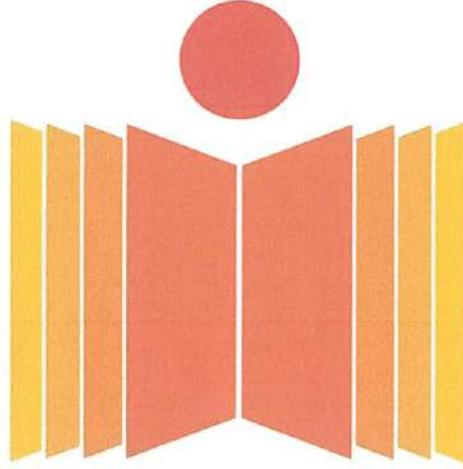


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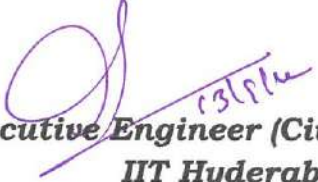


भारतीय प्रौद्योगिकी संस्थान हैदराबाद  
Indian Institute of Technology Hyderabad

## Volume - 4

# TECHNICAL SPECIFICATIONS FOR ELECTRICAL & MECHANICAL (E & M) WORKS

*Name of the work: Construction of Precast 2Nos Faculty Housing Towers (G+12), 3Nos Staff Housing Towers (G+12) and 3Nos Hostel Blocks (G+6) RCC Structures at IIT Hyderabad, Kandi, Sangareddy.*

  
**Executive Engineer (Civil)**  
**IIT Hyderabad**



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*Name of the work: Construction of precast 2Nos Faculty Housing Tower (G+12), 3Nos Staff Housing Towers (G+12) and 3Nos Hostel Blocks (G+6) RCC Structures at IIT Hyderabad, Kandi, Sangareddy.*

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**Scope of work and Technical Specifications for Internal Electrical wiring and internal electrification installations, UPS System, Illuminated Signage's, street lighting, compound and Foot Path Lighting etc. for the following sub heads mentioned in the payment schedule**

- 1 . Sub-head A6 (Annexure A6)
- 2 . Sub-head B6 (Annexure B6)
- 3 . Sub-head C6 (Annexure C6)
- 4 . Sub-head D7 (Annexure D7)
- 5 . Sub-head E7 (Annexure E7)
- 6 . Sub-head F7 (Annexure F7)
- 7 . Sub-head G7 (Annexure G7)
- 8 . Sub-head H7 (Annexure H7)

The scope of work includes Planning, Design & preparation of Drawings, obtaining approvals from the department, supply, Installation, testing, commissioning and handover of Internal and External Electrical Installations, Building level LT panels, SDBs, Power wiring, telephone/TV conduiting, LED light Fittings, call bell, Exhaust fans, Ceiling/wall fans, Switch boards, switches, sockets, MCBs, MCB DBs, power supply and distribution through cable, lightning protection requirement, earthing, street lights, bollards, associated panels etc for the building as per CPWD specifications as amended up to date as described in the details of specifications of this sub head. Complete wiring in all the buildings for light, power, communication etc. shall be done in appropriate size PVC conduits. However, for FFS and FAS wiring shall be one in MS conduit only if surface wiring permitted anywhere only MS conduits shall be used for the purpose.

**All the works under this subhead shall be carried out as per following specifications**

- a) CPWD General Specification for electrical work part I Internal 2013 as amended up to date.
- b) CPWD general specification for electrical work part II External 1994 as amended up to date.
- c) CPWD general specification for electrical work part IV Sub-Station 2013 as amended up to date.
- d) Indian Electricity Act 2003 amended up to date.
- e) National Electrical Code 2016 amended up to date.
- f) Indian Electricity Rule 1956 amended up to date.
- g) National Building Code 2016 as amended up to date

NOTE: These specifications and conditions are applicable for following buildings of this Project:

S.No	Name of Building	No. of Floors
1	Faculty Tower FT 1A	G+12
2	Faculty Tower FT 1B	G+12
3	Staff Tower ST 1A	G+12
4	Staff Tower ST 2A	G+12
5	Staff Tower ST 2B	G+12
6	Precast Hostel block-1	G+6
7	Precast Hostel block-2	G+6
8	Precast Hostel block-3	G+6

**General Conditions**

1. The work shall be carried out according to approved drawing/details which shall be subsequently issued to the successfully qualified tenderer for execution, in stages as per instruction of the Engineer-in-Charge, who will have the right to instruct the contractor for change of layout as per requirement at site and the same shall be binding on the contractor and the contractor shall not claim any extra payment due to change in layout.
2. All damages done to the building during the execution of electrical work shall be the responsibility of the contractor and the same will be made good immediately at his own cost to the satisfaction of the Engineer-in-Charge. In case, the repair is not satisfactory, the department will get it rectified &any



- expenditure incurred by the department in this connection shall be recovered from the contractor and decision of the Engineer-in-charge about recovery shall be final & binding on the contractor.
3. The bad workmanship will not be accepted and defects shall be rectified at contractor's cost to the satisfaction of the Engineer-in-Charge. The program of electrical works is to be coordinated with concurrent activities of other component building works.
  4. All the debris of the electrical works should be removed and the site should be cleared by the contractor immediately after the accruing of debris daily. Similarly rejected material if any should be immediately cleared off from the site by the contractor.
  5. Cement/mortar for this benefited work is to be arranged and used by the contractor himself and nothing extra will be paid on this account.
  6. The entire installation shall be at the risk and responsibility of the contractor until these are tested and handed over to the department. The watch & ward is the responsibility of the contractor till handing over.
  7. All items of interrelated works considered necessary to make the scope complete and operative are deemed to be included, shall be provided by the contractor at no extra cost.
  8. The connection inter connection, earthing and inter earthing shall be done by the contractor wherever required and nothing extra shall be paid on this account.
  9. Nothing extra shall be paid for inter connections with thimbles/Wires/Tapes strips etc. used on the work.
  10. The contractor shall on demand by the Engineer-in-charge, furnish the proof to the satisfaction of Engineer-in-charge regarding purchase of Wires, Modular switches & accessories, MCBs ,DBs, LED lights, fan & fixture and accessories and other items, from the manufacturer/manufactures authorized outlets.
  11. All PVC/ MS conduits accessories shall be of the same make as conduits and shall be ISI marked. The conduits shall be terminated as switch boxes/metallic junction boxes with suitable glands/check nuts.
  12. Cutting of brick walls shall be done with due care. All repairs and patch works shall be neatly carried out to match the original finish and to the entire satisfaction of the Engineer in Charge. If the structures are monolithic, the MS (mild steel)/PVC conduit shall be casted in the walls and ceilings as per approved layout drawings and points shall be provided in accordance of the same. In this Project, precast construction technology will be used so the conduits shall be casted accordingly.
  13. All the sub main and circuits wiring includes loose wire for connections inside switch boxes and MCB DBs. No payment for these loose wires shall be made.
  14. To facilitate drawing of wires, 18 SWG GI fish wire shall be provided along with laying of recessed conduit for which no extra payment shall be made. Conduits laid for other services, like Fire alarm system, PA, etc., where wiring is not done along with IEI work, fish wire shall be invariably drawn.
  15. The connection between incoming switch/isolator and bus bar shall be made with suitable size of thimble and cable at no extra cost.
  16. Copper conductor of insulated cables of size 1.5 Sq.mm and above shall be stranded and terminals provided with crimped lugs.
  17. All hardware items such as screws, thimbles, GI wire etc. which are essentially required for completing an item as per specification will be deemed to be included in the item even when the same have not been specifically mentioned.
  18. All hardware items such as nuts/bolts/screws/washers etc. to be used in work shall be zinc/cadmium plated iron.
  19. While laying conduit, suitable size junction boxes shall be provided for pulling the wire as per the decision of the E -in-C.
  20. Materials to be used in work are to be ISI marked. The makes of the materials have been indicated in the list of preferred makes. No other makes will be acceptable without approval the of E-I-C. The materials to be used in the work shall be got approved by the Engineer in Charge/his representative before its use at site. The E-in-C shall reserve the right to instruct the contractor to remove the material which, in his opinion, is not acceptable.

21. The power points 6 Amps and 16 Amps can be looped together as per CPWD specification. In single loop max 3 nos. of 6 Amps power points can be looped and Max two nos. of 16 Amp power points can be looped. AC point/ Geyser Point / Industrial Point shall have separate circuit wiring with 4.0 sq mm wire.
22. All switches shall be modular type with approved Makes and brand.
23. Switch for geyser point shall be provided outside the washroom & socket inside the toilet near geyser location both shall be of minimum 25 Amps rating.
24. 1 nos. call bell point shall be provided in all specially abled toilets.
25. The design, supply, installation, testing and commissioning of lightning protection of each building is in the scope of contractor. The design shall be done as per NBC- 2016, by rolling sphere method and CPWD specifications.
26. LED fittings as a whole including driver shall be guaranteed for 5 years. All the LED fittings shall be suitably engraved/ stickered inside, with for date of handing over.
27. The manufacturer shall give undertaking that in case of discontinuation of model and non-availability of spares, they have to replace the fittings with equivalent/ high end model in case of manufacturing defect during the warranty period of 5 years.
28. The contractor shall arrange certificate from the manufacturer to attend the complaints for repairing / replacement directly from IIT Hyderabad of all LED fittings on the basis of complaints of defective LED fittings.

#### **Technical specifications**

1. The work shall be carried out as per CPWD specifications for Electric work.
2. Wiring for all E & M services shall be done in conduit using PVC insulated FRLS wire only.
3. Minimum size of copper conductor for power wiring/light plug wiring shall be 4 sq.mm multi strand with FRLS copper conductor cable and for light/fan points/exhaust fan/call bell point, wiring shall be done with 1.5 sq mm multi strand FRLS copper conductor cable.
4. Control wiring in all electrical panels shall be done with 2.5 sq mm FRLS copper conductor cables.
5. Wiring for Intercom / Telephone shall be terminated in suitable size of G.I. Junction box and RJ-11 socket (for analogue phone) & RJ45 socket (for IP phone). All the other end of wiring shall be terminated in krone box at each floor and in the EPABX room. The wiring shall be suitably tagged/mentioned mentioning the location of each point. Wiring for both analogue & IP phone shall be done with cat-6A UTP 4 pair cable.
6. All switches, sockets, Telephone socket, Data sockets, stepped type electronic fan regulators, bell push and accessories along with matching mounting boxes shall be of modular type and same shall be of one make out of the list of approved makes.
7. There shall be separate shafts in the building each for Electrical works (LT cables), ELV works (CCTV, LAN, TV, Telephone, Fire alarm, PA etc) and Firefighting works etc.
8. Required illumination level for general lighting shall be achieved as per CPWD General specification for Electrical part-I -2013/NBC-2016/IS guidelines. Wherever range of illumination for space is mentioned, higher side of Lux level shall be taken for design purpose and decision of Engineer-in-Charge is final in that regard
9. Lighting inside the building shall be arranged in such a way that the required average illumination level is available in each of the areas as given in the relevant sections of National Building Code – 2016 (NBC)
10. For all the works mentioned in the chapter, the agency shall also follow the provisions as per NBC 2016 and provisions which are more stringent shall be followed for Design consideration.
11. The minimum scale of amenities/inventory (electrical) to be provided in each of the buildings shall be as given below. These are only indicative, minimum and not exhaustive. It is the responsibility of the

Contractor to provide the required number of fixtures, fittings and equipment to cater to the intended requirement/specifications of a particular building and as per direction of Engineer-in-charge.

**FOR FACULTY TOWERS & STAFF TOWERS**

(For Design consideration only, minimum and Indicative)

SI. No.	Description	Quantity
1	Power Plug Points (16 amp 6 pins)	2 in drawing room 1 in dining room 1 in each bed room 3 in kitchen 2 in utility area 1 in study room
2	Light Plug Points (6 amp)	3 in drawing room 2 in dining room 3 in each bedroom 4 in kitchen 1 in store area 1 in each toilet 1 in Main balcony 1 in utility area 1 in study room
3	Bracket light	2 in drawing room 2 in each bedroom 1 in study room 1 in kitchen 1 in main balcony 1 in utility area
4	Ceiling Fans	2 in drawing room 1 in dining room 1 in each bedroom 1 in kitchen 1 in study room
5	Call Bell Points	1 no
6	Exhaust Fans	1 each in kitchen & toilets
7	AC Points (with MCB connected socket outlet with wiring) with separate Modular switch	1 in drawing room 1 in dining room 1 in each bedroom 1 in study room
8	Geyser Points (with MCB connected socket outlet with wiring) with separate modular switch	1 in each toilets

9	LAN points	1 in drawing room 1 in each bedroom 1 in study room
10	Cable TV Points	1 in drawing room 1 in each bed room
11	Telephone Point	1 in drawing room 1 in master bedroom
12	Decorative light fittings	2 in drawing room 2 in dining room
13	LED Batten fittings	2 in drawing room 1 in dining room 1 in each bedroom 1 in kitchen  1 in study room  1 in store room
14	Modular switches and sockets	To be provided in all areas
15	Foot light/Night Lamp	1 in each bed room 1 in drawing room
16	LED Mirror light	1 in each Toilet 1 in each wash basin

**Note:**

- (i) In kitchen, exhaust fan shall be of suitable size (as approved by Engineer-in-charge) with louvers / bird screen medium duty with metallic body.
- (ii) In Bath room / toilet, exhaust fan of suitable size (as approved by Engineer-in-charge) shall be of BLDC type only.
- (iii) Above each wash basin LED type mirror light of approved design shall be provided.
- (iv) Modular type call bell shall be provided, model as approved by E-in-C.
- (v) In each bed room, one light point and Fan Point shall be two-way controlled. One controlling switch shall be at entrance and other shall be near Bed side.
- (vi) In each toilet, one light point shall be two way controlled. One controlling switch shall be at the entrance door of toilet.
- (vii) Lux levels shall be as per NBC 2016
- (viii) BLDC Ceiling fans of 1200mm sweep shall be provided and model as approved by the Engineer –in-Charge.

- (ix) All the common areas e.g. LIFTS and Staircases, Parking areas, Lobbies, Connecting corridors etc. shall have lighting arrangement along with LED light fixtures as per actual design.
- (x) Also each LIFT lobby on every floor shall be provided with 01Nos. 16A 6 pin plug point for Housekeeping/Cleaning/Service purposes.
- (xi) The Parking areas shall be provided with EV charging points as per the design and scheme approved by E-in-C.

Note: 1. The above socket outlets/Light points/Light fixtures are indicative only and shall be provided as per approved drawings/plan by Engineer-in-charge. If required, they shall be varied in whole buildings without any extra cost implication to IITH.

2. Any other area not mentioned above but for functional requirement, any power point, Light point, LAN point, telephone point, TV point if required, the same shall be provided after approval from Engineer-in-charge.

3. Sufficient additional LAN points shall be provided as per the requirement of IBMS, access control, CCTV integration and other IP based services based on the scheme approved by Engineer-in-charge.

