTAL 7F	10394	89	13.65	4627	57.69	61.01	-49.55	21183
GRAND TOTAL CHAMBA	32978	319	89.25	15120	222.96	225.75	-183.50	86403

(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)

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

6.0 System Design

(A) HOSPITAL BLOCK (NAHAN)

The total peak load comes out to 155 TR. For this requirement, 3 Nos. 80 TR air cooled scroll chillers are proposed. Out of these, two chillers shall be working and one shall be standby.

Heating load comes out to be 86 KW. For this 100 KW 02 nos. hot water generators are proposed. Out of these, one shall be working and one shall be standby.

(B) HOSPITAL BLOCK (CHAMBA)

The total peak load comes out to 226 TR. For this requirement, 3 Nos. 125 TR air cooled screw chillers are proposed. Out of these, two chillers shall be working and one shall be standby.

Heating load comes out to be 185 KW. For this 200 KW 02 nos. hot water generators are proposed. Out of these, one shall be working and one shall be standby.

(C) TEACHING BLOCKS (at NAHAN & CHAMBA)

Teaching Blocks at Nahan & Chamba both shall be provided with VRV/VRF air-conditioning with cooling and heating mode combined.

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.
- 6.2 Water chilling machines shall work in conjunction with chilled water pumps. The AC plants shall be located in AC plant room except chillers which shall be placed outside the building.
- 6.3 Chilled water produced shall be pumped to various air handling units/ Fan coil units. Chilled water shall be pumped through insulated chilled water pipes installed in ceiling spaces and in vertical risers 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/monsoon re-heating. This is after taking partial credit for the high equipment load inside and the diversity applicable.
- 6.5 The main electrical panel, distribution board & chilled water/ condenser water pumps will be located in the respective plant rooms.
- 6.6 All the AHU's / FCUs on respective floors shall be connected with chilled water pipes coming from the water chilling machines.
- 6.7 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.
- 6.8 A central control console shall be provided with indication lamps and push buttons for remote start/stop of the equipment.

6.9 The main areas of the complex are as under:

- A** OTs
- B** ICUs
- C** OPD
- D** PRE & POST OPERATIVE AREAS
- E** ADMINISTRATION AREAS
- F** PATIENT ROOMS / WARDS etc.

The system adopted for the air-conditioning of OTs shall be as following:

OPERATION THEATRES

- All operation theatres shall have independent air handling unit to prevent cross contamination.
- All OT's shall be designed for re-circulatory system with 5 air changes fresh air except OTs which are on 100% fresh air. .
- The laminar flow air distribution system shall be followed. Air shall be supplied from ceiling level to flow unidirectional up to the operation table. The return air shall be collected from four corners of the room to prevent the contamination from re-circulation in space.
- All ducting for OTs shall be of aluminium because GI duct can cause formation of flakes on contacting moisture that can be carried downstream.
- Both supply and return air shall be ducted.
- Three level filtration shall be adopted with pre-filters, fine filters and HEPA filters of following filtration efficiency :

HEPA Filters 99.97% down to 0.3 μ

Fine Filters 99% down to 3 μ

Pre Filters 90% down to 10 μ

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.

OTs shall be maintained at positive pressure by supplying about 15% more air than return air to prevent any contamination from entering OT space.

- AHUs with HEPA filters shall be designed for high static pressure to overcome high pressure drops

PRE/POST OPERATIVE AREAS/STERILE CORRIDOR/PATIENT WARDS

- AHUs for pre post operative areas shall be provided with pre and fine filters.

7.0 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 up to main Electrical Distribution Panel in A/C plant room.
- 8.4 Soft filtered water supply up to 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 and insulation of boxing in non AC areas.
- 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.

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.

SCROLL TYPE AIR COOLED WATER CHILLING MACHINE

1. SCOPE

Scope of this sub-section comprises the supply, erection, testing and commissioning of Air- cooled hermetic scroll compressor driven chilling machines confirming to these specifications and in accordance with the technical 'schedule of equipment' and 'bill of quantities'.

2. TECHNICAL SPECIFICATIONS

2.1 Chiller

The water chilling machine shall be self contained type consisting of multiple scroll compressors, squirrel cage induction motor, air cooled condensers, chiller, refrigerant piping, wiring and automatic controls all mounted on a steel base frame forming a compact assembly. The water chilling machine shall be complete with full charge of Zero ODP Environmental friendly refrigerant R410A, oil, vibration isolation pads and accessories, factory assembled and tested for rated capacity.

The IKW/TR for part load conditions of 25%, 50% & 75% under operating conditions shall be indicated.

Structure shall be factory assembled and constructed out of formed & powder coated galvanized steel panels.

The air cooled chiller package housing compressor, chiller and condensers shall be mounted on structural foundation. The Contractor shall supply all necessary foundation bolts, nuts, washers, leveling screws, mounting frame or base plate, vibration isolation pads etc. After erection, the unit shall be properly leveled before grouting the foundation bolts and the levels should be shown to the Engineer's representative. All the equipment shall be thoroughly tested and checked for leaks.

Chillers shall be shell and tube and multi-pass type. The shell shall be of welded steel construction fitted with machined steel tube sheets on either ends. End water boxes shall be designed to provide adequate space for water movement such that there is no erosion of the tube ends. End box covers shall be removable, and allow easy access for cleaning the tubes.

The chillers shall either have internally finned copper tubes or tubes with other means for increasing heat transfer surface. The tube shall be supported in the shell by adequate, stiff supports to eliminate vibration and noise. The tube ends shall be mechanically bonded to the tube sheets to prevent leakage of refrigerant gas.

Tubes shall be of minimum 12mm O.D. The chiller shall be tested against leaks with a pressure of not less than 21 Kg/cm² both on the shell and the waterside.

The refrigerant side shall be designed in accordance with ASME standards (Boiler and pressure vessel) code, Section VIII - Division 1. The evaporator shall have a refrigerant relief device to meet the requirements of the ASHRAE 15 safety code for mechanical refrigeration.

Chillers shall be complete with the following accessories:

- a. Thermostatic expansion valves, pilot solenoid valves and filter drier.
- b. Necessary drain valves and vent.
- c. Anti freeze thermostat.
- d. Other standard accessories, necessary for the equipment supplied.
- e. The chiller shall be insulated with factory-installed insulation.

2.2. Condenser

Condensers shall be air cooled type of copper tube and copper fin construction. Copper tube dia shall be minimum 9.5mm. Condenser shall be manufactured to ASME codes for unfired pressure vessels and designed for refrigerant working pressure of 450 psig. Condenser shall be complete with provisions for refrigerant piping connections, shut off valves and any other standard accessory necessary with the equipment supplied. In case of twin compressor system two independent sets of condenser coils shall be incorporated. The condenser coils shall be arranged in staggered rows and shall be expanded into super slit aluminum fins to achieve superior efficiency. The fins shall have hydrophilic coating.

The condenser fans shall be directly driven by a motor and positioned or vertical air discharge. The draw-through design provides uniform airflow over the entire condenser coil shall be, thus ensuring proper condensation throughout the coil. The condenser fan motors shall be of totally enclose squirrel case type with IP-55 type protection and shall be designed for outdoor operation in high ambient temperatures. They shall operate on 415 Volts, 3 Phase, 50 Hz supply.

2.3. Compressor

- 2.3.1 Chiller packages shall be provided with Hermetic Scroll compressors. The compressor shall be hermetically sealed having an integral cast iron frame & cast iron scrolls with a sight glass & an oil adjustment port. The compressor shall be internally lubricated with a highly refined, low foaming, mineral oil and should be provided with a crankcase heater.

2.4. Compressor Motor

- 2.4.1 The compressor motor should be hermetic, refrigerant gas cooled with inherent all phase protection and shall be suitable for 415 V (+/-10%), 3 phase, 50 cycles AC supply.
- 2.4.2 Motor shall be screen protected drip proof squirrel cage induction type, designed and guaranteed for continuous operation at name plate rating and motor to be suitable for the refrigerant being used. Temperature sensor shall be provided in

motor winding to protect the motor for high temperature rise.

2.5. Starter for compressor motor

- 2.5.1 The starter for the motor shall be automatic Soft type with tappings to limit starting current, within 2 times the full load current.
- 2.5.2 Unit mounted pre-wired & pretested with factory settings Starters shall include all necessary safety devices i.e. Overload relays, under voltage release and single phase preventing device.
- 2.5.3 The motor starter shall be factory mounted and fully wired and factory tested during the run test of the unit. The starter shall have a metal nameplate showing Manufacturer's identifying, serial number, maximum full load amps, and maximum overload trip setting. Starter shall have affixed to the inside of the door complete, as built, wiring scheme showing all accessory items.

2.6. Capacity Controls

The compressors shall have an automatic regulating capacity from 100% to 25%. In case of multiple compressors, sequencing of compressors shall be provided to allow the compressors to start at a time lag of 3-4 minutes.