#### **FOR STUDENTS HOSTEL BLDGS.**

##### **(For Design consideration only, minimum and Indicative)**

The minimum scale of amenities (electrical) to be provided in the buildings shall be as per provision mentioned below (however, it is add that the said list is only indicative and not exhaustive and it shall be the responsibility of the contractor to provide required number of fixtures and fittings to cater the requirement):

SI. No.	Description	Student's Hostel room
1	Light Plug Point( 6 Amp)	6nos. in each room 2nos. in each common toilet
2	Ceiling Fans	1nos. in each Room
3	Exhaust Fans	3nos in common toilet (1 nos. for each WC)
4	LED Mirror light	2 nos. in each common Toilet
5	LED Batten fittings	2nos. in each room
6	Foot light/Night lamp	1 in each room
7	Modular switches	Yes
8	LAN Ports	2 Nos in each room
9	Pending light	1 No. in each room

**Note:**

- (i) LED type batten fitting in each room (Minimum of 2 nos.) (Lux levels shall be as per NBC 2016)
  - (ii) If Balcony is available, one number LED down lighter
  - (iii) All the common areas e.g. LIFTS and Staircases, Lobbies, connecting corridors etc. shall have lighting arrangement along with LED light fixtures as per actual design.
  - (iv) Also each LIFT lobby on every floor shall be provided with minimum 01 No. 6/16A 6 pin plug point for Housekeeping/Cleaning/Service purposes
  - (v) For all LAN/WI-FI points, necessary power sockets along with wiring, SDBs, PVC cable management system etc. shall be provided as per approved drawings and directions of Engineer-in- Charge.
  - (vi) In toilet area: For general lighting LED type batten fittings of suitable numbers shall be used. BLDC exhaust fans shall be provided (the size and number shall be decided as per air changes required as per NBC norms). One no. 6/16 amp socket outlet for housekeeping/cleaning purpose shall be provided. LED type mirror lights of suitable size and wattage shall be provided near wash basin.
  - (vii) There shall be sufficient no. of 6/16 amp socket outlets in washing area for washing machine and 2 no's for water purifier.
  - (viii) Ceiling fan of 1400 mm sweep rating BLDC fans in each room shall be provided. (Minimum of 1no in each room)
  - (ix) In area like recreation room /common room/multipurpose hall etc. power outlet for amenities like water purifier /air conditioner etc. shall be provided as per drawing /layout approved by Engineer-in-charge.
- Note: a. The above socket outlets/Light points/Light fixtures are indicative only and shall be provided as per approved drawings/plan by Engineer-in- charge. If required, they shall be varied in whole buildings without any extra cost implication to IITH.
- b. Any other area not mentioned above but for functional requirement, any power point, light point, LAN point, telephone point, TV point will if required, the same shall be provided after approval from Engineer-in-charge.
- c. Sufficient additional LAN points shall be provided as per the requirement of IBMS, access control, CCTV integration and other IP based services based on the scheme approved by Engineer-in-charge. .
- (x) All internal electrical works shall be carried out with FRLS PVC insulated copper conductor cables (IS:694) in Opened/recessed conduit except in Fire Alarm work, where M.S conduit shall be used. All switches, sockets, IP Phone socket, Data sockets, stepped type electronic fan regulators, bell push and accessories along with matching mounting boxes shall be of modular type.
  - (xi) All lighting fixtures should be LED type having efficacy more than 100 Lumen / Watt, CRI >70, THD <10%, LM 79 & LM 80 test report from NABL accredited lab should be submitted by the agency.
  - (xii) Required illumination level for general lighting shall be achieved on the basis of required lux level in various areas, light power density as per CPWD specification/NBC norms.
  - (xiii) Arrangement of luminaries in various areas of buildings shall be done on the basis of Illumination

level & light power density as specified in CPWD specification Internal 2013 and National Building Code 2016 and shall be got approved from Engineer-in-charge.

- (xiv) Ceiling fans will be provided in every building and at each location except toilets / Bathroom. All ceiling fans shall be of 1400 mm sweep and should be of 5 Star rated BLDC type. Optimum size / number of ceiling fans for room of different sizes shall be as per provision laid down in CPWD specifications for internal EI work 2013. Minimum air delivery and service value shall be as per the above specification. BLDC Exhaust fans of suitable capacity and sweep shall be provided in all the toilets as per standard specifications and as per the approval of Engineer-in-Charge.
- (xv) T.V outlet wiring shall be terminated in suitable size of G.I. box along with splitter. The interconnections of all splitter boxes fixed at all floors shall be done properly to form proper distribution system with the prior approval of Engineer-in-charge.
- (xvi) Telephone outlet point wiring shall be terminated in suitable size of G.I. Junction box in DUs direct from ground floor to each DU/ user location. However, conduit for telephone wiring may be provided through branching by providing suitable size of G.I. box along suitable tag block at each floor. The inter connections of all junction boxes fixed at all floors shall be done properly making proper distribution system with the prior approval of Engineer-in-charge.
- (xvii) Providing incoming television / telephone cables from outside of each building is not covered in the scope of this bid.
- (xviii) The minimum indicative lux levels recommended for different typical areas of buildings under consideration are:

S.No	Area description	Lux level	Recommended light fixture
1	Service/Utility rooms such as Electrical room, UPS room, LT panel room, substation, pump room, Car parking area	250-300lux	Surface LED batten
2	Fire control room, Common Toilets	300lux	Surface/ Recessed round LED Downlighters
3	Lift shaft, Terrace, Mumty, OH Tank wall	50lux	LED Bulk head fitting with IP 65 protection
4	Corridor, lift Lobby, waiting area	150lux	Surface/ Recessed round LED Downlighters
5	Staircase, basement, ramp area	150lux	Surface round LED Downlighters
6	Entrance lobby waiting area	200lux	Cove light/ Strip light/ downlight /Cylindrical surface LED light (Combination of Fittings and layout as per direction of E-in- C)
7	Hostel, residential block room (Except Living room)	300lux	LED batten Indoor light
8	Road and Outdoor parking areas	15lux	LED street lights

**Note: Any other area specifically not mentioned above shall be given with lighting solution after approval from Engineer-in-charge.**

- (xix) All suspended light fittings shall use suspension GI wire and assembly either supplied by Light fitting manufacturer or by their recommended OEM/OEA.
- (xx) Heavy duty Metallic exhaust fan of 900 RPM with louvers as per the requirement of ventilation shall be provided in Electrical Panel room, substation, utility rooms etc. The no. of exhaust fan/ventilation fan shall be calculated on the basis of no. of air change required as per NBC 2016 norms.
- (xxi) 1 no. call bell point along with call bell & switches shall be provided in all specially abled Toilets.
- (xxii) For LAN Cat-6A UTP, 4 pair cable shall be provided as per the design and to be terminated in G.I. Junction box. & Wiring for cable TV with coaxial cable RG-6 grade, 0.7 mm solid copper conductor PE insulated with fine tinned copper braided & protected with PVC.
- (xxiii) Bulk-head fitting pressure die cast housing with IP 65 protection surface mounted – In each landing floor level of all the vertical shafts except firefighting shaft and in Terrace area outside mummy, entrance of pump room and as per direction of E-in-C .
- (xxiv) 1 No 6/16 Amp Socket outlet with switch in lift shaft ( As per requirement of lift agency), Electrical and LV(Communication) shaft in each landing level of every shaft.
- (xxv) LED exit signages with 2 hours battery back with bicoloured LED status indicator & should be visible from 40 mtrs, at every 6.00 m in corridor and at all conspicuous locations to indicate Exit, staircase location, toilet location, handicapped toilet location, lift location etc. as per NBC norms. All exit signages in staircases, exit path and in critical areas shall be on UPS DB.
- (xxvi) Fire Stair case lighting shall be provided with LED lights with minimum 2 hours UPS backup.
- (xxvii) Lighting automation to be provided by connecting suitable dual mode (sensor should sense movement and occupancy both) occupancy sensor to lighting circuit for entire building excluding complete fire staircase lighting, 20% of corridor lighting on each floor and common area. There shall be arrangement of bypass switch so that in case of failure of sensor, the light can be operated after bypassing the sensor.
- (xxviii) 20% of corridor lighting on each floor and common area, is to be connected to separate UPS DB for Emergency purpose providing lux level of not less than 10 lux in specified areas, which shall not be connected to lighting automation as per NBC 2016.
- (xxix) In parking areas, staircase areas, corridors etc. no switch for individual light control is to be provided all such point shall be executed on looping basis and shall be group controlled by MCB/switch from DB. In these areas Light controls shall be provided in such a manner to switch ON/OFF general lighting as per requirement /bay or section wise.
- (xxx) Inside the lift shaft there shall be arrangement of one light point with LED Bulk head fittings of suitable rating (minimum 800 lumens) shall be provided at each floor level end. All light points shall be in group controlled and wired with 1.5sq mm FRLS copper conductor cable. 16-amp power plug shall also be provided at all floors with 4 sq mm FRLS copper wiring. In lift shaft, all 16 Amp power point shall be on single loop.
- (xxxi) All Cables in Parking area, Electrical Room, Panel room, LV rooms, Shafts shall be laid on cable trays and approx. 25% capacity of all such cable trays shall remain unused as future provision. Minimum width of cable tray shall not be less than 150 mm.



- (xxxii) Such cable tray on Parking area, Electrical Room, Panel Rooms, area shall be hot dipped GI as per direction of E-in-C. Proper factory-made TEE, Bend, elbows, cross, joints and other accessories shall be used.
- (xxxiii) Cable trays shall be Perforated Hot Dipped Galvanised Iron (galvanisation thickness i.e average mass of Zinc coating shall not be less than 65 microns for 2 mm thick & 50 microns for 1.6 mm thick as per IS standard) with perforation not more than 17.5%, in convenient sections, joined with connectors, suspended from the ceiling with G.I. suspenders including G.I. bolts & nuts, etc. as required. Suitable size as per site conditions shall be used with thickness 1.6 mm for cable trays with width  $\leq$  300 mm & thickness 2 mm for cable trays with width > 300mm. The same shall be in conformity with CPWD General Specifications.
- (xxxiv) GI Metal trunking (Race ways) for drawing LAN cables shall be done for all computer outlets. GI Metal trunking shall have separator in between power cable & LAN cables. and approx. 25% capacity of all such cable trays shall remain unused as future provision.
- (xxxv) Floor trunking shall be made up of minimum 1.6 mm thick Pre-Galvanised / Hot dipped G.I sheet (minimum 275 GSM) including junction box of suitable size, Couplers, Jointing sleeves, floor fixing supports complete as required. Size of the same shall be as per requirement as per approval of engineer in charge.
- (xxxvi) AL/ Cu XLPE cable shall be use for power distribution in all buildings as per the scheme approved by Engineer-in-charge.
- (xxxvii) Cable size shall be decided as per maximum load of the building and 25% future expansion and shall got approved by Engineer – in –Charge.
- (xxxviii) The rupturing capacity of the MCB's shall not be less than 10KA, higher capacity shall be provided if required in the detailed design. The MCB's shall have ISI mark and rupturing capacity of the MCCB's shall be as per design of fault level, but shall not be less than 36KA. Make of MCB/MCCB shall be the same as the make of MCB DB (in that particular DB).
- (xxxix) Earthing: All earthing shall be done with copper plate earthing unless otherwise specially mentioned. Copper plate earthing system comprising of earth electrode, earth conductor, earth bus, protective conductor etc for building shall be as per provision laid down in CPWD specifications part – I, 2013. Earthing system should be designed such as to maintain earth resistance as specified in CPWD specifications. Earth resistance shall be checked / tested in harsh climatic conditions.
- (xl) If copper plate earthing is not possible at site due to very hard rock as per direction of E-I-C Copper bonded Rod earthing will shall be executed. It shall consist of Supply, Installation & testing of Earthing Station, consist of 3Mtr Copper Bonded Rod of minimum 17.2mm diameter. with minimum 25Kg resistance lowering compound Earthing. Copper Bonded Earth Rod made from high tensile low carbon steel and each rod should molecularly bonding 99.9% pure electrolytic copper to the low carbon steel core in accordance with national and international standards such as BS6651, BS7430 and UL467. comprises specifically selected compounds, which possess excellent electrical conductivity. The earth electrode shall be provided in 100 mm dia boaring, and providing masonry enclosure with cover plate having locking arrangement and watering pipe etc complete as required.
- (xli) Lightning Arrestor: -Lightning conductor shall be provided for building & Lightning protection system shall be designed as per rolling sphere method as per NBC 2016 guidelines.

(xlii) All LT and HT cables laid outside the building portion in open area shall be laid in RCC HUME pipes or in ground with sand cushioning and with brick protection with route marker or in RCC trench or in cable tray as per CPWD Specification and direction of Engineer-in-Charge. The instructions of Engineer- In-charge shall be applicable and binding on the contractor.

#### Light Fitting Technical specifications

S.No	Item description	Specifications
1	LED Batten	Surface mounting type LED fitting with diffuser having a lumen output not less than 2200 lumens, CCT 5700 - 6500K and LED efficacy better than 120 lumen/ watt with opal diffuser in polycarbonate complete with CRCA / Pressure Die Cast Aluminium Housing and life of 50K burning hours (L 70) at 30 deg , THD $\leq$ 10%, CRI better than 80 with inbuilt protection against short circuit, over voltage protection and surge protection of up to 2 KV including connections etc. as reqd.
2	Mirror light	Surface mounting type LED fitting with diffuser having a lumen output not less than 1100 lumens, CCT 4000K and LED efficacy better than 110 lumen/ watt with opal diffuser in polycarbonate complete with CRCA / Pressure Die Cast Aluminium Housing and life of 50K burning hours (L 70) at 30 deg , THD $\leq$ 10%, CRI better than 80 with inbuilt protection against short circuit, over voltage protection and surge protection of up to 2 KV including connections etc. as reqd.
3	Recess /Surface mounted Round LED Downlight (Type-1)	Luminaire having minimum lumen output of 1500 lumens, CCT 4000K/ 5700K to 6500K and system efficacy better than 110 lumen/ watt with opal diffuser in polycarbonate complete with Pressure die cast aluminium Housing, THD $\leq$ 10%. Service life of 50,000 hrs @ L 70 with inbuilt protection against short circuit, over voltage protection and surge protection of up to 2 KV including connections etc complete as required.
4	Recess/ Surface mounted LED Downlight (Type-2)	Luminaire having minimum lumen output of 1800 lumens, CCT 5700 K- 6500K and system efficacy better than 110 lumen/ watt with opal diffuser in polycarbonate complete with Pressure die cast aluminium Housing, THD $\leq$ 10%. Service life of 50,000 hrs @ L 70 with inbuilt protection against short circuit, over voltage protection and surge protection of up to 2 KV including connections etc complete as required.
5	Cylindrical pendent light for Dining Area	Cylindrical pendent LED light having minimum lumen output of 3000 lumen, IP20, CCT4000k/ 5700K / 6500K and system efficacy better than 100lumen/watt with optics made of precise reflector with beam angle, extruded aluminium housing, not less than 300mm height and 100mm dia, THD $\leq$ 10%. Service life of 50,000 hrs @ L 70 with inbuilt

		protection against short circuit, over voltage protection and surge protection of up to 2 KV including connections etc complete as required.
6	Bulkhead Fitting	LED bulkhead fitting light having minimum lumen output of 800 lumens, IP 65, CCT 5700- 6500 K and system efficacy better than 100 lumen/ with opal diffuser in polycarbonate complete with powder coated Pressure die cast aluminium Housing, life of 50K burning hours (L 70), THD ≤ 10%, CRI better than 80 with inbuilt protection against short circuit, over voltage protection and surge protection of up to 2 KV including connections etc. as reqd.
7	Outdoor Wall light	Wall mounted round LED light having minimum lumen output of 1200 lumens, IP 65, CCT 5700-6500 K and system efficacy better than 100 lumen/ with opal diffuser in PMMA complete with polycarbonate/ Pressure die cast aluminium Housing, life of 50K burning hours (L 70), THD ≤ 10%, CRI better than 80 with inbuilt protection against short circuit, over voltage protection and surge protection of up to 2 KV including connections etc. as reqd.
8	Spot light (Garden lights)	LED light having minimum lumen output of 500 lumens, CCT 4000 K and system efficacy better than 90 lumen/ with anodized aluminium reflector optic, Pressure dies cast aluminium Housing, life of 50K burning hours (L 70), THD ≤ 10%, CRI better than 80 with inbuilt protection against short circuit, over voltage protection and surge protection of up to 2 KV including connections etc. as reqd.
9	Wall washer (façade light Type-1)	Concealed recess Linear LED wall washer with 1 feet-4 feet warm/neutral white light suitable for wall washing evenly, Service life of 50,000 hrs @ L 70 with inbuilt protection against short circuit, over voltage protection and surge protection of up to 2 KV including connections etc complete as required.
10	Outdoor light (façade light Type-2)	Outdoor LED spot light with 6-10 w warm/neutral white light suitable for wall washing evenly, Service life of 50,000 hrs @ L 70 with inbuilt protection against short circuit, over voltage protection and surge protection of up to 2 KV including connections etc complete as required.
11	Street light Type-1	LED Street light having minimum lumen output of 12000 lumens, IP 66, CCT 5700K - 6500 K and system efficacy better than 120 lumen/ watt with injected moulded with aluminium Housing, THD ≤ 10%. Service life of 50,000 hrs @ L 70 with inbuilt protection against short circuit, over voltage protection and surge protection of up to 10 KV including connections etc complete as required.
12	Street light Type-2	LED Street light having minimum lumen output of 6000 lumens, IP 66, CCT 5700K - 6500 K and system efficacy better than 120 lumen/ watt with injected moulded with aluminium Housing, THD ≤ 10%. Service life of 50,000 hrs @ L 70 with inbuilt protection against short circuit, over

		voltage protection and surge protection of up to 10 KV including connections etc complete as required.
13	Post Top/ Gate light Fitting(Type 1)	LED Luminaire having minimum lumen output of 4000 lumens, IP 65, CCT 5700-6500 K and system efficacy better than 90 lumen/ watt with symmetric optic diffuser in polycarbonate complete with Pressure die cast aluminium Housing, THD ≤ 10%. Service life of 50,000 hrs @ L 70 with inbuilt protection against short circuit, over voltage protection and surge protection of up to 2 KV including connections etc complete as required.
14	Post Top/ Gate light Fitting(Type 2)	LED Luminaire having minimum lumen output of 3600 lumens, IP 65, CCT 5700-6500 K and system efficacy better than 90 lumen/ watt with symmetric optic diffuser in polycarbonate complete with Pressure die cast aluminium Housing, THD ≤ 10%. Service life of 50,000 hrs @ L 70 with inbuilt protection against short circuit, over voltage protection and surge protection of up to 4 KV including connections etc complete as required.
15	Bollard	Minimum 9 W LED Bollard, maximum 900mm height IP 65, IK10 CCT 6500K diffuser in polycarbonate complete with extruded aluminium Housing, Service life of 50,000 hrs @ L 70 with inbuilt protection against short circuit, over voltage protection and surge protection of up to 4 KV including connections etc complete as required.

**Note:**

**For all LED fittings CCT (5700K - 6500K or 4000K or 3000K) shall be chosen based on final design, aesthetics, functionality and as per direction of E-in-C. If any fitting is not available in specific make, Technical and aesthetically Similar shall be installed as per the direction of E-in-C.**

**General Requirements:**

The all buildings will be planned as per a minimum 3 Star GRIHA rating, therefore, the energy consumption of the building should be minimum but without affecting the functional requirements of the building. So, the fittings, fixtures and fans must be energy efficient. To minimize the energy consumption of the building, maximum sun light can be utilized while designing. Wiring for internal and external electric installation, copper wiring in PVC/ conduit i.e. light & fan point, call bell point, light & power plug with modular switch, socket and accessories, LED Fittings, Exhaust/Fresh air fan, Ceiling fan, switch board, DB, MCB, MCCB, RCCB, main panel Ceiling Fans.

**1.0. Lighting**

**Lighting shall be based on average lighting level considerations, which are as per NBC- 2016 except otherwise specified in inventory.**

Contractor shall submit the Dialux analysis of lighting for internal & external usage. All light fixtures shall be LED having LM79 and LM80 certification from NABL accredited laboratory and relevant approved IES files for Dialux. LM79 & LM80 reports to be furnished by contractor for each type of LED fittings.

Nos. of fittings shall be provided to have required LUX level as well as maintaining aesthetic look.

The fixtures shall be of surface/ recessed type as per site requirement and drawing. Number of fittings shall be provided on the basis of average illumination range for different areas subject to maximum LPD specified in CPWD internal specification 2013 (Section 2.9 and Table 11) & ECBC+ Building 2017 Table 6.2 & NBC 2016.

Only 5 Star rating BLDC ceiling & Exhaust fans should be provided in the various part of building as per healthy engineering practice and as per prescribed norms/architectural drawings approved by Engineer-In-Charge.

All the modular switch, sockets, Fan regulators etc. shall be of equivalent specifications/model as of Legrand Arteor series or of similar or higher specification series/model of other approved makes in the tender. The contractor shall submit the data sheets for the modular switches, sockets, fan regulators etc. along with sample to the Engineer-In-Charge for prior approval before procurement of the same at site.

The contractor shall install the 01Nos. of 25ltrs. Horizontal type Electric Water Heater(geysers) in each of the Apartments/Flats in the Faculty Housing Towers as well as Staff Housing Towers.

#### **EXTERNAL LIGHTING**

The scope of this work consists of planning, designing and SITC of LED street lighting with poles and at least 1.2meter of arm, Bollards, post top light etc. as mentioned below along roads, pathways, gardens etc. around the building as per following details. Exact quantity shall be determined as per the requirement of NBC 2016, as per the approved external lighting layout and as per directions of E-in-C.

<b>S. No.</b>	<b>Item</b>
1.	9meter height hot dip galvanized pole along 7meter road
2	6 meter height hot dipped galvanized pole along 6 meter Road
3	5 meter Height hot dipped galvanized pole along 4 meter road
4	LED street light fitting of minimum 120W
5	1200 mm long Single arm 60 mm dia bracket
6	Feeder Pillar for street light (minimum 03Nos.)
7	Garden Bollard light
8	4 meter height Smart Post-top light (Philips G3 BGP161 or equivalent)

**Note:-. The street light poles shall be installed at average distance of 18-20 meter. However, contractor shall design the system to avoid any black spot on the road. All road inside the campus, residential block surrounding area and all hostel block surrounding area will be illuminated by lights.**

Appropriate size of copper/ aluminium armoured cables shall be as per CPWD specifications and shall be laid with appropriate size GI wire required for earthing of every streetlight and bollard fittings. Cable laying shall be done in appropriate size NP2/DWG pipes of strength not less than SN8, which is laid inside ground at required depth below finished floor level including trenching, refilling of earth, compaction etc.

Weatherproof & flameproof SMC (Sheet Moulding Compound)/FRP (Fibre-reinforced Plastic) loop in/loop out boxes to be considered for all external lighting poles for cables terminations as required and as per the directions of Engineer-In-Charge. However inbuilt cable termination box/system within the pole and completely flushed with the pole is also acceptable as per the approval of Engineer-In-charge.

The scope of work is inclusive of RCC foundation of appropriate size with J bolts. The drawings of each and every item, layout drawings, foundations, poles shall be submitted for approval from Engineer-In-charge. The detailed specifications of items are as follows:

### **Street / compound lighting**

**9.00 mtr. long** surface mounting type hot dipped galvanized octagonal pole with at least 1.2 mtr long single arm GI bracket in approved design capable of holding the luminaire. The pole structural design shall be as per ILE TR7 considering the wind speed as per IS:875, the HT steel for construction should be as per BSEN10025 grade S355Jo, hot dipgalvanizing on both internal and external surfaces as per IS: 2629/IS: 2633/IS: 4759 with average coating thickness of 65/70 microns through a single dipping process. The pole shall also be provided with hinged / chained flush door with rubber gasket of length not less than 300mm at an elevation of 1.0 m (approx.) from the base plate with proper strengthening to the cut-out of the door opening having locking arrangement, earthing arrangement (at least 0.5 m height). Each pole shall be complete with a Bakelite sheet complete with DIN rail, 6 amps, 10 kA SP MCB, screw less DIN mounting Connectors suitable for 16 sq.mm. terminations complete with DIN bar, shorting links, end locks etc as required.

The pole shall continuously tapered (bolt fixing type) tubular Pole with top 70 mm dia. (minimum) and bottom 130 mm dia. (minimum) made of 3 mm (minimum) thick H T sheet Steel conforming to grade S 355 complete with G I base plate of size not less than 220 mm (L) X 220 mm (B) X 16 mm thickness welded at bottom of pole complete with 4 Nos 20 mm dia 600 mm long foundation bolts conforming to EN 8 grade, inbuilt / Vandal resistance, weather proof electrical junction box having terminal block, MCB etc mounted on bakelite sheet for looping in /looping out of cables, with flush door having locking arrangement, earthing arrangement (at least 0.5 m height) GI foundation bolts (EN 8 grade) of min. 20 mm dia each with three GI nuts and two GI washers etc complete as per drawing.. The pole shall have a section thickness of not less than 3 mm. The pole shall be fabricated in a single section. The pole shall have a single /double side GI bracket as per the design approved by the engineer- in-charge. (For Street Lights)

The cable entering and exiting provision using appropriate size of DWC pipe compatible with IS 16205, Part 24:2017 in the foundation of poles. RCC foundation (1:2:4 with 12mm reinforcement) size not less than 500 mm x 500 mm x 1200 mm in ground and 200 mm above ground level with foundation bolt duly embedded before casting as per manufactures designs and recommendations. (Design & drawing must be got approved from Engineer-in-Charge).

Supply Installation , Testing & Commissioning of IP66 LED street light fitting having system lumen output not less than 12000, efficacy not less than 110 lumens per watt and life expectancy of 50000 burning hours@ L70, Power Factor > 0.90 & THD <20%, CRI better than 70,neutral white light

and made of pressure die cast /extruded Aluminium housing with separate optics and control gear compartment, toughened glass protector, permanently sealed and a removable control gear plate, , mounting spigot suitable for horizontal mounting (Ø 32 – 42mm) with tilt flexibility of (+)(-) 10 degrees, suitable for operation on 230 V +/- 10 % single phase 50 Hz AC Supply , surge protection of not less than 10 KV and driver efficiency more than 85% complete in all respect i/c connection from MCB with 1.5 sq mm copper wire (i/c extra loop of 0.5 m ). The pole shall have a single /double side GI bracket as per the design approved by the engineer- in-charge. (For Street Lights).

- 1) The cable entering and exiting provision using appropriate size of NP2 RCC/DWC pipe compatible with IS 16205, Part 24:2017 in the foundation of poles. RCC foundation (1:2:4 with 12mm reinforcement) size not less than 500 mm x 500 mm x 1200 mm in ground and 200 mm above ground level with foundation bolt duly embedded before casting as per manufactures designs and recommendations. (Design & drawing must be got approved from Engineer-in-Charge).
- 2) Supply Installation , Testing & Commissioning of IP66 LED street light fitting having system lumen output not less than 12000, efficacy not less than 110 lumens per watt and life expectancy of 50000 burning hours@ L70, Power Factor > 0.90 & THD <20%, CRI better than 70,neutral white light and made of pressure die cast /extruded Aluminium housing with separate optics and control gear compartment, toughened glass protector, permanently sealed and a removable control gear plate, , mounting spigot suitable for horizontal mounting (Ø 32 – 42mm) with tilt flexibility of (+) (-) 10 degrees, suitable for operation on 230 V +/- 10 % single phase 50 Hz AC Supply , surge protection of not less than 10 KV and driver efficiency more than 85% complete in all respect i/c connection from MCB with 1.5 sq mm copper wire (i/c extra loop of 0.5 m )

## **2.0. For surface car parking, landscape, service area.**

**2.1. 4 meter long** street light pole made of 65 mm dia (nominal size) medium class G.I. pipe welded with M.S. base plate of size 300 mm x 300 mm x 6 mm thick l/c drilling of holes for cable entry, earth stud and painting pole with one coat of anti-corrosive paint and two coats of approved quality of Aluminium paint, Erection of the same in cement concrete 1:2:4 ( 1 cement: 2 coarse sand : 4 graded stone aggregate of 20 mm nominal size) foundation with cement concrete collar of minimum size 0.5m dia X1.0 m depth X 0.4m height above ground level including excavation and refilling etc as required. LED street light luminaire with 2500 lumens, suitable for 230V, single phase, 50 Hz,AC supply complete with all accessories and connections, earthing the body etc. complete as reqd. SMC cable looping box 230mm X 170mm X 105mm deep, having hinged cover plates including providing and fixing one No. 6 amps SP MCB "C" series, and 4 way 32A brass connector terminals on 6 mm thick phenolic laminated sheet for looping of 2 x 10 / 16 Sq.mm cable and suitable size detachable gland plate inside with necessary hole at the bottom for cable entry pipe etc.as required. Cable entry pipe with 50 mm dia 1.5 mtr long medium class GI pipe suitably bent at the bottom end for cable entry to street light looping box including threading the pipe and fixing the same with MS clamp to the pole including painting etc. complete as required. – Not less than 4 Nos.

**4 meters pipe pole post top lights shall be installed in parking and around Staff & Faculty housing and also in front of hostel blocks every Entry / Exit of every blocks as per the approved drawing and directions of Engineer-In-Charge.**

## **2.2. Bollards in the landscape**

Minimum 9 W LED, LED bollard, 900mm height, CCT 4000 K and IP 65 and IK10 protection with appropriate size RCC foundation as approved by officer in charge complete etc. as required.

The bollards shall be installed along the road inside green area and on periphery of green area in front of Hostel and Residential building at distance of 3-4 meter.