2.7. Fans

- 2.7.1 The fans shall be dynamically and statically balanced, direct drive, corrosion resistant glass fiber reinforce composite blades molded into low noise, providing vertical air discharge from extended orifices for efficiency and low sound. Guards shall be made from heavy gauge, steel wire epoxy oven baked painting.
- 2.7.2 The Fan Motors shall be of High efficiency, direct driven, 6 Pole 3 phase, insulation class "F". Totally Enclosed Fan Cooled (TEFC), rigid mounted, with double sealed, permanently lubricated, ball bearings.

2.8 Control Panels

- 2.8.1 The chiller shall be provided with a factory installed and wired micro processor based rain tight control panel. The control panel shall be provided with necessary TPN isolator for termination of incoming power cable. A contactor shall be included in the control centre for each compressor and a pair of fan motors.
- 2.8.2 The control system shall automatically control the operation of the unit from the time the unit is started, through the operating period, until the unit is stopped. The internal components shall be arranged for easy access. The panel shall incorporate necessary interlocking between equipment as required. The motor control centre should include safety devices to protect the unit from mal functions. These controls should shut down the unit and signal the operator with their respective lights. The protective controls shall be as listed hereunder:
 - i. High condenser pressure cutout.

- ii. Low oil pressure cutout.
 - iii. High oil temperature cutout.
 - iv. High discharge temperature cutout.
 - v. Solid state motor over current cutout.
 - vi. Solid state low evaporator temperature control.
- 2.8.3 The Software shall be stored in non-volatile memory, with programmed set-points retained in lithium battery backed real time clock (RTC) memory for minimum 5 years.
- 2.8.4 Liquid crystal display, descriptions in English, numeric data in English (or Metric) units. Sealed keypad with sections for Set points, Display/Print, Entry, Unit Options and clock, and On/Off Switch.
- 2.8.5 **Programmable Set-points:** Display language; chilled liquid temperature set point and range, remote reset temperature range, manual override for servicing, low and high ambient cutouts, number of compressors, low liquid temperature cutout, low suction pressure cutout, high discharge pressure cutout, anti-recycle timer (compressor start cycle time), and anti-coincident timer (delay compressor starts).
- 2.8.6 **Display Data:** Return and leaving liquid temperatures, low leaving liquid temperature cutout setting, low ambient temperature cutout setting, outdoor air temperature, English or metric data, suction pressure cutout setting, each system suction pressure discharge pressure (optional), anti-coincident system start timer condition, compressor run status, no cooling load condition, day, date and time, daily start/stop times, holiday status, automatic or manual system lead/lag control, lead system definition, compressor starts/operating hours (each), status of hot gas valves, evaporator heater and fan operation, run permissive status, number of compressors running, liquid solenoid valve status, load and unload timer status, water pump status (optional).
- 2.8.7 **System Safety:** Shall cause individual compressor systems to perform auto shut down; for high discharge pressure, low suction pressure, high pressure switch, and motor protector. Compressor motor protector shall protect against damage due to high input current or thermal overload of windings.
- 2.8.8 **Unit Safety:** Shall be automatic reset and cause compressors to shut down if low ambient, low leaving chilled liquid temperature, under voltage, and flow switch operation. Contractor shall provide flow switch and wiring per chiller manufacturer requirements.
- 2.8.9 **Alarm Contacts:** Low ambient, low leaving chilled liquid temperature, low voltage, low battery, and (per compressor circuit): high discharge pressure, and low suction pressure.
- 2.8.10 Manufacturer shall provide any controls not listed above, necessary for automatic chiller operation. Mechanical Contractor shall provide field control wiring necessary to interface sensors to the chiller control system.

2.9 Power Panels

- 2.9.1 Rain tight, powder painted steel cabinets with hinged, latched, and gasket sealed outer doors. Provide main power connection (s), control power connections, compressor and fan motor start contactors, current overloads, and factory wiring. Power supply shall enter unit at a single location, be 3-phase of scheduled voltage, and connect to unit terminal blocks. Exposed compressor, control and fan motor power wiring shall be routed through liquid tight conduit.
- 2.9.2 Service life: All equipment, cables and wiring shall be designed, manufactured and installed so as to secure a service life of minimum 20 years.
- 2.9.3 Switchboards, equipment, and components shall be rated for operation in ambient temperatures of 50 deg C and humidity up to 75%.

2.10 **Refrigerant Circuit**

The unit shall consist of copper refrigerant piping, independent refrigerant circuits for multi compressor unit. Each refrigerant circuit shall include: liquid line shutoff valve with charging port, filter-drier, solenoid valve, sight glass with moisture indicator, thermostatic expansion valves, and flexible, closed-cell foam insulated suction line.

3. **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.

4. **Painting**

The AC contractor shall be responsible to restore the equipment to original condition in case of any scratches or damages to the equipment up to the handing over the same to the owner.

5. **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 up to 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.

SCREW TYPE AIR COOLED WATER CHILLING MACHINE

1.0 **General**

The Screw Type water chilling units shall be packaged factory assembled including evaporator, air-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.

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 (Air Cooled Type)

Each unit shall have air cooled multipass condenser coils with aluminium fins suitable for coastal areas and internally grooved copper tubes, fitted with safety valve, purge valve, liquid line valve and charging connection.

The cooling coil shall be of seamless copper tubes, not less than 0.44 mm thick and 12mm o.d. the coil shall have corrugated aluminium fins. The fins shall be spaced by collars forming integral part of the fins. The tubes shall be staggered in the direction of air flow. The fins shall be uniformly bonded to the tubes by hydraulic / mechanical expansion of the tubes.

The coils shall be tested against leaks at air/ gas pressure of not less than 2 times the operating pressure. This pressure shall be maintained for a period of 2 hours. No drop should be observed indicating any leaks.

The In/ Out refrigerant headers shall be of heavy class copper, to connect all the tubes.

The condenser shall be complete in all respects and include supports for mounting, refrigerant in and out connections, purge valve, safety valve, liquid line valve and charging connections.

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.

AIR HANDLING UNITS

1. 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. Air Handling Units: (Double skin type)

The air handling units shall be double skin, fully enclosed, sectionalised type construction, draw-thru type and shall include mixing section, coil section, fan section, filter section with filters etc. The unit shall be of floor mounted design installed on spring/vibration isolators/mountings for limiting vibration to the civil structures.

2.1 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 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 and fan outlet velocity shall not exceed 1800 fpm. 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 0.5 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. For coastal areas the fins shall be phenolic coated and for 100% fresh air application fins shall be hydrophilic type. Fin spacing shall not exceed 5 fins per cm. The cooling coil shall be AHRI / Eurovent certified. 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. Min.300 mm distance shall be maintained between the coils. 6 row coils shall be 4+2 construction and 8 row shall be 4+4 construction.

The water headers shall be of copper to connect all the tubes. The headers shall be

complete with water in/out connections, vent plug on top and drain at the bottom. The coil shall be designed to provide water velocity between 0.6 to 1.8 m/s (2 to 6 fps).

2.3 **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.

2.4 **Housing/ Casing**

The casing shall be of sandwich panels fixed on modular frame design The frame work shall be of extruded aluminium hollow section duly powder coat painted/ anodized fitted with extruded Aluminum corner pieces and insulated with 25 mm PUF pressure injected having density 40 Kg/m³ insulation. The structure shall be having thermal break profile for total unit. Panels shall be made of 25 mm thick (overall) sandwich type with injected polyurethane foam insulation for rigid non-vibrating construction. The insulation shall not absorb moisture and should be rot resistant. The panels shall be flush mounted to the casing with no sharp edges/corners. They shall be rapid access type fitted from inside with Allen screws to have flush finish from outside. The sealing of frame to panel shall be by means of non-hygroscopic seal compressed between the panel and the aluminum frame channels to prevent cold tracking and air leakage between panel & frame. The outer wall shall be of pre coated CRC sheet of 0.8 mm thickness chemically treated, having scratch free pre plasticized coating and 0.8 mm GI inner sheet. The AHU shall be provided with electrical power/control junction box on external side of the unit conveniently mounted for cable connections.

Frame work for each section shall be bolted together with non hygroscopic 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 1.25 mm thick SS 304 sheet with necessary slope to facilitate fast removal of condensate. It shall be isolated from the bottom floor panels through 15 mm thick PUF insulation.

2.5 **Mixing Box**

The construction of this section is same as unit but will have airfoil blade design opposed blade dampers for Return Air, Fresh Air and Exhaust Air as may be required. The casing and frame shall be same as the casing of AHU. The insulation shall not absorb moisture and should be rot resistant. The panels shall be flush mounted to the casing with no sharp edges/corner. They shall be rapid access type fitted from inside with Allen screws to have flush finish from outside. The sealing of frame to panel shall be by means of non-hygroscopic seal compressed between the panel and the aluminum frame channels to prevent cold tracking and air leakage between panel & frame. The outer wall shall be of galvanized sheet chemically treated, having scratch free pre plasticized coating and pre coated GI inner sheet.

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.

2.6 Controls

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

2.7 Fresh Air Controls

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

2.8 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 valves 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.

-Ports shall be provided across fine and HEPA filter with Magnehlic gauges to measure pressure drop with bibcock. (Included in AHU's)

2.9 **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.

2.10 **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.

3. **Ceiling Suspended Air Handling Units: (CSU)**

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 0.5 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 pipe 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.

3.1 **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).

3.2 **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.

3.3 **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.

3.4 **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.

3.5. **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.

4.0 **FILTERS**

4.1 **General**

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

4.2 **Pre-filters (fabric type)**

Synthetic fibre Pre-filters shall be in light weight aluminium framed with non woven synthetic fibre replaceable media minimum 50 mm thick, shall be provided on suction side of AHU as standard equipment with the unit. These filters shall have the 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.

4.3 **Fine filters (MERV-14)**

Microvee filters shall be of dry type. Filters media shall be made from washable non woven 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 after the coils. Filters shall be designed to remove particle down to 3 micron size and with efficiency of 99 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 and fan section and are always backed by pre-filters provided on the suction side of the AHU. Face velocity across these filters shall not exceed 500 FPM. They shall be capable of being replaced or removed for servicing without the use of special tools.

4.4 **High Efficiency Particulate Absolute (HEPA) Filters (MERV-17)**

HEPA filters shall be made in extended surface configuration of deep space folds of sub micron glass fibers. 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 Filter section of the AHU after fan section 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 MS 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. Face velocity across these filters shall not exceed 500 FPM.

VARIABLE REGRIGERANT FLOW SYSTEM

1.0 SYSTEM DESCRIPTION:

The VRV/VRF System should be air cooled, split type air conditioning systems consisting of modular condensing units connected to multiple indoor units, each having the capability of individual set point control. Each modular condensing unit should incorporate inverter scroll compressors to obtain 10% to 100% step less capacity control for enhanced Power saving. The indoor units should be provided with Cordless Remote Control as a standard accessory.

The VRV/VRF units shall be capable of operating within a wide range of ambient temperatures. The Condensing units should be capable of provide cooling within an ambient range of -5 Deg. C to 50 Deg. C DB and heating in the range -10 Deg. C to 15 Deg. C DB.

The COP value should be at least 3.49 & 4.5 at 100% & 50% load respectively. The contractor has to submit the certificate from OEM confirming the COP values. Each outdoor unit shall have variable inverter technology. Each module should not be more than 18 HP and beyond 36 HP there should be minimum 3 modules. Each module must have at least one variable compressor.

2.0 REFRIGERANT:

The Entire Condensing unit and Evaporating unit should be factory assembled and tested. The units should come with an initial charge of refrigerant R410a from the factory. Any additional required refrigerant shall be added at site free of cost and loss of refrigerant due to defect in equipment or workmanship shall also be filled up free of cost during execution and guarantee period.

3.0 REFRIGERANT PIPING DISTANCE LIMITS:

To be capable of refrigerant piping runs up to 150 m between the condensing unit and indoor units with 50m level difference without any oil traps or double risers. The oil Equalizing line should be inside the Condensing unit, to avoid 'inverted' oil traps at site. The level difference between fan coil units connected to the same refrigerant circuit can be extended to 15m.

REFRIGERANT PIPEWORK:

The scope of Refrigerant Piping work shall include Supply, installation, testing and commissioning of all interconnecting pipe-work between the condensing unit & indoor units. Refrigerant quality seamless copper tubes with brazed connections and the appropriate Distribution joints and headers shall be used. The piping should be routed at site in such a manner, that brazed joints in the Refrigeration Piping are kept to a minimum. The air-conditioning system supplier shall design sizes and erect proper interconnections of the complete refrigerant circuit.

JOINT ORIENTATION:

Proprietary Distribution refrigeration pipe joints and headers shall be installed in an appropriate orientation to enable correct distribution of refrigerant. The

Distribution joints shall be factory insulated with pre-formed sections of expanded Polystyrene / equivalent.

CLEANLINESS OF PIPING:

All pipe-work must be kept clean and free from contamination to prevent breakdown of the system. All pipe ends shall be kept sealed until immediately prior to making a joint.

PRESSURE TESTING:

After complete installation of refrigerant, pipe work shall be pre-pressure tested and repaired if necessary and further pressure tested to 3,800 Pa, to hold for a minimum 24 hours with dry nitrogen prior to insulating the joints. After satisfactory testing, the refrigerant pipe shall be evacuated and dehydrated to (- 755 MM HG) and held for 24 hours depending on the pipe length.

ADDITIONAL CHARGE:

Additional refrigerant charge weight must be calculated based on the actual length of the refrigerant pipe work. The refrigerant charging process must be carried out with an appropriate charging station and under supervision of Consultancy.

PIPING INSULATION:

All suction lines in the Refrigerant pipe work shall be insulated with as specified to avoid condensation. The whole of the liquid and suction refrigerant lines including all fittings, valves and strainer bodies, etc. shall be insulated with 19mm /13 mm thick elastomeric nitrile rubber.

FIXING PIPE WORK:

Pipe works shall be fixed supported at a minimum of 2 metre centers suitable saddling arrangement. The exposed Refrigerant pipes on the terrace shall be covered with openable GI Cable trays.

4.0 INDOOR UNITS:

The indoor units shall be hi-wall type as shown in drawings. All indoor units shall be provided with Cordless Remote controls for ease of operation.

ELECTRONIC EXPANSION VALVE

Each indoor unit shall be fitted with an electronic expansion valve to control the refrigerant flow in response to the load variations in the room. The electronic expansion valve is to be controlled via a computerized control sensing the return air temperature, refrigerant inlet and outlet temperatures. During the cooling operation the electronic expansion valve shall control the refrigerant superheat degree at the evaporator.

INDOOR UNIT FANS

Shall be direct driven, DIDW multi-blade type and statically and dynamically balanced to ensure low noise and vibration free operation. The noise level shall not exceed 42 dbA.

COOLING COILS

Shall be direct expansion type constructed from copper tubes expanded into aluminium fins to form a rigid mechanical bond.

SUPPLY AIR DISCHARGE LOUVERS

The indoor units shall be provided with auto swing type supply air louvers for indoor units. The louvers shall be capable of providing continuous swing operation or to be fixed in any direction required.

UNIT CONTROL BOARD:

It shall include in the indoor unit a printed circuit board complete with, address switches for a variety of operation controls, emergency operation switch and fault / operation indication LED's. The fan motors shall be thermally protected.

UNIT CASING:

The indoor unit casing (ceiling mounted units) shall be fully insulated and sealed to prevent condensation.

CONDENSATE DRAIN:

The Drain connection of each indoor unit to the main header should be of Min. 25/32 mm dia. The header pipe should be of 40mm dia. The drain pipe should be of hard PVC, whereas the connection of the indoor unit to the hard PVC pipe / GI pipings shall be with flexible braided pipe. The drain piping should be insulated with fire retardant type 9 mm thick tubular nitrile Rubber Elastomeric insulation and the cassette type units shall be provided with condensate drain water pump it should lift the water to the drain headers automatically.

UNIT CONTROL:

In case of individual and group control, set the addresses of each indoor unit to minimize commissioning time. In case of centralized control, set the addresses by the remote controller.

CONDENSING UNITS:

To be fully weatherproofed, factory assembled and pre-wired with all necessary electronic and refrigerant controls. Construct the casing from mild steel panels coated with a baked enamel finish and powder coatings. The condenser coil fins shall be provided with a corrosion resistant finish.

MODULAR DESIGN:

Make provision for side by side installation by the modular design of the condensing units. Each module should not be more than 18 HP and beyond 32 HP there should be minimum 3 modules. Each module must have at least one variable compressor.

FAN MOTOR SPEED CONTROL:

The condensing unit fan motors to have at least two speed operations to maintain constant head pressure control in all ambient temperatures and modes of operation.

COMPRESSORS:

Provide highly efficient hermetic scroll type compressors. Provide the Digital

Scroll/Inverter compressor with electronic controls, capable of loading and unloading to follow the variations on cooling and / or heating loads. The microprocessor panel should incorporate control for precise monitoring of status of the system. The inverter shall be IGBT (Insulated gate bipolar transistor) type to prevent electromagnetic interference & conversion losses for efficient and quiet operation. All parts of compressor shall be sufficiently lubricated. Oil heater shall be provided in the compressor casing.

HEAT EXCHANGERS:

The heat exchanger shall be constructed from seamless copper tubes rigidly mechanically bonded to Aluminium fins to form a cross fin coil. Treat the Aluminium fins with an anti-corrosion film.

REFRIGERANT CIRCUIT:

The refrigeration circuit for the condensing units shall be completed with refrigeration compressors, motors, fans, condenser coils, electronic expansion valve, solenoid valves, 4 way valve, distribution headers, capillaries, filters, shut down valves, service ports, receivers and accumulators and all other components which are essential for safe and satisfactory operation.

SAFETY DEVICES:

Following safety devices shall be provided as a part of the outdoor unit. High pressure switch, fuses, crank case heater, fusible plug, over current protector.