### **Street light control panels**

- 3.0. The panel shall be of cubicle compartmentalized wall/floor mountable outdoor type (IP 54) fabricated out of minimum 2.00 mm thick CRCA sheet, duly powder coated, manufactured by CPR approved panel builders having in-house facilities for 7 tank process treatment and powder coating. The panel shall have incoming MCCB, Busbar section with insulated tinned copper bus bars cu (size 20% extra over calculated current), metering section with ammeter, voltmeter, LED indicating lamps, cable alley etc. Street/compound/ parking/ garden bollard lighting control section shall be provided with individual astronomical timer in outgoing required to feed street lighting for automatic operation, wireless RF controller gateway which can communicate with the sensors located at fittings, 3 pole contractor, suitable size TPN incoming MCB, outgoing SP MCBs as per the number of circuits, multi way connectors for terminating the UG cable, Auto ON /OFF with Astronomical switch, contactor(s), timer toggle switch(s), interconnecting copper wiring not less than 2.5 sq mm, etc as required suitable for operation on 415 V, 3 phase, 50 Hz, AC power supply. There should be separate controls for Street/compound light/ Bollard light. Earthing/loop earthing etc shall be done as per CPWD specifications.
- 3.1. Distribution of electric power to street / compound lighting etc. and gate lights shall be with FRLS XLPE insulated and PVC sheathed aluminium conductor armored UG cable of 1100 (ISI marked). 6 SGW GI wire shall be used for street light earthing. Minimum 1-1.5 RM cable shall be kept extra at each street light pole for loop and maintenance purpose.
- 3.2. The cables shall be laid direct in ground, NP2 pipe, closed or open duct, cable trays or on surface of wall etc. depending upon the site conditions and as per direction of Engineer-In-charge. Tagging of cables on both ends of each circuit of street, compound lighting and gate lights shall be done. Before lay of cable work, trench/ cable tray/ pipe work shall be inspected by E-I-C
- 3.3. Lighting luminaries for street / compound/ garden bollard and gate lighting shall be of LED type as specified in bid documents.
- 3.4. All lights of street, compound/ Garden bollard and gate shall be controlled by astronomical time switch. There shall be arrangement of bypass switch so that in case of failure of time switch, the lights can be operated after bypassing the same.
- 3.5. Earthing of Street / compound lighting shall be carried out as per CPWD General Specifications Part-I (Internal)-2013 and CPWD General Specifications Part-II (External)-1994.
- 3.6. RCC pipe of suitable size (as mentioned below) for protection of UG cables shall be used for road crossing, entry in to buildings and paved areas.
- 3.7. Underground cables of size up to size of 35 sq.mm (up to 2 run of cables)- 150 mm dia.
- 3.8. Underground cables of size exceeding 35 sq.mm but not exceeding 120 sq.mm (up to 2 run of cables) - 200 mm dia.
- 3.9. Underground cables of size exceeding 120 sq.mm but not exceeding 300 sq.mm (up to 2 run of cables) - 250 mm dia.
- 3.10. After completing the work, necessary test results as envisaged in CPWD General Specifications Part-I (Internal)-2013 and CPWD General Specifications Part-II (External)- 1994 shall be recorded and submitted to the department. The results shall be within the permissible limits.
- 3.11. Street light panel / feeder pillar panel shall be installed on brick / RCC foundation at minimum height of



500 mm above ground level as per approved diagram.

- 3.12. After 12.00 night 50 % of all outdoor lights (every alternate fitting) shall be off. circuitry out and outdoor loop wiring shall be provided accordingly
- 3.13. Each panel will have surge protection Device of suitable capacity

### **FEEDER PILLAR**

Outdoor type Feeder Pillars shall be suitable for 3 phase, 50Hz, 415 volts, A.C. system and shall generally conform to IS 5039. Feeder Pillar shall be fabricated as per CPWD specification and sound engineering practice. Fabrication shall be started only after approval of drawing by Engineer-in-charge. All components of feeder pillars like MCCBs, Bus bar, MCBs, astronomical timer etc shall fulfill all requirement of relevant IS codes. MCCBs upto 250 amp capacity should have breaking capacity not less than 36 KA and that of more than 250 Amp shall have breaking capacity 50 KA. All MCBs to be used shall have breaking capacity not less than 10KA Bus bar shall be of tinned copper electrolytic grade. For all MCCBs and MCBs ICs = ICu. Enclosures of feeder pillars shall be painted with 7 tank process.

The street light feeders should have controlled by the Manual/ Auto mode (Digital timers).

### **MOULDED CASE CIRCUIT BREAKERS**

Moulded Case Circuit Breaker shall be incorporated in the Feeder Pillars wherever specified. MCCBs shall conform to IS: 13947 (Part-II) IEC-947(2) in all respects. MCCBs shall be suitable either for single phase AC 230 volts or three phase 415volts. All MCCBs shall be of microprocessor based having overload, earth fault and short circuit protection. The main incoming MCCB/ACB provided in the main panel of each building shall also be microprocessor based and shall be suitable/compatible for BMS operation.

### **Signages / Sign boards:**

The scope of works consists of:

- (i) **Signages:** Designing , manufacturing, providing and fixing of self glowing photo luminescent safety signages on 1.2 mm thick aluminium sheet of various matter as briefed by the Engineer-in- charge such as electrical safety precaution, instructions for lift passengers, fire safety measures, indication of various shafts, entrance , exit, stairs, toilets, fire exit etc having single side printing /computerized setting of letters on the photo luminescent as base chemical covered with stabilizer coating complete as required for various buildings under construction . Wherever required light(LED) illuminated signages shall be used.
- (ii) **Sign Boards (For various buildings):** The scope of work also consists of design, supply, fabrication and fixing of sign board using word made of acrylic cut out letter with LED and reflecting vinyl sheet as per design approved by Engineer-in-charge. The board shall be fabricated with 3mm thick ACP sheet. Powder coated aluminum sheet shall be fixed from therear side of the entire board to make box section. Powder coated aluminum cuts and bracket shall be used of minimum 3 mm thickness.

### **UPS Scope:**

The scope covers supply, installation, testing & commissioning of 10kVA UPS system complete with batteries & all accessories.

The UPS shall be provided in the following buildings:

S.No.	Name of Building	UPS qty.	UPS rating
1	Faculty Tower FT 1A	1	10kVA
2	Faculty Tower FT 1B	1	10kVA
3	Staff Tower ST 1A	1	10kVA
4	Staff Tower ST 2A	1	10kVA
5	Staff Tower ST 2B	1	10kVA
6	Precast Hostel block-1	1	10kVA
7	Precast Hostel block-2	1	10kVA
8	Precast Hostel block-3	1	10kVA

**UPS:**

"True Online-Double conversion type single/multi module UPS. Input 240/415V Nominal; 50Hz; 3Phase 4wire system". -

Output 240/415V Nominal; 50Hz; 3Phase 4 Wire system with Battery each UPS comprising of the following Major components.

IGBT based Rectifier cum charger.

IGBT based Inverter.

Sealed maintenance free battery with 30min back up time, Inter connecting cables; Links; Racks and standard accessories (Battery Sizing calculation for back up to be provided by vendor along with GA drawing)Built in SNMP card.

All other equipment necessary to operate the UPS is in the scope of the contractor.

**GENERAL SUMMARY**

This specification describes the operation and functionality of a continuous duty, dual input feed with configurable single-phase or three-phase output power ( 3:1 or 3:3), solid-state, static Uninterruptible Power System (UPS) hereafter referred to as the UPS.

The UPS shall utilize double conversion online topology designed to protect electronic equipment by supplying reliable, network-grade power with extremely tight voltage and frequency regulation. The UPS shall feature an internal static bypass and input power factor correction.

**Configuration Specifics:**

1. The system power train shall comprise of, input disconnect and filter stage, input PFC power stage, energy storage stage (DC bus capacitor bank), output power stage (inverters), static bypass switchfor connecting bypass line to the output, and battery charger.
2. The system shall also include, field-replaceable fan module, removable input/output wiring trays, battery disconnects, an LCD interface display, EPO, and an integrated UPS network management card with temperature monitoring.

The UPS and associated equipment shall operate in conjunction with a primary power supply and an output distribution system to provide quality uninterrupted power for mission critical, electronic equipmentload.

All programming and miscellaneous components for a fully operational system as described in this specification shall be available as part of the UPS.

#### STANDARDS

EN50091-1/ EN/IEC62040-1-1, EN50091-2 / IEC62040-2, EN55022 Class A, EN55024, EN61000-4-2, 4-3,4-4, 4-5, 4-6, 4-11, EN60950, IEC 60950, CE, VDE, C-tick, ISO 9001, ISO 14001

#### MODES OF OPERATION

Normal: The input Power Factor Corrector (PFC) stage and output inverter stage shall operate in an on-line manner to continuously regulate power to the critical load. The input and output converters shall be capable of full battery recharge while simultaneously providing regulated power to the load for all line and load conditions within the range of the UPS specifications.

Battery: Upon failure of the AC input source, the critical load shall continue being supplied by the output inverters, which shall derive their power from the battery system. There shall be no interruption in power to the critical load during either transfer to or from battery operation back to normal operation.

During the re transfer from battery to on-line operation, the load shall be softly transferred from battery back on-line within 10 seconds, to avoid step load changes on the mains supply.

Recharge: Upon restoration of the AC input source, the input converters and output inverters shall simultaneously provide regulated power to the critical load and recharge the battery.

Bypass operation: Bypass mode shall be reached either as a user selection/maintenance and automatically with indication.

3. Bypass mode can be selected through the Control menu screen on the Powerview display
4. The UPS will automatically switch into bypass mode if:
  - a. Both normal and battery operation modes are unavailable
  - b. An output overload condition occurs
  - c. The UPS has an internal fault

During bypass operation the utility power is connected to the load, bypassing the internal converters. If the bypass mode becomes unavailable, the UPS will automatically switch to mains power. In the event that mains power is unavailable the system will switch to battery power.

With the UPS supplied from dual feeds and operating on battery, due to a mains failure, it shall be possible to request the unit to go to bypass, in addition to automatically transfer to bypass when the batteries are depleted. In this bypass mode the inverter shall become a PFC and back-feed the DC busses. This allows the charger to continue charging the batteries.

#### SUBMITTALS

General arrangement drawing and details:

5. Bill of materials.
6. Product catalog sheets or equipment brochures.
7. Product guide specifications.
8. System single-line operation power and control diagram.
9. Installation information, including weights and dimensions.
10. Information about terminal locations for power and control connections.
11. Battery Sizing calculation including weight & dimension.
12. Any other information/clarification asked by Engineer/consultant/Employer related to design and product specification.

Delivery Submittals:

13. Installation manual, which includes instructions for storage, handling, examination, preparation, installation, and start-up of UPS.
14. User manual, which includes operating instructions.

## **PRODUCT**

### **MECHANICAL DESIGN**

Generally, The UPS shall be contained in two rugged steel cabinets one containing the power electronics and the other containing the batteries and single phase distribution outlets; The UPS and battery cabinets shall be capable of conversion between Tower / Stack and Rack-Mount configurations;

### **SYSTEM CHARACTERISTICS**

System Capacity:

15. The system capacity shall be rated for 0.8 Pf output:  
Input:
16. AC input nominal voltage:
17. AC input voltage window:
  - a. Full Load, 160 -275V (Line-Neutral) for single phase input or 277 -476V (Line-Line) for three phase input;
  - b. Half Load, 100 -275V (Line-Neutral) for single phase input or 173 -476V (Line-Line) for three phase input;
18. Input frequency range: 40-70Hz;
19. Input Power Factor; > 0.98 at 100% load

20. Input Current Distortion: < 4% at 100% load, 230VAC (<7% for 3 phase output)

21. Crest factor: 3:1.

UPS Output:

22. AC Output Nominal Output: (Customer configurable) As specified in BOQ

23. AC output voltage distortion: Max. 2% @ 100% linear load; Max. 5% @ 100% non-linear Load;

24. AC output voltage regulation (Static): +/-1%;

25. Voltage Transient Response: +/- 8% maximum for 100% load step

26. Voltage Transient Recovery within < 10ms recovery time;

27. Output Voltage Harmonic Distortion:

a. <2% THD maximum for a 100% linear load

b. <5% THD maximum for a 100% non-linear load

28. Overload Rating:

a. Online: 105% - infinite; 125% - 1 minute; 150% - 30 seconds;

b. In bypass: Overload is limited by the external input circuit breaker feeding the UPS. System AC-AC Efficiency: >95%

29. Output Power Factor Rating: 0.2 –1.0 lagging, nominal: 0.8 lagging.

30. Output frequency: 50 +/- 0.7Hz tracking

31. Output connectors:

a. Single phase: Hardwire 3-wire (Phase + N + G),

b. Three phase: Hardwire 5-wire (3 Phase + N + G)

32. Output frequency Slew rate: 1.0Hz/Sec, 0.5Hz/Sec 0.25Hz/Sec

### **ENVIRONMENTAL**

33. Storage Ambient Temperature:

a. -15° to +55° C

34. Operating Ambient Temperature: 0°C to +40°C (+32°F to +104°F).

35. Relative Humidity: 0 to 95% non-condensing

36. Audible noise:

a. <50dBA at <70 % load at 1m,

b. <60dBA at >75 % load at 1m.

## **INPUT PFC POWER STAGE**

The input PFC power stage of the UPS shall constantly rectify the power imported from the mains input of the system, converting the input mains AC power to DC power for precise regulation of the DC bus voltage, battery charging, and output power stage (inverter) regulated output power.

Input Current Total Harmonic Distortion: The input current THD<sub>i</sub> shall be held to 6% or less at full system load, while providing conditioned power to the critical load bus, and charging the batteries under steady-state operating conditions. This shall be true while supporting loads of both a linear or non-linear type. This shall be accomplished with no additional filters, magnetic devices, or other components.

Input Current Limit:

The input converter shall control and limit the input current drawn from the utility supply

Overloads at low line input voltages shall draw power from the battery, (battery assist mode) in order to support the load and maintain the input current below the set current limit points.

Charging:

The battery charging shall maintain the DC bus float voltage of +/-219V, +/-1% at the nominal temperature of 20°C (68°F)

The battery charging circuit shall contain a temperature monitoring circuit, which will regulate the battery charging current to optimize battery life.

The battery charging circuit shall remain active when in automatic Bypass and in Normal Operation.

The battery charging system shall adjust the charging current by automatically sensing the number of battery modules and by monitoring the individual battery current. Maximum charger power shall be 3kW.

## **OUTPUT POWER STAGE (INVERTER)**

The UPS output power stage (inverter) shall constantly recreate the UPS output voltage waveform by converting the DC bus voltage to AC voltage through a set of IGBT switches. In both online operation and battery operation, the output power stage (inverter) shall create an output voltage waveform independent of the mains input voltage waveform. Input voltage anomalies such as brown-outs, spikes, surges, sags, and outages shall not affect the amplitude or sinusoidal nature of the recreated output voltage sine wave of the output power stage (inverter).

Overload Capability: The output power stage (inverter) shall be capable of withstanding 150% overload for 30 seconds or 125% overload for 1 minute or 105% overload for an indefinite length of time. The system shall transfer to bypass if the overload persists and then return back on-line when the overload is removed.

Battery Protection: The UPS shall have monitoring and control circuits to limit the level of discharge on the battery system.

## **AUTOMATIC BYPASS**

As part of the UPS, a system automatic bypass switch shall be provided. The system automatic bypass shall provide a transfer of the critical load from the Inverter output to the automatic bypass input source during times when the inverter cannot support the load. Such times may be due to prolonged or severe overloads, or UPS failure. The UPS shall constantly monitor the output current, as well as the bypass source voltage, and inhibit potentially unsuccessful transfers to automatic bypass from taking place.

The design of the automatic bypass switch power path shall consist of an electromechanical bypass contactor and series SCR's.

**Automatic Transfers:** An automatic transfer of load to bypass shall take place whenever the load on the critical bus exceeds the overload rating of the UPS. Automatic transfers of the critical load from bypass back to normal operation takes place when the overload condition is removed from the critical bus output of the system. Automatic transfers of load to bypass shall also take place if for any reason the UPS cannot support the critical bus.

**Manual Transfers:** Manually initiated transfers to and from bypass shall be initiated through the UPS interface display or via the serial communications port.