OIL RECOVERY:

The unit shall be equipped with an oil recovery system to ensure stable operation for systems with long refrigerant piping. The oil recovery system shall be operated after the first hour of operation and then every consecutive 4 hours of operation. High efficiency oil separators shall be fitted to the discharge side of the compressor together with factory fitted oil equalization system.

SELECTION SWITCHES:

Shall fit the condensing unit printed circuit board (PCB) with selection switches for the length of pipe work, emergency operation switches and service mode switches, together with LED indications for operation / fault indications.

CONTROL:

System shall use computerized control to maintain a correct form of temperature. For the indoor units incorporate an on /off switch, fan speed selector, thermostat setting and liquid crystal display which indicates temperature setting. Operational mode, malfunction codes etc.

INDOOR UNIT CONTROL:

IT shall be accomplished by individual controllers for each indoor unit.

FAULT DIAGNOSIS:

The system shall be equipped with a diagnostic function for quick and easy maintenance and service.

CENTRAL REMOTE CONTROLLER:

A multi-functional centralized controller (Central Remote Controller) shall be supplied as specified in price schedule and bill of quantities.

- It shall be able to control up to 64 zones or 64 groups (each group consists of Max. 16 units) or 128 nos. of indoor units with the following functions:-

- a) Temperature setting for each zone, or group or indoor unit.
- b) On/off as a zone or individual unit.
- c) Indication of operating condition
- d) Select one of 10 operation modes for each zone.

- The controller shall have wide screen liquid crystal displays and wired by a non-polar 2 wire transmission cable to a distance of 1 km away from the indoor unit.

DX TYPE AIR COOLED PRECISION UNITS

1.1 General:-

The room air-conditioning system shall be a floor discharge unit designed specifically for high sensible heat ratio applications such as Server, Computer rooms and UPS room etc.

Each unit shall be capable of providing sensible cooling capacities at rated ambient temperatures with adequate airflow. Each unit shall be capable of providing actual cooling capacity as mentioned in the schedule of quantities.

Inside Conditions: - 22+ 1 0C and relative humidity is 50 + 5% RH.

The system shall contain Scroll compressor, Evaporator, Humidifier, Condenser and an Externally Equalized Thermostatic expansion valve (TXV) all of which shall be contained within the cabinet of the unit.

1.2 Cabinet Construction:-

The frame shall be constructed of Galva bond steel & shall be double skin type. The external panel shall be constructed of 1.2mm zinc coated sheet steel. Front, rear and end panels shall be fitted with 25mm glass fiber insulation, fire rated .The cabinet shall be powder coated and have a textured finish. The hinged front panel shall be removable and include captive ¼ turn fasteners. The cabinet shall be assembled with pop rivets providing ease of disassembly.

1.3 Filtration:-

The filter chamber shall be an integral part of the system and withdraw able from the front of the unit. Filtration shall be provided by deep V form G4 performance dry disposable media to AS1324.

1.4 Fans:-

The fan section shall be designed for an external static pressure of 25 Pa. The fans shall be located downstream of the evaporator coil and be of the forward curved centrifugal type, double width, double inlet and statically and dynamically balanced to G 6.3DIN ISO 1940 part I. Each fan shall be separately driven by a high efficiency electric motor with an **IP55 enclosure rating**. The drive arrangement shall be self-tensioning and provide for belt replacement without the use of tools. The motor base plate shall include locators to ensure optimum axial alignment of the motor.

1.5 Humidifier:-

Humidification shall be provided by boiling water in a high temperature polypropylene steam generator. The steam shall be distributed evenly into the bypass airstreams of the environment control system to ensure full integration of the water vapor into the supply air without condensation. The humidifier shall be capable of providing 7.5 kg of steam per hour. The humidifier shall have an efficiency of not less the 1.3 kg/kw and be fitted with an auto flush cycle activated on demand from the microprocessor control system. The

humidifier shall be fully serviceable with replacement electrodes. Wastewater shall be flushed from the humidifier by the initiation of the water supply solenoid water valve via a U-pipe overflow system. Drain solenoid valves will not be used.

1.6 Electrical Heating:-

The electric heating elements shall operate at a heat density level not exceeding 60 kW/ m². The low watt density elements shall be of finned tubular steel construction finished in high temperature paint.

The heating circuit shall include dual safety protection through loss of air and manual reset high temperature controls.

1.7 Compressor systems:-

a. Scroll Compressor:-

The compressor shall be of the high efficiency complaint scroll design with an E.E.R. (energy efficiency ratio) of not less than 3.25) at ARI rating conditions. The compressor shall be charged with mineral oil and designed for operation on R407c/ R 410 a. Each compressor shall have internal motor protection and be mounted on vibration isolators.

b. Refrigeration Circuit:-

The refrigeration system shall be of the twin circuit direct expansion type and incorporate hermetic scroll compressors, complete with crankcase heaters. Cooling steps shall be a maximum of 50% of total unit cooling capacity for one and two compressor models. The system shall include a manual reset high pressure control; auto reset low temperature switch, externally equalized thermal expansion valve, high sensitivity refrigerant sight glass, large capacity filter drier and charging/access ports in each circuit. Each refrigeration circuit shall include rigidly mounted isolation valves in the discharge and liquid lines to aid servicing and installation (air cooled units only).

1.8 Evaporator Coil:-

The evaporator coil shall be A-shape coil (for down flow) incorporating draw-through air design for uniform air distribution. The coil shall be constructed of rifled bore copper tubes and louvered aluminum fins, with the frame and drip tray fabricated from heavy gauge aluminum. All metal parts in contacts with condensate shall be the same material to prevent electrolytic corrosion. The drip trays shall ensure the collection of condensate and be accessible for cleaning.

1.9 Dehumidification:-

A specific dehumidification cycle (split-liquid) shall operate by reducing the operating surface temperature in a section of one of the refrigeration coils by means of a solenoid valve in the liquid line. Full airflow of the unit will be maintained at all times to ensure consistent air distribution to the conditioned space.

1.10 Remote Air Cooled Condenser:-

The air cooled condenser shall be the low profile, weatherproof type incorporating high efficiency, direct drive, external rotor motors with axial blade fans. The condenser shall be constructed from heavy-duty aluminums and corrosion resistant components. Heavy duty mounting legs and all assembly hardware shall be included. Condensers shall be suitable for 24-hour operation and be capable of providing vertical or horizontal discharge. The condenser shall be fully factory wired and require a 230-volt I phase 50 hz electrical service.

1.11 Fan Speed Control Condenser:-

The condenser fans shall be directly driven by 4 pole 1210 rpm 230 volt 50 hz electric motors with an IP54 enclosure rating and class F insulation. The motor shall be equipped with permanently sealed ball bearing and high temperature grease. The motors shall be speed controlled to ensure stable operating conditions from -5 oC to 45 oC ambient by a factory fitted, direct acting pressure actuated fan speed controller. The control system shall be complete with input isolation switch, transducers and pressure switches.

The high performance heat exchanger shall include mechanically expanded crosshatched copper tubes and louvered aluminum form maximum heat transfer. The coil shall be finished in a high temperature modified epoxy coating to offer increased protection in aggressive environments. the coil shall be have maximum of 3 rows and 472 fins per meter and the face velocity shall not be more than 2.91 m/s.

1.12 Unit Size:-

The maximum footprint area of the unit shall not exceed 1.5 m² . The unit shall require front access (600 mm) only for routine service and installation work.

1.13 Unit Controller:-

The unit controller shall be microprocessor based and include a large .LCD backlit graphic display for clear visibility of text and graphics. The display and control buttons shall be accessible from the unit front without removing any external panels. The controller shall feature ISP (In-system- Programming) technology to support program upload via a PC.

Control strategies shall be P-I-D with dew point compensation for accurate temperature and humidity control. A selection of return or supply air control shall be provided to suit the application. The controller shall have a user friendly menu driven interface with supporting help screens and shall use multi protocol data communications. Access to the controller settings to prevent against unauthorized access. In normal operating mode screen shall display unit number, temperature and relative humidity set points and actuals, graphs, time, date and operating status. Dynamic icons identify the system operating mode. A 48-hour real time log of temperature and humidity data shall be retained by the control system. All parameters and data shall be protected in memory by an onboard battery. An EIA- 232 communications interface shall provide the capability of remote monitoring with the option of EIA-485 interface on 2 or 4 wire connections.

1.14 Control:-

The control system shall allow programming of the following conditions:

- Temperature set point
- Humidity Set point
- High Temperature Alarm
- Low temperature Alarm
- High Humidity Alarm
- Low Humidity Alarm

The control system shall include the following settable features:

- Unit identification number.
- Startup Delay, Cold start Delay and Fan Run on timers
- Sensor Calibration.
- Remote shutdown & general Alarm management
- Compressor Sequencing.
- Return temperature control.
- Choice of Modulating output types.