## **DISPLAY AND CONTROLS**

**Control Logic:** The UPS shall be controlled by an embedded microcontroller which performs the following functions:

- Monitoring quality of input, bypass and output voltages;
- Monitoring vital parameters of the UPS;
- Executing the state machine;
- Remaining runtime calculation;
- Self-diagnostics, self-test and proactive fault detection;
- Communication to the Network Interface Card or another Smart Slot accessory card if equipped.

**Display Unit:** A microprocessor controlled display unit shall be located at the front of the system. The display shall consist of an alphanumeric display with backlight, providing system status, LED alarm indicators and a keypad consisting of pushbutton switches for control and status reading selection.

**Metered Data:** The following metered data, shall be available on the alphanumeric display:

- Year, Month, Day, Hour, Minute of occurring events
- Source and Bypass Input Voltages
- Output AC voltage

- Input, Bypass and Output AC currents
- Input, Bypass and Output Frequency
- Battery voltages and currents
- Internal and battery pack temperature

**Event log:** The display unit shall allow the user to display a time and date stamped log of the 10 most recent status and alarm events.

**Alarms:** The display unit shall allow the user to display a log of all active alarms. The following minimum set of alarm conditions shall be available:

1. Low/No AC input, startup on battery
2. UPS Fault
3. On Battery
4. Shutdown or unable to transfer to battery due to overload
5. Load Shutdown from Bypass. Input Frequency Volts outside limits
6. Fault, Internal Temp exceeded system normal limits
7. UPS in Bypass due to Internal Fault
8. UPS in Bypass due to overload
9. Low Battery

**Controls:** The following controls or programming functions shall be accomplished by use of the display unit. Pushbutton switches shall facilitate these operations.

1. Silence audible Alarm
2. Display or set the date and time
3. Transfer critical load to and from bypass
4. Test battery condition on demand
5. Adjust set points for different alarms

**Communication Interface Board:** A communication interface shall provide the following communication ports which can be used simultaneously:

1. RS232 Serial Port #1
2. RJ-45 Interface port for Power View Display
3. RJ-45 Ethernet connection, on installed Network Management Card



UPS should have the RS-485 MODBUS compatability for IBMS integration.

## **BATTERY**

### External SMF Battery

4. The complete set of batteries consists of multiple units so as to obtain an overall nominal voltage (direct voltage). A battery rack comprises 12 Volt batteries connected in series. The battery rack must comply with standards governing electrical safety, which requires the use of adequate protections and particular care when higher voltages are present and direct contacts are possible. Battery calculation sizing to be provided by contractor for approval.
5. The UPS battery system shall comprise of user replaceable external batteries providing nominal voltage for the positive DC bus rail and nominal voltage for the negative DC bus rail.
6. The battery blocks shall be of the Valve Regulated Lead Acid (VRLA) type sealed maintenance free.
7. The UPS shall incorporate an Intelligent Battery Management system to continuously monitor the health of the battery system and notify the user if that system is weak or needs replacing.

### **General description for Batteries**

8. Batteries shall be of the SMF type.
9. Each battery system shall have identical Amp-hrs capacity.
10. Ground wires shall be supplied for connection from the UPS to each battery enclosure grounding point.

### **Charging:**

- The battery charging circuit shall remain active when in bypass or on-line.
- Charging system shall automatically adjust the maximum charger power based on the installed proprietary battery capacity and current through each battery string to avoid excessive charging that could result in bloated batteries. Each proprietary battery pack shall report its battery currents and temperature to UPS through communication
- The Battery Charger must be equipped with control and regulation circuit both for charging voltage and current to batteries, in order to have a controller battery charge and optimize the battery life. The UPS must charge batteries with an early boost charge followed by a constant charge and, at the end, with a floating charge. During normal run the UPS will execute periodically a battery equalizing in order to recover natural charge leakages and keep all batteries at the same capacity. Battery charger calculation sizing to be provided by contractor for approval.

## **ACCESSORIES**

### **REMOVABLE INPUT/OUTPUT ELECTRICAL TERMINAL**

The input and output terminal connections shall be designed to be removable trays for easy electrical connection and unit removal.

The removable input and output trays shall contain a means of configuring the system for 1 or 3 phase input and output as well as for single or dual feed input.

## **SOFTWARE AND CONNECTIVITY**

Network Adaptor: Built in Smart Slot Network Management Card shall allow one or more network management systems (NMS) to monitor and manage the UPS in TCP/IP network environments.

Unattended Shutdown

The UPS, in conjunction with a network interface card, shall be capable of gracefully shutting down one or more operating systems when the UPS is operating in the battery mode. Network Shutdown software shall be available with the UPS.

The UPS shall also be capable of using an RS232 port to communicate with the host computer by means of serial communications so as to gracefully shut down one or more operating systems during an on battery situation.

## **REMOTE UPS MONITORING, CONFIGURATION AND CONTROL**

The following three methods of remote UPS control, configuration and monitoring are available:

Web Monitoring: Remote monitoring shall be available via a web browser such as Internet Explorer.

RS232 Monitoring: Remote UPS monitoring shall be possible via either RS232 or contact closure signals from the UPS.

Simple Network Management Protocol (SNMP): Remote UPS Monitoring shall be possible through a standard MIB II compliant platform.

## **SOFTWARE COMPATIBILITY**

The UPS manufacturer shall have available software to support graceful shutdown and remote monitoring for the systems detailed on the following web link:

## **EXECUTION**

### **START-UP**

Start-up is requested, factory trained service personnel shall perform the following inspections, test procedures, and on-site training:

Visual Inspection:

- Inspect equipment for signs of damage.
- Verify installation per manufacturer's instructions.
- Inspect cabinets for foreign objects.
- Inspect battery chassis and modules.
- Inspect power chassis Mechanical Inspection
- Check all UPS and internal power wiring connections.
- Check all UPS and nuts, and/or spade lugs for tightness.

Electrical Inspection:

- Verify correct input and bypass voltage.
- Verify correct UPS control wiring and terminations.

- Verify voltage of all battery modules.
- Verify neutral and ground conductors are properly landed.
- Inspect external service bypass panel for proper terminations.

Site Testing:

- Ensure proper system start-up.
- Verify proper control functions.
- Verify proper bypass operation.
- Verify system set points.
- Verify proper inverter operation and regulation circuits.
- Simulate utility power failure.
- Verify proper charger operation.
- Document, sign, and date all test results.
- Load test- UPS contractor shall arrange the required loads for on-site testing
- Battery test

On-Site Operational Training: During the factory assisted start-up, operational training for site personnel shall include key pad operation, LED indicators, start-up and shutdown procedures, maintenance bypass and AC disconnect operation, and alarm information.

**MANUFACTURER FIELD SERVICE**

Worldwide service: The UPS manufacturer shall have a worldwide service organization available, consisting of factory trained field service personnel to perform start-up, preventative maintenance, and service of the UPS system and power equipment. The service organization shall offer 24 hours a day, 7 days a week, 365 days a year service support.

Replacement parts: Parts shall be available through the worldwide service organization 24 hours a day, 7 days a week, 365 days a year. The worldwide service organization shall be capable of shipping parts within 4 working hours or on the next available flight, so that the parts may be shipped to the customer site within 24 hours.

**MAINTENANCE CONTRACTS**

A complete offering of preventive and full service maintenance contracts for the UPS system and the battery system shall be available from the vendor. All contract work shall be performed by the vendor's factory trained service personnel.

**WORKMANSHIP**

As instructed by Engineer-in-charge.

DATA SHEET FOR UPS SYSTEM		
SL. No.	DESCRIPTION	TENDER REQUIREMENT

	RATING OF UPS	10KVA
1.0	Environmental Characteristics	
1.1	Working temperature	Up to 40 Deg. C ( no de rating)
1.2	Storage temperature	0 to 70 Deg C
1.3	Humidity	Up to 95% non-condensing
1.4	Interference	AS PER IEC 62040-2 /EN50091A
1.5	Operating altitude.	Sea level to 1000 meters.
2.0	General Characteristics	
2.1	Efficiency	
2.1a	AC/AC total efficiency @ 25% load	>88%
2.2b	AC/AC total efficiency @ 50% load	>88%
2.3c	AC/AC total efficiency @ 75% load	>90%
2.3d	AC/AC total efficiency @ 100% load	>94%
2.4	Noise level @ 1Mt distance	<65 dBA
2.5	Conversion technology	True online & Double conversion
2.6	Configuration	Parallel mode/Standalone
2.7	Maximum No. of systems can be paralleled	3
2.8	Dimensions in mm (LxBxH)	BY VENDOR
2.9	Weight in Kgs	BY VENDOR
2.10	Cooling	Forced cooling using fans
2.11	Cable entry-Top/bottom	BY VENDOR
2.12	Degree of Protection	IP23
3.0	Input Electrical Characteristics	
3.1	Type of rectifier	IGBT
3.2	Input Voltage(3Phase)	415 V
3.3	Input Frequency	50 Hz
3.4	Input Power factor @ 50 to 100% load	>0.99 lag
3.5	System power walk-in	10 msec
3.6	Input current harmonic distortion(THD)	
3.6a	THD @ 25% load	<5%
3.6b	THD @ 50% load	<5%
3.6c	THD @ 75% load	<5%
3.6d	THD @ 100% load	<5%
3.7	Maximum current drawn during battery charging &	BY VENDOR
3.8	Recommended Cu. cable size in Sq.mm	BY VENDOR
3.9	Recommended breaker rating in amps	BY VENDOR

3.10	Rectifier DC voltage ripples	<1%
3.11	Rectifier DC Current ripples	<1%
3.12	Charging time	<10 Hrs
4.0	Output Electrical Characteristics	
4.1	Output Voltage(3Phase)	415V
4.2	Static output Voltage variation	+/-1%
4.3	Output wave form	True
4.4	Dynamic output Voltage variation when load varies from 0-100% & vice versa.	AS PER IEC/EN 62040-3CLASS-1
4.5	Dynamic output Voltage variation at 100% load step.	AS PER IEC/EN 62040-3CLASS-1
4.6	Output Voltage variation at balance load	AS PER IEC/EN62040-3CLASS-1
4.7	Output Voltage variation at unbalance load	AS PER IEC/EN62040-3 CLASS-1
4.8	Phase displacement-100% Unbalance load	+/-2 deg
4.9	Voltage adjustment – Manual	REQUIRIED
4.10	Output frequency	50 Hz
4.11	frequency regulation	+/-1 Hz / Sec
4.12	Phase displacement-in balance load	AS PER
4.13	Output Power factor @ rated capacity	0.8 LAG TO
4.14	Overload capacity	
	For 30 minutes	110%
	For 10 minutes	125%
	For 1 minute	150%
4.15	Short circuit capability	BY VENDOR
4.16	Crest Factor	>3:1 LN
4.17	Recovery time	+/-1 %
4.18	Galvanic Isolation Transformer	External
5.0	Static bypass arrangement	
5.1	Rated Voltage(3Phase with neutral)	415 V
5.2	Voltage variation	+/-10%
5.3	Nominal Frequency	50 Hz
5.4	Maintenance bypass switch	Yes
6.0	Battery details	
6.1	Type of batteries	SMF LEAD ACID
6.2	Back-up	15
6.3	AH of the battery	BY VENDOR
6.4	Battery Charging Time from fully discharge	<6HRS
6.5	Life of Battery	>5YRS
6.6	Battery temperature sensor	REQUIRED
6.7	No of Batteries provided.	BY VENDOR

6.8	Battery Monitoring in UPS	Yes
6.9	Battery Mounting	MS Cabinet
6.10	Dimensions of battery cabinet (LxBxH)	BY VENDOR
6.11	Weight of battery cabinet	BY VENDOR
7.0	Communication	
7.1	Battery temperature sensor	REQUIRED
7.2	Programmable inputs/outputs	REQUIRED
7.3	BMS compatibility(Hardware & software items for third	REQUIRED
7.4	Ielene service- communication with LAN for sending	REQUIRED
8.0	Losses in KW	BY VENDOR

## INTERNAL BUILDING POWER DISTRIBUTION SCHEME FOR FACULTY HOUSING TOWERS AND STAFF HOUSING TOWERS

### A. FOR FACULTY HOUSING TOWERS

- 1) In this Project, there are 02Nos. Faculty Housing Towers proposed for construction. The incoming power to these faculty towers will be given from nearby existing SV-7(ESS-7) substation.
- 2) There shall be two LT panels named as Main Normal Power Panel-1 and Main Emergency Power panel-1 to be installed in one of the Faculty Housing Towers (say FT-1A).
- 3) The incoming power supply to Main Normal Power Panel-1 shall be given from Main Normal Panel at SV-7 substation and to Main Emergency Power panel -2 shall be given from Main Emergency panel at SV-7 substation. The incoming power supply cables shall be multiple runs of suitable size XLPE insulated LT cables as per approved Electrical SLD by the Engineer-in-charge.
- 4) Another set of two LT panels named as Main Normal Power Panel-2 and Main Emergency Power panel-2 to be installed in another Faculty Housing Tower (say FT-1B).
- 5) The incoming power supply to Main Normal Power Panel-2 shall be given from Main Normal Power Panel-1 at FT-1A building and to Main Emergency Power panel -2 shall be given from Main Emergency Power panel-1 at FT-1A bldg. The incoming power supply cables shall be multiple runs of suitable size XLPE insulated LT cables as per approved Electrical SLD by the Engineer-in-charge.
- 6) There will be two separate metering Panel-1 and metering Panel-2 to be installed in FT-1A bldg. and FT-1B bldg. respectively.
- 7) The Metering Panel-1 will have incoming power from Main Normal Power Panel-1 and Main Emergency Power panel-1 and the Metering panel-2 will have incoming power from Main Normal Power Panel-2 and Main Emergency Power panel-2.
- 8) From Metering panel-1, the Normal power supply as well as Emergency power supply will be extended to each flat of FT-1A. Both the normal as well as emergency power supply cables in each flat will be terminated in the Automatic changeover and current limiter (ACCL) to be installed in each flat. The ACCL shall be installed in a small cubicle panel to be installed in each flat. This panel shall comprise of ACCL of required current rating along with necessary MCBs, contactors etc. along with separate LED indication lamps for normal and emergency power supply.
- 9) From Metering panel-2, the Normal power supply as well as Emergency power supply will be extended to each flat of FT-1B. Both the normal as well as emergency power supply cables in each flat will be terminated in the Automatic changeover and current limiter (ACCL) to be installed in each flat. The ACCL shall be installed in a small cubicle panel to be installed in each flat. This panel shall comprise

of ACCL of required current rating along with necessary MCBs, contactors etc. along with separate LED indication lamps for normal and emergency power supply.

- 10) The output power supply from each ACCL shall be given to the Main DB of each flat of FT-1A and FT-1B.
- 11) The normal power supply here means the Electricity board (EB) supply and the emergency power supply here means the IITH Diesel Generator (DG) supply.
- 12) All the Normal and Emergency power distribution panels including ACCL shall be designed such as to provide 70% load of each flat on EB source and 30% load of each flat on DG source. The ratings of all switchgears including the ACCL shall be designed and selected accordingly.
- 13) The ACCL shall have following features:  
True RMS measurement. User configurable (Editable) password Simultaneous sampling of Volts & Amps. Simplifies electrical complexity. Safeguards generator by gradual loading & precision monitoring. Fully solid state, using contractor components. Inverse Current tripping Saves the age of the cable. Under and Over Voltage protection when it is running on DG. Programmable DG start time which avoids overloading the DG. Intelligent controller trips exactly on the programmed settings – Better accuracy. Resetting the Trip by key press or through communication. RS-485 communication port.
- 14) Also from the Main Normal Power Panel-1 and Main Emergency Power panel-1 in FT-1A, the power supply to different Utility panels, Fire fighting panels, LIFT panels etc. of FT-1A bldg. shall be provided.
- 15) Similarly from the Main Normal Power Panel-2 and Main Emergency Power panel-2 in FT-1B, the power supply to different Utility panels, Fire fighting panels, LIFT panels etc. of FT-1B bldg. shall be provided.
- 16) The power supply to fire staircase lighting and common area lighting shall be given through UPS of individual building only. Out of the total common area lighting of each building, 30% of the common area lighting shall be on DG Backup.
- 17) Sufficient number of spare MCCBs/MCBs etc. shall be provided in all LT distribution panels as per the drawings approved by Engineer-In-charge.
- 18) One 20 Passenger lift in each tower to be provided with DG back up power, to keep lift in operation during EB power failure.

## **B. FOR STAFF HOUSING TOWERS**

- 1) The same Power distribution scheme as given above for Faculty Housing Towers shall be followed in the Staff Housing Towers.

## **C. FOR HOSTEL BLOCKS (1, 2 & 3)**

- 1) In each Hostel block-1, there will be two LT panels namely Main Normal power panel-1 and Main Emergency power panel-1.
- 2) These Main Normal Power Panel-1 and Main Emergency Power panel-1 will be given power supply from Main Normal Panel and Main Emergency panel respectively at SV-18 substation.
- 3) Another set of two LT panels named as Main Normal Power Panel-2 and Main Emergency Power panel-2 to be installed in Hostel block-2.
- 4) These Main Normal Power Panel-2 and Main Emergency Power panel-2 will be given power supply from Main Normal Power Panel-1 and Main Emergency power panel-1 respectively.
- 5) Also one more set of two LT panels named as Main Normal Power Panel-3 and Main Emergency Power panel-3 to be installed in Hostel block-3.
- 6) These Main Normal Power Panel-3 and Main Emergency Power panel-3 will also be given power supply from Main Normal Power Panel-1 and Main Emergency power panel-1 respectively.

- 7) Now in Hostel block-1, from the Main Normal Power panel-1, there will be two SDB Normal panel-1 and SDB Normal Panel-2. The SDB Normal panel-1 will feed the one wing of Hostel block-1 and the SDB Normal panel-2 will feed the second wing of Hostel block-1.
- 8) Similarly, in Hostel block-1, from the Main Emergency Power panel-1, there will be two SDB emergency panel-1 and SDB emergency panel-2. The SDB emergency panel-1 will feed the one wing of Hostel block-1 and the SDB emergency panel-2 will feed the second wing of Hostel block-1.
- 9) From the SDB Normal Power panel-1 &2, all the hostel rooms will be fed whereas from the SDB Emergency power panel-1 &2, all the staircase lighting, common areas lighting, washrooms will be fed.
- 10) From the SDB Normal Power panel-1 &2 as well as SDB Emergency power panel-1 &2, the rising mains bus duct shall be extended vertically and tap-off points on each floor shall be given vide MCCB and the power shall be distributed accordingly.
- 11) Also for other essential utilities like LIFTS, Fire fighting pumps, water supply pumps etc., the power shall be fed from both normal and emergency panels as per the final approved Electrical SLDs by the Engineer-In-charge.
- 12) For Hostel blocks-2 and Hostel block-3, the above power distribution scheme mentioned for hostel block 1 shall be followed.

NOTE: (i) All the MCCBs above 200A rating in all the LT panels shall have microprocessor based communicable safety release with over current, short circuit and earth fault protection with RS-485 port.

(ii) All the incomers and outgoing in all the LT panels shall be provided with MFMs (showing minimum parameters as I, V, PF, KVA, KVAh, KWh, KVARh etc.) having RS-485 communication port.

**Other General Specifications to be complied by the contractor:**

**Distribution Boards:**

- a) Distribution boards along with the controlling MCB's/Fuse or Isolator as shown shall be fixed in an M.S. Box with hinged door suitable for recessed mounting in wall. Distribution boards shall be made of minimum 16 SWG steel sheet duly rust inhibited through a process of de-greasing, acid pickling, phosphating and powder coated to an approved colour of adequate micron rating duly approved by Engineer/Employer/architect/consultant.

Three phase boards shall have phase barriers and a wire channel on three sides. Neutral bars shall be solid tinned copper bars with tapped holes and chase headed screws. For 3 phase DB's, 3 independent neutral bars shall be provided for per phase isolation in addition to main neutral links.

- b) Conduit knockouts shall be provided as required/shown on drawings and the entire board shall be rendered dust and vermin proof with necessary sealing gaskets. The top and bottom side of DB should be detachable.
- c) All DB's shall be using copper insulated Busbars of appropriate rating. Bus bars shall be suitable for the incoming switch rating and sized for a temperature rise of 35° Cover the ambient. Each board shall have two separate earthing terminals. Circuit diagram indicating the load distribution shall be pasted on the inside of the DB as instructed. Two earthing terminal for single phase and two terminals for 3 phase DB's shall be provided with one earth strip connecting the studs and the other earth link should be provided with base insulator in such a way that link should in contact with body of distribution board. Door earthing for DBs to be provided. (If it is 2 leaf door, then 1 no earthing per door).



### **RCCB/RCBO:**

- a) The RCCB should suffices all the requirements of BIS as per code BIS - 12640 (Part I) - 2000. The RCA should be current operated and not on line voltage.
- b) The RCCB/RCBO should ensure mainly the following functions.
  - 1) Measurement of the leakage & fault current value.
  - 2) Comparison of the Leakage & fault current with a reference value.
- c) The RCCB/RCBO should have a toroidal transformer which has the main conductors of primary (P - N) which check the sum of the current close to zero. All metal parts should be inherently resistant to corrosion and treated to make them corrosion resistant. It should be truly current operated. It should operate on core balance toroidal transformer. Its accuracy should be  $\pm 5\%$ . It should operate even in case of neutral failure. It should trip at a present leakage current within 30 M.S. It's enclosure should be as per IP 30. It's mechanical operation life should be more than 20,000 operations. It should conform to all national and international standards like BIS, BS 4293 - 1983, CEE 27 (International commission Rules for the approved of electrical equipment).

### **MCB/ Isolators:**

Miniature circuit breakers shall be quick make and break and break type conform with British standard BS : 3871 (Part-I) 1965, IEC 898-1995 and BIS :8828 (1996). The housing of MCBs shall be heat resistant and having a high impact strength. The fault current of MCBs shall not be less than 10000 amps, at 230 volts. The MCBs shall be flush mounted and shall be provided with trip free manual operating mechanism with mechanical "ON" and "OFF" indications.

The circuit breaker dollies shall be of trip free pattern to prevent closing the breaker on a faculty current. Tightening torque at terminals shall be not less than 2.5 Nm. Power losses should not be more than as specified in IEC 898-1995.

The MCB contact shall be silver nickel and silver graphite alloy and tip coated with silver. Proper arc chutes shall be provided to quench the arc immediately. MCB's shall be provided with magnetic fluid plunger relay 3 as for over current and short circuit protection. The over load or short circuit devices shall have a common trip bar in the case of DP and TPN miniature circuit breakers. All the MCB's shall be tested and certified as per Indian Standard, prior to Installation.

For protection of electric circuits with equipment that does not cause surge current (i.e. lighting and socket outlet circuits)'B' curve MCB to be used in which magnetic releases operates between 3 and 5 In.

For protection of electric circuits with equipment that cause surge current (i.e. inductive and motor circuits) 'C' curve MCB to be used in which magnetic releases operates between 5 and 10 In.

For protection of electric circuits with equipment that cause surge current (i.e. transformer, heavy start motors circuits) 'D' curve MCB to be used in which magnetic releases operates between 10 and 15 In.

Isolators shall confirm to BIS 13947-3 and IEC 60947-3.

### **Flame Proof DB**

Flameproof Distribution boards should be suitable for Gas Groups Class II. It should be made of cast

Aluminum Alloy LM6. And also required to have necessary provisions as per relevant standards. All the hardware should be made out of stain steel.

Miniature Circuit Breakers (MCB), MCCB and Distribution Boards shall be custom designed and supplied to house various capacities and combination of MCB, MCCB, Switches, Fuses, Indicating Lamps, Busbar Panels as specified.

The enclosure shall be flame proof and suitable for indoor / outdoor installation as per requirement. A canopy shall also be supplied, if it is located in outdoor area. Panel board shall have external fixing lugs, and shall be suitable for mounting on vertical face such as wall / column, or steel pedestal.

Panel shall comprise of one four-pole incoming isolating device, bus bars and required number of outgoing feeder-isolating devices equally distributed over the phases. Each outgoing shall have 2 pole isolation viz. Phase and neutral. The number of outgoing feeders, and rating of both incomer and outgoing shall be as required/as mentioned in BOQ. Incomer, busbars, and outgoing feeder elements shall be housed in separate compartments. The separation between the compartments should be such that no flame propagation is allowed.

Incomer shall have mechanical On and Off indication and facility for pad locking the operating handle in off position. An explosion proof cable gland for incoming cable shall be provided, suitable for cable size required. Crimping type lugs shall be provided for incoming cable. Bus bars shall be made of high conductivity copper and supported by non-hydroscopic insulators. Individual compartments shall have separate inspection covers secured by screws / bolts requiring special tools for opening.

A separate internal and external earthing link to be provided with required no's of ways. Terminals shall be provided in an independent compartment for connection of outgoing cables. Terminals should be anti-loosening type and suitable for required sq. mm-copper/aluminium.

Caution plates shall be provided on the inspection covers to avoid opening without isolation. Nameplates shall be provided for each outgoing circuit, and for the complete panel indicating panel number.

All internal and external surfaces shall be powder coated with two coats of epoxy-based paint. Colour shade of final paint shall be as per relevant standards. The finished panels shall be dried in stoving ovens in dust free atmosphere. Panel finish shall be free from imperfections like pinholes, orange peels, runoff paint etc. All unpainted steel parts shall be cadmium plated /stain less steel or suitably treated to prevent rust formation. All moving elements shall be properly greased.

### **3.0 RISING MAIN & BUS BAR TRUNKING**

#### **Scope**

The specification covers design, manufacturing, supply, installation, testing and commissioning of Sandwich type bus bar trunking for use as feeder bus bars for interconnection between separate electrical equipment /load centers, and for use as plug in bus bar risers.

#### **System details**

The bus bar shall be suitable for operation in a **1000V** system, with frequency of 50 Hz having 100% neutral and integral earth.

The bus duct, tap off boxes, adaptor units shall conform to IEC 61439-6 for all protection certification.

Upward transmission of power inside the buildings shall be done with factory made air insulated compact type rising mains with **copper bus bar** with all accessories i.e; adapter box, cable end box, tap-off box with MCCB. Rating of rising mains shall be decided as per connected load of the building and future expansion and as approved by Engineer – in –Charge. Rating of rising mains in various building shall be minimum of 100 amps, 200 amps (Sc rating for 1 sec. -15KA), 315 amps (Sc rating for 1 sec. - 20KA), 400 amps (Sc rating for 1 sec. - 25KA), 630 amps (Sc rating for 1 sec. - 45KA), 800 amps (Sc rating for 1 sec. - 50KA) as per design / connected load and future expansion.

### **Design & Construction requirements – Sandwich bus bars**

#### **General**

The busbars shall be of sandwich construction, non-ventilated design. It shall be possible to mount the busbar system in any orientation, without affecting the current rating.

The bus duct shall consist of three phases and neutral bus bar permanently positioned dust and vermin proof and the degree of enclosure protection shall be IP 54 for indoor installation and shall be IP-65 with canopy for outdoor installation as per schedule of quantities. Housing shall have provision to run external earthing throughout the trunking.

#### **Busbars**

The bus bars shall of high conductivity, **Copper** as specified in the tender.

Where an earth conductor is required, it shall be a separate, integral earth conductor, of the same high conductivity material as the phase conductors.

#### **Insulation**

The bus bars shall be insulated throughout their length by Epoxy with Mylar/ Mylar class B. The insulation material used shall be of Class B (130 deg. C). The insulation must comply with UL 94 V-O. All insulation material between conductors and joints shall be halogen free and self extinguished type.

The temperature rise at external surface of bus way shall not exceed 55 deg C rise above the ambient temperature as per IEC 61439-6 standards when operating at rated load current.

Protection degree of the housing and joints shall be IP55 for indoor and IP65 for outdoor. Canopy shall be provided throughout the length of bus way for outdoor application.

**Housing:** The housing shall be made of minimum 1.6mm extruded Aluminum case duly enameled sheet steel, with an epoxy powder coated paint finish. The housing shall be profiled suitably, to provide higher strength and efficient heat dissipation and to reduce hysteresis and eddy current losses. The width of the housing shall preferably be the same for all ratings of busbars, in order to provide interchangeability of tap off boxes.

#### **Joints**

The joints between sections shall be made so as to provide flexibility during installation and expansion / contraction of busbar during operation. The joints shall be of the single bolt type and shall be removable as separate sub assembly.

The joint construction must have the following features:-

- a) Heat expansion of at least 3mm per joint.
- b) The joint insulation must be of one piece molded design and not have any cut edges which can absorb moisture.

- c) The joint construction must allow a +/- 14mm adjustment at the time of installation, for ease of adjusting to site measurement variations.
- d) The joint bolt must be insulated with a bolt insulator. The bolt insulator must be of molded one piece.
- e) The joint system must be designed in a way that the installer cannot insert the busduct length too far and damage the bolt insulator.
- f) The busbar ends shall not have holes or slots at the joints – the electrical continuity shall be through pressure plates, achieving a high area of joint cross section and expansion capability.
- g) It shall be possible to install and remove the joints without disturbing the busbar run.

### **End termination**

At the termination either on the transformer side or on the panel side, bus duct shall be provided with flangeends, adopter box and copper flexible (preferably multi sheet types) to connect bus bar of bus duct to bus bar of panels or transformer terminals. Rubber bellows at the transformer end to be provided

#### **Accessories:**

A full range of accessories like bends, end flanges, end feed units, and support brackets etc. shall be available.

### **Installation**

Bus ducts running along the wall shall be supported at intervals not exceeding 1.5 m. In case of branching, there shall be support on all branches at a distance of 300 mm from the point of branching, Support shall not be less than 40 x 40 x 6 mm MS angle secured in an approved manner. Supports may also be provided in the form of brackets fixed to walls where the duct runs along the wall. In case of ceiling suspended bus ducts, supports made out of 40x40x6 mm MS angle iron shall be provided along with 12mm dia MS rod withthreading and nut bolts. The horizontal distance between two such supports shall not be more than 1200 mm. The ducts support shall be suspended from suitable approved suspension devices provided in the ceiling. Fire barrier shall be provided at each floor/wall crossing as per relevant IS code. Continuous earth bus of suitable size shall be provided along with throughout the length of Bus duct. Fire barrier of 2hrs ratings shall be provided on each floor.

### **Testing**

The busbars shall be type tested at a reputed international test laboratory (ASTA or CPRI) for short circuit withstand. The test shall be for a minimum duration of 1 second. Tests shall be performed for all current ratings, covering the different frame sizes of the manufacturer.