1.15 Alarms:-

The microprocessor shall activate an audible, visual and general alarm in the event of any of the following conditions:

- High Temperature
- Low Temperature
- High Humidity
- Low Humidity
- Loss of Air
- High Pressure
- Low Pressure
- Humidifier Low Water
- Water Under Floor
- Spare Alarm 1 and 2 (Customized text)

The unit shall also incorporate the following protections:

- Single phasing preventors.
- Reverse phasing
- Phase imbalancing
- Phase failure

Overload tripping (MPCB) of all components

KITCHEN AHU WITH ACTIVATED CARBON FILTER

AHU SECTION

The ductable unit shall be ceiling mounted type. The housing/casing of the air handling unit shall be double skin construction. The framework shall be of extruded aluminium hollow sections. The entire frame shall be assembled using pressure die cast aluminium joints to make a sturdy, strong & self supporting frame work for various sections.

25mm thick double skin panels shall be made of 0.63 mm pre-plasticised GSS sheet on outside and 0.63 mm galvanized sheet inside with P.U. insulation injected in between. These panels shall be screwed on to the framework with soft rubber gasket on aluminium frame to make the joints air tight. Insulation material shall be of 38 Kg./m³ density minimum. Detachable steel drain pan with necessary slope to facilitate fast removal of condensate shall be provided. Necessary outlet from the drain pan shall be provided. The unit shall be suitably insulated from inside to avoid condensation on outer surface. Necessary provision for ceiling suspension shall be provided.

FAN AND MOTOR

The fan shall be DIDW centrifugal backward curved fan having three phase motor as specified. The fan shall be in 100% galvanized construction and shall be statically and dynamically balanced.

The fan motor shall be three phase squirrel cage suitable for 415 +/-10% V Ac supply fan and motor shall be belt driven.

COIL

The chilled water coil shall be of seamless copper tubes not less than 0.4 mm thick and 12mm OD. Coil face areas shall be such as to ensure rated capacity from each unit and such that air velocity across each coil shall not exceed 150 meters per minute. The coil shall be pitched in the unit casing for proper drainage. The fins shall be spaced by collars forming integral part of the fins. The tubes shall be staggered in the direction of airflow.

The fins shall be uniformly bonded to the tubes by mechanical expansion of the tube for minimum thermal contact resistance with fins. Fin spacing shall be 11 to 13 FPI & shall be 0.17 to 0.2 mm thick. The coils shall be tested against leaks at a hydraulic pressure of 21 kg/sqcm. This pressure shall be maintained for period of 2 hours. No drop should be observed indicating any leaks. The water headers shall be completed with water in /out connections, vent plug on top and drain at bottom and designed to provide water velocity between 2 to 6 FPS. The coils exceeding 6 rows depth should be in two equal parts.

ELECTROSTATIC SECTION

Made of 16 gauge galvanized sheet, High bake epoxy powder coated, Washable type aluminum mesh pre-filter, Washable type aluminum mesh post filter, Stainless steel spiked ionizers to create high voltage DC field, aluminum collector plates which should be

alternatively charged positive & negative with large collecting area with 14" deep cell, to work as magnet for charged smoke & oil particles. The system should be fitted with adsorber module having activated carbon granules of minimum thickness of 18mm, which can be accommodated inside the ESP Section, with slide in and slide out facility.

Average efficiency of 90-95% in single pass as per DOP test method. Electrostatic Precipitator should be able to charge particles from 0.01 micron to 10 micron through solid state power supply. Collector cell should be of permanent type and slide out facility for easy removal for cleaning. Operating Voltage: 220V/1Ph/ 50Hz, Power consumption: 50 watts per unit/module upto 7500 cfm. Ionizing Voltage: 12.5 – 13.0 kVDC, Collector Cell Voltage: 6.0 – 6.5 kVDC, System should be fitted with interlock switch for safety; the system should be able connected to a fan section to achieve airflow of 500 FPM across the air cleaner.

The filter should have a constant pressure drop.

FAN COIL UNITS

1. General

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

2. Fan Coil Units

2.1 The fan coil units shall be ceiling suspended horizontal /vertical type complete with finned coil, fan section with motor, drain pans, air filters, filter box, fan speed regulator and other controls.

2.2 Cooling Coil

The coil shall be of seamless copper tubes not less than 9 mm O.D. 0.41 mm thick and shall have continuous aluminium plate fins. The fins shall be spaced by collars forming integral part of the fins. The tubes shall be staggered in the direction of air flow. The coil circuit should be sized for adequate water velocity but not exceeding 1.8 M/s (6 F.P.S) the air velocity across coil shall not exceed 500 FPM or 155 MPM the fins shall be uniformly bonded to the tubes by hydraulic expansion of the tubes.

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

2.3 Fan Section

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

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

2.4 Drain pans

2.4.1 The drain pan shall be of double skin construction made of 1.00 mm stainless steel (AISI 304) covering the whole of coil section and extended on one side for accommodating coil connection, valve etc and complete with a 25 mm drain connection. The drain pan shall be insulated with 25 mm expanded polystyrene and covered with second G.I. tray.

2.5 Filter Plenum (Horizontal Type)

2.5.1 The Plenum shall be part of unit ceiling housing the fans and the coils.

2.5.2 Each unit will have a 15 MM thick washable air Filter made of Nylon mesh filter

media in an aluminium frame with 85% efficiency down to 20 micron.

3. **FCU casing**

The Vertical type fan coil units will be provided with plastic cover with a steel casing to house the coil, filter and have space for piping & controls.

4. **Speed Control**

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

5. **Painting**

The fan coil units should be powder coated in suitable colors.

6. **Automatic Controls**

6.1 Each unit shall have a room type thermostat and a 2 way motorized water valve. The valve shall be fixed at a convenient location. The thermostat shall have pre-calibrated thermistor sensors for operation of room temperature between 15⁰C – 35⁰C with a switching differential of 1⁰C. The thermostat shall be suitable for heat cool modes. Thermostat shall have a provision for “temperature set point reset” facility for occupied and unoccupied functions. The thermostat shall be mounted along with the speed control switch on a common plate. The plate shall clearly indicate the fan positions. The controls should be as per specifications under ‘controls’.

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

7. **Water Connections**

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

HEATING SYSTEM

1. General:

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

Hot Water Generator

- 1.1 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 of thickness not less than 10 mm 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 inlet and outlet connections with flanges shall be on upper end lower side. Connections for safety valve and controls shall be provided on the top. A required no. of sockets for heater elements shall be provided. 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.
- 1.2 Sheathed tubular electric resistance type heater elements shall be used and connected for equal loading.
- 1.3 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.
- 1.4 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.
- 1.5 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 clad with 1 mm thick aluminium sheet.
- 1.6 The electric hot water heater shall be installed as per the manufacturer's instruction and as shown on drawings.

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 cutoff 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.	Impellar	Bronze/Gunmetal machined to close tolerance.
3.	Pump Shaft	High quality alloysteel 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.

3.3 Pumps for Variable Speed Drive

- 3.3.1 The pumps for variable Speed Drive should be similar to the Vertical Split Casing given above.
- 3.3.2 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%.
- 3.3.3 The pump motor shall be controlled by Variable Frequency Drive (VFD), instead of standard starters.

4. Variable Frequency Drive (VFD)

- 4.1 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.
- 4.2 Each pump shall have an independent VFD.
- 4.3 However, the Microprocessor based controller shall be common for each set of pumps in a particular application.
- 4.4 The drive shall have a key pad control and a LED display module, alongwith a manual ON/OFF and bypass switch.
- 4.5 The drive shall have a diode bridge rectifier to convert 3-phase AC to fixed DC voltage power factor shall remain above 0.98.
- 4.6 The drive shall be capable of displaying the following information, such as, frequency, voltage, current, KWH, percent torque, percent power RPM etc.

3.4 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.

3.5 PUMP MOTOR & STARTER

The driving motor shall be totally enclosed fan cooled type with class `B' insulation. The motor shall be designed for quiet 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.

3.6 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.

3.7 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.

3.8 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.

3.9 EXPANSION TANK

Unless mentioned otherwise, an expansion tank of PVC double layered (Sintex or equivalent) , 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 up to 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

2.0 Centrifugal Fans:-

2.1 Design Requirements:-

The design parameters for the centrifugal fans shall be as below.

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 performance & sound. 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 the 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.

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 2.5 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 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:

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, 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:-

All fans shall be AMCA (Air Movement and Control Associates Incorporation of USA) certified for air performance & sound.

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 2.5 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 or as per manufacturer's standard and factory practices. 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. Motors 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 1000 mm and 1440 RPM for fan with impeller diameter 1000 mm and less.

g. Painting:-

Fans and accessories shall be painted with two coats of red-oxide primer zinc chrome primer conforming 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 without 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 generally shall be as described above 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 1000 mm and 1440 RPM for fan with impeller diameter 1000 mm 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:-

The air velocity limits shall be as below:-.

Velocity at blower outlet shall not exceed 12 M/S

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.