Degree of ingress protection (IP rating) shall also be tested at any reputed independent laboratory. This test shall be for IP54 for indoor application and IP65 for outdoor application for sandwiched busbars. All tests should be as per IEC 439 -6.

The following tests shall be carried out at site and test results to be recorded: -

- a) Insulation resistance
- b) Earth continuity test

### **Tap Off Boxes:**

The tap-off box shall have IP55 protection.

Bolt-on tap off boxes shall be installed to the joints without changing or adding any piece. Bolt-on tap offboxes shall be able to be moved between different rated bus ways.

Plug-in tap off boxes shall be suitable to install or removed from bus bars without switching off the power on the bus bar.

Contacts of plug-in tap off box shall be plated by silver.

Tap off boxes shall be manufactured of sheet steel and epoxy painted RAL3020 colour. Plug-in tap off boxes shall have electro-mechanical safety interlock system. Which means;

- a) Electro-mechanical interlock mechanism shall ensure that the tap off box cannot be removed mechanically from the bus bar, when the switch is at "ON" position.
- b) Electro-mechanical interlock mechanism shall ensure that, cover of the box can be opened only, when the switch is at "OFF" position.
- c) When the cover is opened, inside protection degree shall be minimum IP2X against accessing to live conductors.
- d) While inserting the contacts of plug-in tap off box, earth contact shall make the first touch. while removing, it shall be disconnected last.

Tap off boxes shall be suitable for **any brand of MCCBs**. Electromechanical interlock mechanism shall be suitable for all these MCCBs too.

#### **End Feed Unit:**

The End feed unit will be manufactured from 1.6mm thick steel with epoxy painted RAL 7038 ( or any such other shade ). Inside the End feed unit MCCB/ACB of required rating and specification will be located. End feed units at top will be connected to Bus bars of Rising Mains through solid connections. Terminals at the bottom will be provided to accept cable connections as required. The operating handle of MCCB/ACB will be interlocked so that the door can be opened only when MCCB or ACB are in off position. The current rating of MCCB should correspond with current rating of bus bar trunking and short circuit breaking capacity with one second short circuit withstand of bus bar trunking.

#### **Drawing:**

Detailed layout and fabrication 3D drawings showing the sizes of bus bars enclosure, fixing, details, supports, bends, joints, wall entry assembly etc. shall be submitted by the Contractor for approval of Engineer/Employer's comments /modifications suggested by; the Employer shall be incorporated by the Contractor.

#### **Certifications:**

Each bus bar rating shall have a separate type test certificate as per latest IEC 61439-6 from an independent internationally accredited laboratory (like KEMA, ASTA etc.) for all test specified in standard:

- 1) Strength of material and parts

PART 1 - Resistance to corrosion

- 2) Properties of Insulating materials

- a) Thermal Stability of enclosure

PART 2 - Resistance to abnormal heat and fire due to internal electric effect

- 3) Mechanical impact

- 4) Marking

- 5) Ability to withstand mechanical loads

- a) Straight bus bar trunking unit

- b) For joints
- c) Resistance of enclosure to crushing
- 6) Degree of protection of assembly
- 7) Clearance & Creepage distance
- 8) Protection against electric shock and integrity of protective circuit.
  - a) Effective continuity between the exposed conductive parts of the assembly and the protective circuit
  - b) Short circuit withstands strength of the protective circuit.
- 9) Dielectric properties
  - a) Power frequency withstand
  - b) Impulse voltage withstands
- 10) Verification of temperature rise
- 11) Short circuit withstand strength
- 12) Resistance to flame propagation
- 13) Fire resistance in binding penetration
- 14) Impact resistance of IK10 test

Each product shall have a "Type Label" including coding system, which identifies the brand, type of the unit, number of conductors and electrical details. The same coding shall be on the related certificate.

**The size of the conductor should be clearly specified on the certificate.**

**Rating details:**

- (I) Rated Operational Voltage: 1000 V,
- (II) Protection Degree: IP 55 (indoor) & IP65 with canopy (outdoor), IP67 & IP68
- (II) Standard insulation Voltage: 1000 V
- (III) Rated frequency: 50 HZ
- (IV) Impulse voltage: 8 KV
- (V) Asymmetrical short circuit current: As specified in the BOQ
- (V) Maximum Temperature rise above ambient temperature: 55°C
- (VI) Ambient temperature: 50° C peak

**4.0 CABLE TRAY AND RACEWAY:**

**CABLE TRAY**

The cable tray shall be fabricated out of 1.6mm(up to 30mm width) and with 2 mm thick(above 30mm width) slotted/ perforated GI sheets as channel sections, single or double bended. The channel sections

shall be supplied in convenient lengths and assembled at site to the desired lengths. Cable tray shall be galvanized with zinc coating as per CPWD specifications.

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 and cable tray shall be scraped and removed before the installation.

The permissible uniformly distributed load for various type of cables trays and for different supported span shall be as per BIS. The width of the cables tray shall be chosen so as to accommodate all the cables 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 1000mm.

Factory fabricated bends, reducers, tee / cross junction. Etc., shall be provided as per good engineering practice. The radius of bends, junctions etc. shall be less than the minimum permissible radius of bending of the largest size of cable to be carried by the cable tray.

The cable tray shall be suspended from the ceiling slab with the help of 10 mm dia MS round or 25 mm x 5 mm flats at specified spacing. Flat type suspenders may be used for channels up to 450 mm width bolted to cable trays. Round suspenders shall be threaded and bolted to the cable trays or to independent support angle 50 mm x 50 mm x 5mm at the bottom and as specified These shall be grouted to the ceiling slab at the other and through an effective means, as approved by the Engineer, totake the weight of the cable tray with the cables.

The entire tray (except in the case of galvanized 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.

The cable tray shall be bonded to the earth Terminal of the switch bonds at ends.

The cable tray 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.

The ladder type of cable tray shall be fabricated 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 center to center spacing of 250 cm as per BIS.

## **RACEWAY**

**GI Trunking** made up of Pre Galvanized sheet metal with zinc coated steel sheet double folded and arc welded. The double folding ensures that the impact resistant is high and no concrete seepage occurs. Raw Material Specification: (Indian Standards BIS 277:2003). The material thickness should be 1.6mm with a standard length of 2.5mtrs. The trucking should be compartmentalized for provision of data, power and voice cables. The trucking should have a depth as mentioned in the BOQ with three/two/one compartments as mentioned in BOQ. The MT Racks also has their respective joint sleeves, which acts ascouplers to join the lengths.

The joint sleeves too come with pre galvanized sheet steel material with double folding. The joint sleeves

are provided with fixing screws on the top cover to tighten the trucking lengths.

**Access outlets**, manufactured from high-pressure die cast material with top cover made of robust metallic steel plate of 2.5mm thickness. The top lid has a provision for recess of 8mm to accommodate carpet/tiles. The trap cover must be provided with Electrostatic Polyester Epoxy Coating. The trap cover also comes with flexible rubber grommet openings for input cable connections. The trap frame is welded with a die cast to the lid ensuring easy opening and maximum safety to user. The base of the box is made of pre-galvanized sheet steel with a thickness of 1mm. The base box has a provision to accommodate three compartment trucking to run Mains Voltage & Extra Low Voltage cables. The system must have Positive Double Earthing Connections. The base box has the provision to accommodate 25/38mm deep trucking with a Knockout up to 225mm width. The box comes with the accessory tray with power and data plates pre-fixed. These power plates can accommodate a maximum of up to 17 modules of citric wiring accessories. The data plates are angular designed for flexible connection of RJ45 outlets. Height adjustment: The system must have the stainless steel levelling screws to ensure perfect flush with finished floors Available Dimensions: 250\*250\*60-75mm. Load bearing Capacity: Up to 2 tons

## **EARTHING:**

### **Scope**

This chapter covers the essential requirements of earthing system components and their installation. All the earthing works shall be executed in accordance with CPWD General Specifications. For details not covered in these specifications IS code of Practice on Earthing (IS 3043 : 1987) shall be referred to. All the earthing works to be executed as per the approved design & drawings by Engineer-In-Charge.

### Application

- (i) The electrical distribution system in the Department is with earthed neutral (i.e. neutral earthed at the transformer / generator end). In addition to the neutral earthing, provision is made for earthing the metallic body of equipment and non-current carrying metallic components in the sub-station, as well as in the internal/ external electrical installations.
- (ii) Earthing system is also required for lightning protection, computer installations and hospital operation theaters, etc. for functional reasons.
- (iii) Earthing requirements are laid down in Indian Electricity Rules, 1956, as amended from time to time, and in the Regulations of the Electricity Supply Authority concerned. These shall be complied with.
- (iv) **Application for Internal E.I.**
  - (a) Every sub-main will have earth continuity conductor to run along with sub-main wiring. In case of 3-phase sub-main wiring two earth continuity conductors shall be provided.
  - (b) Every circuit will have its earth continuity conductor to run along with circuit wiring. In case of 3-phase circuit two earth continuity conductors shall be provided.
  - (c) Looping of earth is allowed only in case of point wiring.
  - (d) When 2/3 power outlets are looped to one circuit, earth looping of these outlets is permissible.

### Types of Electrodes & Material

#### **Earth Electrodes**



### *Types*

The type of earth electrode shall be any of the following, as specified. (For selection criteria in designs, Appendix F of CPWD Specifications may be referred to).

- (a) Pipe earth electrode.
- (b) Plate earth electrode.
- (c) Strip or conductor earth electrode.

### *Electrode Materials and Dimensions*

- (i) The materials and minimum sizes of earth electrodes shall be as per Table IX (revised).
- (ii) GI pipe electrodes 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 2 m of length from the bottom.
- (iii) The length of the buried strip or conductor earth electrode shall be not less than 15 m. This length shall suitably be increased if necessary, on the basis of the information available about soil resistance, so that the required earth resistance is obtained. Prior approval of the Engineer-in-charge shall be taken for any such increase in length.
- (iv) All hardware items used for connecting the earthing conductor with the electrode shall be of GI in the case of GI pipe and GI plate earth electrodes, and forged tinned brass in case of copper plate electrodes.

### **Earthing Conductor & Sizes**

- (i) The earthing conductor (protective conductor from earth electrode up to the main earthing terminal/earth bus, as the case may be) shall be of the same material as the electrode, viz. GI or copper, and in the form of wire or strip as specified.
- (ii) The size of earthing conductor shall be specified, but this shall not be less than the following (For calculating the size of the earthing conductor in design, Appendix F(CPWD Specifications) para 3.5.1).
  - (a) 4 mm dia (8 SWG) copper wire,
  - (b) 25 mm x 5mm in the case of GI strip, or
  - (c) 25mm x 5mm in the case of copper strip.
- (iii) Earthing conductor larger than the following sectional areas need not be used, unless otherwise specified.
  - (a) 150 sq.mm. in case of GI, or
  - (b) 100 sq.mm. in case of copper.

### **Earth Continuity / Loop Earthing Conductor & Sizes**

- (i) The material and size of protective conductors shall be as specified below (for criteria in design of these Appendix F may be referred to):

Size of phase conductor	Size of protective conductor of the same material as phase conductor
Up to 4 sq.mm. Above 4 sq.mm. up to 16 sq.mm. Above 16 sq.mm. up to 35 sq.mm. Above 35 sq.mm.	Same size as that of phase conductor Same size as that of phase conductor 16 sq.mm. Half of the phase conductor

#### Location for Earth Electrodes

- (v) Normally an earth electrode shall not be located closer than 1.5 m from any building. Care shall be taken to see that the excavation for earth electrode does not affect the foundation of the building; in such cases, electrodes may be located further away from the building, with the prior approval of the Engineer-in-charge.
- (vi) The location of the earth electrode will be such that the soil has a reasonable chance of remaining moist as far as possible. Entrances, pavements and roadways, should be avoided for locating earth electrodes.

### Installation

#### Electrodes

##### *Various Types of Electrodes*

- (i) (a) Pipe electrode shall be buried in the ground vertically with its top at not less than 20 cm below the ground level. The installation shall be carried out as shown in Fig. 11 (revised) (CPWD Spec Internal Electrical works 2013).
- (b) In locations where the full length of pipe electrode is not possible to be installed due to meeting a water table, hard soil or rock, the electrode may be of reduced length, provided the required earth resistance result is achieved with or without additional electrodes, or any alternative method of earthing may be adopted, with the prior approval of the Engineer-in-charge. Pipe electrodes may also be installed in horizontal formation in such exceptional cases.
- (ii) Plate electrode shall be buried in ground with its faces vertical, and its top not less than 3.0 m below the ground level. The installation shall be carried out as shown in Fig. 12 (revised) (CPWD Spec Internal Electrical works 2013).
- (iii) When more than one electrode (plate/pipe) is to be installed, a separation of not less than 2 m shall be maintained between two adjacent electrodes.
- (iv) (a) The strip or conductor electrode shall be buried in trench not less than 0.5 m deep.
- (b) If conditions necessitate the use of more than one strip or conductor electrode, they shall be laid as widely distributed as possible, in a single straight trench where feasible, or preferably in a number of trenches radiating from one point.
- (c) If the electrode cannot be laid in a straight length, it may be laid in a zigzag manner with a deviation upto 45 degrees from the axis of the strip. It can also be laid in the form of an arc with curvature more than 1 m or a polygon.

##### *Artificial Treatment of Soil*

When artificial treatment of soil is to be resorted to, the same shall be specified in the schedule of work. The electrode shall be surrounded by charcoal / coke and salt as indicated in Fig. 11 and 12 (CPWD Spec Internal Electrical works 2013). In such cases, excavation for earth electrode shall be increased as per the dimensions indicated in these figures.

#### *Watering Arrangement*

- (v) In the case of plate earth electrodes, a watering pipe 20 mm dia. Medium class pipe shall be provided and attached to the electrodes as shown in Fig. 11 and 12 (CPWD Spec Internal Electrical works 2013). A funnel with mesh shall be provided on the top of this pipe for watering the earth.

In the case of pipe electrodes, a 40 mm x 20 mm reducer shall be used for fixing the funnel with mesh.

- (vi) The watering funnel attachment shall be housed in a masonry enclosure of size not less than 30 cm x 30 cm x 30 cm.
- (vii) A cast iron / MS frame with MS cover, 6 mm thick, and having locking arrangement shall be suitably embedded in the masonry enclosure.

#### **Earthing Conductor (Main Earthing Lead)**

- (i) In the case of plate earth electrode, the earthing conductor shall be securely terminated on to the plate with two bolts, nuts, check nuts and washers.
- (ii) In the case of pipe earth electrode, wire type earthing conductor shall be secured as indicated in Fig. 11 (CPWD Spec Internal Electrical works 2013) using a through bolt, nuts and washers and terminating socket.
- (iii) A double C-clamp arrangement shall be provided for terminating tape type earthing conductor with GI watering pipe coupled to the pipe earth electrode. Galvanized "C" shaped strips, bolts, washers, nuts and check nuts of adequate size shall be used for the purpose.
- (iv) The earthing conductor from the electrode up to the building shall be protected from mechanical injury by a medium class, 15 mm dia. GI pipe in the case of wire, and by 40 mm dia, medium class GI pipe in the case of strip. The protection pipe in ground shall be buried at least 30 cm deep (to be increased to 60 cm in case of road crossing and pavements). The portion within the building shall be recessed in walls and floors to adequate depth in due co-ordination with the building work.
- (v) The earthing conductor shall be securely connected at the other end to the earth stud/earth bar provided on the switch board by:
  - (a) Soldered or preferably crimped lug, bolt, nut and washer in the case of wire, and
  - (b) Bolt, nut and washer in case of strip conductor.