PACKAGE TYPE AIR WASHERS

1. The Packaged type Air Washer shall be complete in all respect and shall generally comply with the following specifications given below:

2. Air Washers

The packaged air washers shall be of G.I sheet metal sectionalized construction and shall include fan section, cooling pad section, motor drive, eliminators etc.

2.1 Fan Section:

The impellers of the fan or fans shall be of G.I sheets, double inlet forward curved centrifugal design, both statically and dynamically balanced. The fan housing shall be of sturdy construction made from 16 G(1.6 mm) G.I sheet with smooth air inlets. The fan shall be mounted on properly aligned shaft and mounted on self aligning bearing blocks. The casing of the cab section shall be made of 16 G(1.6 mm) G.I sheets suitably reinforced to provide rigidity. The frame work shall be either be folded G.I sheets or of hot dipped galvanized iron.

The fan section shall be complete with multi V belt drive, belt guard and adjustable motor mounting base.

2.1.1 Cooling Pad

The Cooling pads shall be of honey comb design to provide extended and sufficient wetted surface to give a water absorbing efficiency of at least 90% at an air efficiency velocity of 500 FPM (2.5 m/sec)

The cooling pads shall be made of either acetate paper or high impact PVC. The cross section and depth shall be sufficient for specified efficiency. The cooling pad section shall be of 16 G (1.6 mm) G.I sheets similar to fan section. It shall be complete with galvanized supports for mounting the pads and a water distribution through the uniform supply of water over the entire surface.

2.1.2 Water Sump

The water sump below the pad section shall be of 3 mm M.S plate with welded joints and stiffness. The tank shall be complete with makeup, overflow and drain connections. A float valve shall be provided for makeup water line. The tank shall be given 2 coats of corrosion resistance paint and final coat of black enamel paint.

The pump set shall be of mono block construction, with end suction and top discharge with flanged connections, cast iron impeller and casing all mounted directly on a squirrel cage, drip proof induction motor of suitable capacity.

2.2 Motors and Starter

2.2.1 The motor for each blower shall be totally enclosed, fan cooled, squirrel cage induction type and conform to specifications as given under section 9.

2.2.2 The starters shall be “Direct on Line” type up to 7.5 H.P and all larger starters shall be fully automatic Star Delta Type. The starters shall conform to the IS specifications.

2.3 Miscellaneous:

Necessary accessories shall be provided wherever necessarily required for proper operation and shall also include:

Necessary

Vibration isolators for the Blowers

Canvass connections at the outlet of each fan

Nuts, bolts, shims etc as required for the grouting of the equipments

Float valves in the air washer tank, along with quick fill connection

Gate valves in drain; make up, quick fill lines etc. as required.

2.4 Limitations

The air velocity limits are a follows:

Velocity across air washer shall not exceed 2.5 m/sec (500 FPM)

Velocity at blower outlet shall not exceed 8m/sec (1500 FPM)

DRY TYPE SCRUBBER

Electrostatic Precipitation Based Dry Type Scrubber Unit:

Electrostatic Section:

Electrostatic Precipitator should be able to charge particles from 0.01 micron to 10 micron through solid state power supply

Type of Filters: Electronic Precipitator

Operating Voltage: 220V/1Ph/ 50Hz

Power consumption: 50 watts per module/unit upto 7500 cfm.
(+/- 10% Voltage Variation)

Construction: Made of 16 gauge galvanized sheet, High bake epoxy powder coated.
All doors are gasketed to prevent air and water leakage.

Pre Filter: Washable type aluminum mesh pre-filter

Post Filter: Washable type aluminum mesh.

Ionizer: Stainless steel spiked ionizers to create high voltage DC field.

Collector Plate: Aluminum collector plates which should be alternatively charged positive & negative with large collecting area. Collector cell should be of permanent type and slide out facility for easy removal for cleaning.

Average efficiency: 90-95% in single pass as per ASHRAE test method.

Pressure Drop across filters (mm of water): 7mm (ESP and pre filter section w/o activated carbon)(Clean/Dirty) 15mm (ESP section and pre filter section with activated carbon)

Performance Indicators Lights): There shall be 2 LED lights (Green & Red) installed on the access door of the unit to indicate the status of the system as fault, normal or wash function. Also auto cut-off switch when door is opened.

Kitchen Scrubber

1. General

The kitchen scrubber shall be complete in all respects and shall generally comply with the following specifications given below :

2. Air Washers

2.1 The scrubber shall be of 16G G.I. Sheet metal fan section, mixing box and SS-304 made spray section, filter section and eliminators.

2.2 Enclosure/Housing

2.2.1 Enclosure shall be made of powder coated 18 gauge GI sheet with riveted and soldered lap joints casing angles shall also be of 40mm x 40mm. Angle shall be riveted and soldered to the casing.

2.2.2 The front panels shall be easily open-able for servicing the fan sections. It should provide easy access to remove air filters for cleaning.

2.2.3 The opening for access doors and gaps between sections shall be provided with the neoprene rubber T-gaskets fixed in grooves in the extruded sections.

2.2.4 The panels shall be fixed to the frame work with self tapping stainless steel screws and both ends of the screw shall be provided with rubber caps.

2.2.5 The access door to fan section is to be provided with a switch to shut the fan when the door is open.

2.3 Fan Section

2.3.1 The impellers of the fan or fan shall be of GI sheets, double inlet forward curved centrifugal design, both statically and dynamically balanced. The fan housing shall be of sturdy construction made from 16G (1.6mm) GI sheet with smooth air inlets. The fan shall be mounted on properly aligned shaft and mounted on self aligning bearing blocks. The casing of the cab section shall be made of 16G (1.6mm) GI sheets suitably reinforced to provide rigidity. The frame work shall be either be folded GI sheets or of hot dipped galvanized iron.

2.4 Spray Section

2.4.1 Spray section and tank shall be fabricated from 18 G 304 A stainless steel sheets with bolted construction having suitable stiffeners.

2.4.2 The section shall be complete with SS 304 water distribution header having ports and sized for uniform and adequate water flow through perforated SS 304 pipes. The spray nozzles shall be of brass construction.

- 2.4.3 The tank shall be fitted 3/4" (20 MM) float valve of commercial grade brass.
- 2.4.4 The spray section shall have provision for fixing one or two sets of air filters as specified later.

2.5 **Water Sump**

- 2.5.1 The water sump below the spray section shall be of 3mm MS plate with welded joints. The tank shall be complete with makeup, overflow and drain connections. A float valve shall be provided for makeup water line. The tank shall be given 2 coats of corrosion resistance paint and final coat of black enamel paint.

2.6 **Drift Eliminators**

- 2.6.1 Drift eliminators shall be of PVC supported at the top and bottom fixed to the spray section by means of GI notched bars. Eliminators shall be a set of vertical plates with a series of bends and deflections to give large surface area on which water drops and dust shall be impinge. Eliminators shall be properly stiffened at the sides.

2.7 **Distribution Plate**

- 2.7.1 Distribution plate shall be GI 18G with sufficient number of circular opening uniformly spaced for even distribution of air for spray type air washer.

3. **Pumps**

- 3.1 The water distribution pumps shall be of heavy duty, vertical type mounted inside the tank. It shall be complete with adjustable bleed of arrangement to prevent concentration of undesirable salts.

4. **Grease Filter & Carbon filter**

- 4.1 The standard pre-filters shall be with 5 layers of SS-304 wire mesh, fixed in a 22 G GI frame with handles for ease of removal.
- 4.2 The above set of filters shall be fixed in filter frames made of 22 G.I. sheets, shaped to prevent air leakage. The filters shall be easily removable. The filter section may from part of the spray section or may be bolted separately to the spray section.
- 4.3 Carbon filter shall be installed to eliminate the particles in the smoke.

5. **Motors and Starters**

- 5.1 The motor for each blower, shall be totally enclosed, fan cooled, squirrel cage induction type and conform to specifications as given under section 3.
- 5.2 The starters shall be "direct on line" type up to 7.5 H.P. All larger starters shall be of fully automatic star delta type.
- 5.3 The pumps shall be provided with single phase, self tripping starter of approved make.

6. **Miscellaneous**

Necessary accessories shall be provided wherever necessary for proper operation and shall also include.

- 6.1 PVC eliminator fixed to the spray section to avoid water spillage.
- 6.2 Necessary piping for water circulation.
- 6.3 Vibration isolators for the blowers and pumps.
- 6.4 Canvas connections at the outlet of each fan.
- 6.5 Nuts, bolts, shims etc., as required for the grouting of the equipment.
- 6.6 Float valve in the spray tank, along with quick fill connection.
- 6.7 Gate valves in drain, make up, quick fill line etc, as required.
- 6.8 Built in isolator switches for the fan and pump motor and wiring from the isolators up to the respective motors.

7. **Limitation**

- 7.1 The air velocity limits are as follows :-
 - 7.1.1 Velocity across scrubber not exceeding 2.54 M/s (500 FPM).
 - 7.1.2 Velocity at blower outlet-not exceeding 10.16 M/s (2000) FPM.

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. All electrical panels, switchgears, instruments, contactors, starters shall confirm to relevant IS standards/codes.

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 wired up to 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 interlocks 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 inter-phase 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 sleeves.

2.15.2 Bus supports shall be resistant low absorption type moulded insulation of high impact strength and high creep age 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 hindrances 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 far 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) 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 (120 gm/sqm) 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	40x40x3mm at the rate of 1.2

- 2.2.5 2251 mm and above 1.25 mm 1.80 mm diagonally with 10 mm dia nuts & bolts at 125 mm centre. 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 fully threaded GI 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 aluminium 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 spacing.
- 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. 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 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.

11.0 **Fire Rated Duct:-**

All fire rated duct shall be fabricated from 1.25mm thick GI sheet irrespective of duct size. All accessories shall be suitably fire rated for 2 hours.

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 (with latest amendments)

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 (with latest amendments).

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 Auto air vent 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 be isolating or removing 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 16 kg/sq.cm working pressure with PN 1.6 rating.

5.2 **Motorized Butterfly Valves with actuator**

5.2.1 Butterfly Valves

5.2.1 The butterfly valve shall consist of cast iron body preferably in two piece construction.

5.2.2 The disc shall consist of disc pivot and driving stem shall be in one piece centrally located.

5.2.3 The valve seat shall be synthetic material suitable for water duty. It shall line the whole body.

- 5.2.4 The disc should move in slide bearings on both ends with 'o' ring to prevent leakage.
- 5.2.5 The handle should have arrangement for locking in any set position.
- 5.2.6 The valve should be suitable for 16 Kg/cm² working pressure with PN 1.6 rating.
- 5.2.7 The actuators of motorized butterfly valve shall be BMS compatible.
- 5.3 ON/OFF Motorized butterfly valve with actuator for Chillers, condenser & Cooling Towers
 - 5.3.1 Motorized valve for chillers, cooling towers shall be 2 position ON/OFF type Butterfly valve with standard train. The valve shall be controlled by an electric actuator mounted directly on the valve. The actuator shall have a reversible synchronous motor and generate the desired stroke by gear train. It shall be suitable for hook up to any major BMS.
- 5.4 Actuator
 - 5.4.1 Each actuator shall have current limiting circuitry incorporated in its design to prevent damage to the actuator.
 - 5.4.2 Actuators shall provide the minimum torque required for proper valve close-off against the system pressure for the required flow.
 - 5.4.3 Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Butterfly isolation and other valves, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop the associated pump or chiller.
- 5.5 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 16 kg /cm² pressure.
- 5.6 All gauge cocks shall be of gunmetal plug type, complete with siphon (brass chrome plated).
- 5.7 All drain valves shall be of gunmetal with a hose union connection of one hand.
- 5.8 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.

9.6.8 The following supporting arrangements for two piping shall be provided as below.

Sr. No.	Nominal pipe Size (mm)	MS rod for ceiling support (mm)	Floor Support (mm)	Base Support
1	Upto 65 mm	10 mm	80 mm MS pipe	40x40x5 thick angle
2	80 mm to 125 mm	10 mm	80 mm MS pipe	50x50x5 thick angle
3	150 mm to 250 mm	12 mm or 50x50x6 thick angle	80 mm MS pipe	75x75x5 thick angle or 80x40 channel
4	300 mm to 350 mm	16 mm or 80x40 channel	80 mm MS pipe	100x50 channel
5	400 mm to 500 mm	16 mm or 100x50 channel	100 mm MS pipe	70x40 channel (box) []
6	600 mm to 700 mm	20 mm or 100x50 channel	100 mm MS pipe	ISMC 200

Wherever more than two pipes shall be hanged, the spacing of supports shall be taken as for minimum dia pipe. and piping support arrangement shall be got approved with submitting of shop drawing.

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 hinderance 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:**

- 2.1.1 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 32-48 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 (Option A) shall be fire retardant, self extinguishing aluminium foil faced closed cell crossed linked polyethylene. Material shall be class1 as per BS 476 part 7 The density of insulation shall not be less than 32 kg./cub m. And material shall be in the form of blankets/rolls of uniform thickness. The 'K' value at 10°C shall not exceed 0.032 W/m K. It shall be factory faced with aluminium foil on one side reinforced and fused to the insulation material ($\mu \geq 10000$, water vapour diffusion resistance).
- 2.2.3 The material for duct insulation (Option B) shall be aluminium foil faced closed cell elastomeric nitrile rubber. The thermal conductivity shall not exceed 0.038 W/m k at an average temperature of 30 deg C. The density of nitrile rubber shall be 40-60 Kg/m³. The insulation material shall be fire rated for class 'O' as per BS 476 part 6 for fire propagation test and class '1' as per BS 476 part 7 for surface spread of flame test. Water vapour permeability shall not be less than .024 per m inch ($\mu \geq 10000$, water vapour diffusion resistance).

Thickness of insulation shall be as specified for the individual applications. Each lot of insulation material delivered at site shall be accompanied with manufacturer test certificate for thermal conductivity value and density.

3. **Cold Equipment Insulation:**

- 3.1 The complete shell of the chiller (factory insulated) as well as its two heads, the

chilled water pumps, and AHUs shall all be insulated.

- 3.2 The insulation shall be 'TF' quality expanded polystyrene for chilled water pipes (thickness as per ECBC to achieve R values).
- 3.3 All insulation except chiller heads shall be covered with glass cloth and fire retardant epoxy coating with UV protection.
- 3.4 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. **Chilled Water Piping/Drain Piping:**

4.1 For EPS (TF quality)

- 4.1.1 The chilled water and drain pipes shall be insulated with 'TF' quality expanded polystyrene. Thickness of the insulation shall be as specified for the individual application as per ECBC 2007 requirement. Samples of insulation material shall be approved, and test certificates for the same shall be submitted for approval before application. Adhesives used if any shall be suitable for both and cold application for the temperature range mentioned above or as per the manufacturer's recommendations.
- 4.1.2 Preformed pipe sections shall be used for pipes upto and including 350 mm dia.
- 4.1.3 Pipes above 350 mm dia. shall be insulated with insulation slabs cut in mitred sections.
- 4.1.4 **Installation**

Chilled Water and Drain Piping

The pipe shall be thoroughly cleaned with a wire brush and rendered free from all rust and grease.

The pipes shall be treated with a coat of cold setting compound.

The insulation preformed section shall be fixed tightly to the surface taking care to seal all joints.

All joints along the circumference of the pipe sections shall be sealed with adhesive.

The insulation then shall be covered with glass cloth and fire retardant epoxy coating and UV protection for exposed areas.

Insulation on pipes in areas exposed to weather or underground shall additionally be covered with tar-felt sheets and fixed with G.I. wires of 1.0 mm. The tar felt sheet shall be stuck with bitumen r 85/25.

5. **Refrigerant Piping:**

5.1 The suction line of refrigerant piping shall be insulated with class O elastomeric insulation.

6. **Ducting:**

6.1 The air handling ducts shall be insulated with nitrile rubber class 'O' as per BOQ.

6.2 Duct insulation thickness shall be as follows:

Duct in conditioned space - 19 mm thick

Duct in unconditioned space - 25 mm thick

Duct with treated fresh air - 25 mm thick

6.3 **Installation**

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

6.3.2 Apply two coats of cold setting adhesive (CPRX compound).

6.3.3 Wrap the duct with insulation blankets of the thickness mentioned elsewhere.

6.3.4 The joints shall be sealed with 50 mm wide and 3 mm thick self adhesive nitrile rubber tape insulation complete and as required

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

7.1 **Material**

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

8. **Installation:**

8.1 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.

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

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

8.4 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 XLPE 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 (As per CPWD specifications)**

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 masonry 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 masonry 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 wire. The earthing lead from electrode owner's shall be suitably protected from mechanical injury by a 15 mm dia gipipe 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 IS: 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 mega ohm.
- 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 BOQ.

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.

LIST OF APPROVED MAKES AND MANUFACTURERS

The makes/brands of equipment listed below are approved for installation.

For all items to be used in the work 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. Equivalent makes may be added with price adjustment with approval of Engineer In charge. The approved samples shall be kept in the custody of the Engineer for comparison.

S.No	Material/Item	Approved Makes
	High Side Equipment	
1	Centrifugal Chilling Units with VFD (ARI Certified)	Carrier/ Trane/ York
2	Screw chiller (ARI Certified)	Carrier/Trane/York/Danhum bush
3	Scroll Chiller	Carrier/ Trane/ York/ Danhum bush/ Bluestar/ Voltas
4	Primary CHW/Cond Pumps(End suction back pullout)	Xylem/Grundfoss/Armstrong/wilo-Mather & Platt
5	Pumps Monoblock	Kirloskar/Beacon/Siemens/KSB/Greaves
6	Pumps Coupled with VFD	Xylem / Grundfoss/ Wilo-Mather Platt/ Armstrong
7	VFD with controls	Xylem/ Danfoss/ Grundfoss/ Wilo-Mather Platt/ Armstrong
8	Cooling Towers (CTI Approved)	Paharpur/Bell/Mihir/Marley/Advance
9	Electric hot water generator	Rapid cool/ Emerald/ Khokar
	Air Handling Units	
10	Air Handling Units (High Static) with cooling coils	Carrier/Caryaire/Blue-star/ZECO/Systemair/Voltas/VTS/ Flaktwood/Unique/Waves/Edgtech
11	Centrifugal Fan for AHU's	Nicotra/ Comefri/ Flakt/ Kruger
12	VFD for AHU	Danfoss/ Siemens/ Allen Bradley/ ABB/ Schneider
13	Ultra Violet Germicidal Irradiation/ PHI	Ruks/Trimed/ RGF
14	Fan Coil Units	Same as AHU
15	Air washer	Ambassador/Humidin/ Roots Cooling/ Ambiator
16	Scrubber (Wet/Dry)	Wet : same as AHU, Dry: Espair/Trion/Thermax/ Rydair
17	Humidifier	Rapid cool/Emerald/Khokar
18	Fan section	Same as AHU
19	Centrifugal /Axial Flow Fans/Tube Axial (AMCA Certified)	Flakt/ Nicotra/ Comefri/ Kruger
20	Propeller Fans	GEC (Alsthom)/ Crompton Greaves/ Khaitan/ Usha
21	Precision AC units	Emerson/ Blue box/ Stulz/ Hiross
22	Window/split AC	Hitachi/ Daikin/ O-general

23	VRV/VRF	Carrier /Hitachi/Daikin/O-general/Toshiba/Samsung
24	Cassette Units-Chilled water based	Daikin/ETA/Media
25	Inline Fans	Flakt/ Nicotra/ Comefri/ Kruger/ System Air/ Ostberg/ Greenheck
26	Heat recovery unit complete with Heat recovery wheel	Flaktwoods/ Novelaire/ DRI/ Greenheck/ Bryair
27	Heat Exchanger	Heat X/ Mark/ Alfa lavel
28	Thermal storage tank	Crystopia/ Dunhambush/ Calmac
	Electrical Equipment	
29	Main AC Panel	L&T/ Siemens / ABB/ Schneider
30	AHU/ventilation electrical panels	Tricolite/ Adlec/ Sterling & Wilson/ C&S/ Jackson Engineers/ Milestone/ Nitya/ SPC/ Risha/ Neptune/ Zeta
31	Electric Motors	Siemens/ Kirloskar/ ABB/ Crompton Greaves.
32	ACB	L&T-U power(Omega)/ GE-Entelliguard/ Siemens-3WL/ ABB/ Legrand-DMS/ Schneider-NW master pact
33	MCCB	L&T-(D shine/DL) / GE-Record Plus / Siemens-VA/ ABB-TMA/ Schneider- compact NSX
34	MCB	L&T/ Legrand-DX3/ Hager / Seimens-VA/ ABB/ MDS Lexic
35	PVC Tape	Steelgrip
36	Push button starter	L&T/ GE / Siemens/ ABB/ Schneider
37	Auxiliary Relays/Contactors	L&T/GE/ Siemens/ ABB/ Schneider
38	Line Type Fuse	L&T/GE/ Siemens/ ABB/ Schneider
39	Timer	L&T/GE/ Siemens/ ABB/ Schneider/ Legrand
40	Terminal Block	Elmex
41	Voltmeter/Ammeter	L&T/GE/ Siemens/ ABB/ Schneider
42	Indicating lamps	L&T/GE/ Siemens/ ABB/ Schneider
43	Selector Switches	L&T/GE/ Siemens/ ABB/ Schneider
44	Change Over Switch	L&T/GE/ Siemens/ ABB/ Schneider
45	CT/PT	L&T/GE/ Siemens/ ABB/ Schneider
	Cables	
46	Power Cables / Control Cables	CCI/ Universal/ Finolex / Rallison
47	Cable tray	OBO/ Legrand/ Cooper/ BEC
48	Cable lugs	Dowells/ Comet
	Dcting	
49	Factory fabricated duct	Ductofab/ Rolastar/ Technofab
50	G.I. Sheet	TATA/ SAIL/ Jindal
51	Spiral duct	Atco/ Seven Star
52	Grilles/Diffusers/Volume Controller	Ravistar/ Caryaire/ Mapro
53	Fire Dampers UL listed	Caryaire/ Ravistar/ Ruskin
54	Sound Attenuator	Caryaire/ Ravistar/Trox

55	Aluminium Sheets	Balco/ Nalco/ Hindalco
	Pipes	
56	G.I.	Jindal Hissar/ Tata/ SAIL/ HSL
57	M.S. upto 150 mm	Jindal Hissar/ Tata/ SAIL/ HSL
58	M.S. 200 mm and above dia factory rolled	Jindal Hissar/ Tata/ SAIL/ HSL
	Valves	
59	Butterfly Valves	Audco/ Honeywell
60	Motorised butterfly valve(actuator)	Belimo/ Honeywell/ Siemens
61	Non Return Valve	Advance/ Kirloskar/ Audco
62	Balancing Valves	Advance/ Audco/ Danfoss/ Honeywell
63	Gate/Globe Valves	Leader/ Divine/ Sant/ Bankim Sarkar / Zoloto
64	GM valve upto 40mm	Leader/ Divine/ Sant/ Bankim Sarkar /Zoloto
65	Ball Valve with Y strainer	Rapid Control/ Sant/ Leader/ Zoloto
66	Pressure independent Balancing valve	Danfoss/ Flowcon/ TA
	Accessories	
67	Pot & Y-strainer	Emerald/ Sant/ Rapid cool
68	Pressure Gauge	Fiebig/ Emerald/ H Guru/ Japsin
69	Thermometer	Fiebig/ Emerald/ H Guru/ Japsin
70	Flow Switch	Rapid Control/ Anergy
71	Automatic Air Vent	Rapid Control/ Anergy
72	Suction Guide	Anergy/ Rapid Control/ Flowcon
73	Filters (pre,fine Hepa)	Thermadyne/ Spectrum/ Kirloskar /Anfilco/ Johnflower/ Dynafilter
	Insulation	
74	Expanded Polystyrene	Beardsell Ltd./ BASF / Lloyd
75	Glass Wool	FGP Ltd./UP Twiga/ Kimmco
76	Polyurethane Foam	Malanpur /Superurethane
77	Crossed linked Polyethylene Foam	Trocellene / Superlon
78	Closed Cell Elastomeric Insulation	K-flex /Vidoflex/ Armacell/ Aeroflex
79	Non woven fibre material	Mikron/ Du pont
80	Mineral wool	Rockwool India Pvt Ltd/ Lloyd
81	Pre-moulded PUF section for pipe & pipe supports	Malanpur/ Lloyd
82	Fibreglass rigid Board/ Pipe section	FGP Ltd./ UP Twiga/ Kimmco
83	Aluminium Tape	Johnson/ Birla 3M/ Garware

84	Expansion tank(pressurized) and Air Separator	Anergy/ Grundfoss/ ITT
85	Bellows	Dunlop/ Kanwal/ Resistoflex
86	2/3-Way motorized valve for AHU/FCU	Johnson control/ Danfoss/ Siemens/ Belimo
87	Thermostats	Honeywell/ Johnson controls/ Belimo/ Danfoss/ Siemens
88	Humidistat	Honeywell/ Johnson control/ Belimo/ Danfoss /Siemens
89	Electric Strip Heaters	Escorts/ Daspas
90	Safety Thermostat for Heaters	Honeywell/ Siemens/ Danfoss/ Belimo /Siemens
91	Cooling/heating Mode Changer	Honeywell/ Siemens/ Danfoss/ Belimo/ Siemens
	Paints	
92	Enamel	ICI/ Asian/ Nerolac/ Berger
93	Bituminus	Indian Oil / HP
94	Tarfelt (for underground chilled water pipe insulation)	Indian Oil / HP
95	IBMS Approved vendor	Siemens/ Honeywell/ Johnson controls/ ABB/Schneider
96	DDC Controllers	Siemens/ Honeywell/ Johnson controls/ ABB/Schneider
97	Sensors(Pressure/Temperature)	Siemens/ Honeywell/ Johnson controls/ ABB/Schneider
98	VAV	Trane/ Trox/ Johnson Controls/ Caryaire/ Belimo
99	Airflow Switch (Air & water)	Johnson control/ Honeywell/ Siemens
	Miscellaneous	
100	V Belt	Dunlop/ Fenner
101	Anchor fastners	Fischer/ Hilti
102	Dash fastner	Fischer/ Hilti
103	Welding rods	Advani/ L&T
104	Flexible pipe connection	Dunlop/ Kanwal/ Resistoflex
105	Hessian Cloth (fire rated)	Navair/ Pyrogaurd
106	Vibration isolator	Resistoflex/ Dunlup/ Kanwal
107	Air Ozone	Ruks/ Trimed/ RGF
108	Fire Sealant	Birla 3M/ Hilti/ Promat
109	Adhesive/ UV Coating	Star bond / Pidilite