In the case of sub-stations or alternators, the termination shall be made on the earthing terminal of the neutral point on the equipment and/or the earth bus, as the case may be.


#### **Loop Earthing/ Earth Continuity Conductor**

- (i) Earth terminal of every switchboard in the distribution system shall be bonded to the earth bar/ terminal of the upstream switch board by protective conductor(s).
- (ii) Two protective conductors shall be provided for a switchboard carrying a 3-phase switchgear thereon.
- (iii) Loop earthing of individual units will not be however necessary in the case of cubicle type

switchboards.

- (iv) The earth connector in every distribution board (DB) shall be securely connected to the earth stud/ earth bar of the corresponding switch board by a protective conductor.
- (v) The earth pin of socket outlets as well as metallic body of fan regulators shall be connected to the earth stud in switch boxes by protective conductor. Where the switch boxes are of non-metallic type, these shall be looped at the socket earth terminals, or at an independent screwed connector inside the switch box. Twisted earth connections shall not be accepted in any case.
- (vi) Earth Resistance
- (vii) The earth resistance at each electrode shall be measured. No earth electrode shall have a greater ohmic resistance than 5 ohms as measured by an approved earth testing apparatus. In rocky soil the resistance may be up to 8 ohms.
- (vii) Where the above stated earth resistance is not achieved, necessary improvement shall be made by additional provisions, such as additional electrode(s), different type of electrode, or artificial chemical treatment of soil etc., as may be directed by the Engineer-in-charge.

**Marking**

- (viii) Earth bars/terminals at all switch boards shall be marked permanently, either as "E" or as 
- (ix) Main earthing terminal shall be marked "SAFETY EARTH – DO NOT DISCONNECT".

**Use of Residual Current Devices (RCDs)**

An extract on selection and application of RCDs (also known as RCCBs) from IS 12640: 1988 is given at Appendix G. Provision of RCD shall be specified in individual cases keeping in view the type, use, importance, system of earthing and nature of electrical installations to be protected by the RCCBs, requirements of the local electric supply company, etc. The sensitivity shall be 30 mA, 100 mA, 300 mA, or 500 mA, as specified.

TABLE IX (Revised)  
**Materials and Sizes of Earth Electrodes**  
 [Clause 8.2.1.2(i)]

<b>Type of Electrodes</b>	<b>Material</b>	<b>Size</b>
Pipe	GI medium class	40 mm dia 4.50 m long (without any joint)
Plate	GI	60 cm x 60 cm x 6 mm thick
	Copper	60 cm x 60 cm x 3 mm thick
Strip	GI	100 sq. mm section
	Copper	40 sq. mm section
Conductor	Copper	4 mm dia (8 SWG)

**Note :** Galvanization of GI items shall conform to Class IV of IS 4736 : 1986.

**NOTE: (i)All Earthing works shall be carried out as per CPWD General Specifications for Electrical works with latest amendments up to date.**

**(ii)The Neutral earthing of DG sets shall be done with Copper plate earthing only.**

## **LIGHTNING PROTECTION:**

### **General :**

Lightning Protection System shall be in accordance with IEC 62305-3, and NBC -2016. Zone of Protection The zone of protection of a lightning conductor defines the space within which a lightning conductor provides protection against a direct lightning stroke by diverting the stroke to itself. For a single vertical conductor, this zone is described as a cone with its apex at the highest point of the conductor and with an angle called as protective angle. For the purpose of providing an acceptable degree of protection the protective angle of termination network shall be considered as 4°. Between two or more vertical conductors of equal height spaced at a distance not exceeding twice their height, the protective angle within the space bounded the air termination shall be taken as 60° to the vertical, while the protective angle away from the conductor will be taken as 45° to the verticals.

Selection and execution of lightning protection system as per the approved design and drawings and instructions of Engineer-In-Charge.

### **Material and Dimensions:**

The materials of lightning conductor, down conductors, earth termination etc. shall be copper / GI as per schedule of quantities and shall be protected against corrosion. All air terminations and down conductors shall be of copper / GI as per schedule of quantities and shall conform to BIS/IEC: 62305-2010.

### **Joints and Bonds**

The lightning protective system shall have as few joints as far as possible. Wherever joints in the conductor are necessary they shall be mechanically and electrically effective, and shall be riveted and brazed in case of copper and by welding / bolting in case of GI in an approved manner. Earth Terminations Each down conductor shall have an independent earth termination. All the earth termination shall be interconnected and shall be capable of isolation for testing.

### **Earth Electrode**

Earth pits shall be as specified. The resistance of earthing system shall not exceed 1 ohm

### **Air Terminations Mesh (On the Terrace)**

As an alternative to vertical air termination, grid of horizontal air termination may also be provided as per BIS2309/IEC:62305-2010. Often combination of both may be provided when structure to be protected for high ratio of length to height. Air termination mesh shall be provided not greater than 10mx20m. Down conductor shall be not more than 10 m apart where the building height in more than 20 m.

The design shall be made according to BIS:2309/IEC 62305-3 using any or combination of three method - Rolling sphere, Angle of protection and Mesh method as per defined lightning protection level.

✓ Rolling sphere method

✓ Mesh method

✓ Protective angle method

The designing is based on level of protection of individual building / structure determined by Risk assessment. It differentiates between four classes of lightning protection system. A Class I lightning

protection system provides the maximum protection and a Class IV, by comparison, the least.

Lightning protection level LPL	Probabilities for the limit values of the lightning current parameters		Radius of the rolling sphere (final striking distance $h_p$ ) r in m	Min. peak value of current I in kA
	< Max. values acc. to Table 5 IEC 62305-1 (EN 62305-1)	> Min. values acc. to Table 6 IEC 62305-1 (EN 62305-1)		
IV	0.84	0.97	60	16
III	0.91	0.97	45	10
II	0.97	0.98	30	5
I	0.99	0.99	20	3

### Relations between lightning protection levels.

The rolling sphere method is the universal method of design particularly recommended for all types of buildings / structure especially to geometrically complicated applications.

Separation distance shall be considered while designing the ELP as per IEC 62305-3 which is essential to avoid creepage flashover. It can be achieved either by maintaining physical separation distance or by use of High voltage insulated (HVI) cable, as a down conductor to compensate the need of the separation distance.

Lightning Protection components shall be tested for natural weathering and exposure to corrosion i.e. Salt Mist Treatment test according to EN 60068-2-52 and Humid Sulphurous atmosphere treatment test according to BS EN ISO 6988.

Metal compatibility shall be ensured to avoid corrosion and contact resistance at connection point.

External Lightning Protection comprises of below listed items: All components shall meet the requirement of IEC 62305. standard.

### Down conductor

In order to reduce probability of damage it is often necessary to have several parallel current paths. As recommended by BIS/IEC:62305-2010 equal spacing of down conductors, 8 mm Copper \ AL \ GI external strip, around the building perimeter.

The down conductor must be kept in constant physical contact with the structure via conductive mounting clamps.

Each down conductor shall be directly connected at the dedicated earthing pit and the dedicated earth pit shall be connected to the other earth pits in the earthing grid.

## Fasteners

Conductors shall be securely fixed to the building to be protected by fasteners which shall be not more than 1.20 meter apart for horizontal run and 1.0 meters for vertical run.

1	Air terminal	It shall be made of Aluminum/ GI or it's alloy, as far as possible drilling shall be avoided on roof top, The terminal shall withstand wind velocity of 145 KM/hour.
2	Down conductor	Preferably round conductor (long length, minimum joints) shall be made of Aluminum / GI or it's alloy, min dia 8 mm.
3	Clamp for support to conductor	The conductor shall be supported with the structure at every 1 mtr, as far as drilling shall be avoided on roof top.
4	Expansion piece	It shall be used at every 20 -25 mtr to compensate the expansion and contraction of metal due temperature variation.
5	Cross connectors	In case of conductors are crossing one over another/ T joints "cross connector clamp" (universal clamps) shall be used.
6	Test clamps	It shall be used for every down conductor at 1(approx.) meter above to ground level (connection /disconnection purpose).
7	Equi-potential bond	All metal (natural conductor) components shall be bonded together with roof/down conductor for equi-potential bonding

## Workmanship

As per IS & instruction of Engineer In charge.

**NOTE: All Lightning protection works shall be carried out as per CPWD General Specifications for Electrical works with latest amendments up to date.**

## **MV CABLES AND LAYING:**

### **MEDIUM VOLTAGE CABLES AND LAYING SCOPE :**

The scope consists of Supply, laying, testing and commissioning of L.T. XLPE Cable.

#### **Standards :**

AS PER SCHEDULE OF APPLICABLE INDIAN STANDARDS

#### **Cables :**

All cables shall be 1100 Volt grade XLPE insulated PVC sheathed with or without steel/GI wire or flat armoring as specified s. The cable shall conform to BIS-7098, Part I. The conductors shall be composed of annealed Bare or tinned of high conductivity copper or Aluminium complying to BIS and cores colour coded to the Indian Standards. All cables laid up to load should be without any joint.

All cables shall be new without any kind or visible damage. The manufacturers name, insulating material, conductor size and voltage class shall be marked on the surface of the cable at every 600 mm centers.

#### **Insulation:**

The core insulation shall be with PVC compound applied over the conductor by extrusion and shall confirm to the requirement of BIS-5831.

Core identification shall be provided with prominent and indelible Arabic numerals on the outer surface of the insulation colour as under.

Single core	- Red, Black, Yellow or blue.
Two core	- Red and Black.
Three core	- Red, Yellow, and blue.
Four core	- Red, Yellow, Blue and Black.
3.5 core	- Red, yellow, Blue and Black.(Reduced neutral)
Five core	- Red, Yellow, Blue, Black and Light Grey.

In case of cables having more than 5 cores two adjacent (counting and directional) in each layer shall be colored Blue and yellow respectively and the remaining cores shall be light grey.

#### **Inner Sheath:**

The inner sheath shall be applied over the laid up cores by extrusion and shall be of extruded XLPE compound.

#### **Armouring:**

Armouring shall be applied over the inner sheath. Armour shall be of galvanized round steel wires up to the cable diameter of 13 mm and above 13 mm galvanized flat steel wires shall be provided. Requirement and methods of tests for armoured material and uniformity of galvanism shall be as per BIS-3975 and BIS -2633.



The outer sheath for the cables shall be applied by extrusion and shall be of PVC compound conforming to the requirement of compound of BIS-5831 for protection of the cable against atmospheric effect. Pollution rodent and termite attack suitable chemical shall be added in PVC compound. Colour shall be black.

#### Testing and Inspection:

All the cables shall be tested and examined at the manufacturer work as per BIS code. All the materials employed in the manufacturing of cable shall be subject to examination and testing after manufacture of cable.

All routine and acceptance tests in accordance with the relevant standard shall be conducted on each size of cables and shall be submitted to Employer at the time of hand over.

#### Packing and Marking:

Cables shall be dispatched in wooden drums of suitable barrel diameter, securely battened with the take off end fully protected against mechanical damage. The wood used for construction of the drum shall be properly seasoned. Sound and free from defect. Wood preventative shall be applied to the entire drum. On flange of the drum, necessary information such as manufacturers name, type, size, voltage grade of cable, length of cable in meters, drum no., cable code, ISI certification mark gross weight etc. shall be printed. An arrow shall be printed on the drum with suitable instructions to show direction of rotation of the drum. Cable shall be supplied in drum length as follows.

#### Workmanship for cable

##### Installation

- a) Cables shall be laid in the routes marked in the drawings. Where the route is not marked, the contractor shall mark it out on the drawings and also on the site and obtain the approval of the Engineer before laying the cable. Procurement of cables shall be on the basis of actual site measurements and the quantities shown in the schedule of work shall be regarded as a guide only.
- b) Cables, running indoors shall be laid on walls, ceiling, inside shafts or trenches. Single cables laid shall be laid in GI/PVC pipe and not to fix on wall slab directly or drawn through GI / PVC pipes fixed on wall or ceiling and supported at not more than 500 mm. Where number of cables is run, necessary ladder type cable trays shall be provided wherever shown. laid in built-up trenches shall be on steel supports. Plastic / Aluminum identification tags shall be provided at every 30 m. All cables laid shall be properly dressed and at least 50 mm space shall be kept between the cables.
- c) Cables shall be bent to a radius not less than 12 (twelve) times the overall diameter of the cable or in accordance with the manufacturer's recommendations whichever is higher.
- d) In the case of cables buried directly in ground, the cable route shall be parallel or perpendicular to roadways, walls etc. Cables shall be laid on an excavated, graded trench, over a sand or soft earth cushion to provide protection against abrasion. Cables shall be protected with brick or cement tiles on all the three sides as shown on drawings. Width of excavated trenches shall be as per drawings. Backfill over buried cables shall be with a minimum earth cover of 750 mm to 1000 mm. The cables shall be provided with cables markers at every 20 meters and at all loop points.
- e) The general arrangement of cable laying is shown on drawings. All cables shall be full runs from panel to panel without any joints or splices. Cables shall be identified at end termination indicating the feeder number and the Panel/Distribution board from where it is being laid. cable termination for conductors

upto 4 sq.mm. may be insertion type and all higher sizes shall have tinned copper compression lugs. Cable termination shall have necessary brass glands. The end termination shall be insulated with a minimum of six half-lapped layers of PVC tape. Cable armoring shall be earthed at both ends.

- f) In case of cables entering the buildings. It would be done duly only through pipes. The pipes shall be laid in slant position. So, that no rain water may enter the building. After the cables are tested. The pipes shall be sealed with M. seal & then tarpaulin, shall be wrapped around the cable for making the entry of water tight.
- g) All cables shall be provided with stainless steel/Aluminum cable identification tags at a maximum distance of 30m.
- h) All cables to be laid should be properly dressed and at least 50 mm space should be kept between the cables.

Testing :

MV cables shall be tested upon installation with a 500 V Meggar and the following readings established:

- 1) Continuity on all phases.
- 2) Insulation Resistance.
  - (a) between conductors.
  - (b) all conductors and ground.

All test readings shall be recorded and shall form part of the completion documentation

#### **MV CABLE JOINTING & END TERMINATIONS SCOPE :**

The scope consists of Supply, testing and commissioning of L.T. XLPE Cable terminations.

#### **Cable joints and termination:**

##### **Connectors:**

Cable terminations shall be made with copper/Aluminium Heavy duty long neck copper crimping lugs only crimped type solderless lugs for all aluminium cables and stud type terminals. For copper cables copper crimped solderless lugs shall be used.

Crimping shall be done with the help of hydraulically operated crimping tool. All cable lugs should be long neck type only.

##### **Cable Glands:**

Cable glands shall be of heavy duty brass single compression type as specified. Generally single compression type cable glands shall be used for indoor protected locations and double compression type shall be used for outdoor locations. Glands for classified hazardous areas shall be CMRS approved.

### **Ferrules:**

Ferrules shall be of self-sticking type and shall be employed to designate the various cores of the control cable by the terminal numbers to which the cores are connected, for ease in identification and maintenance.

### **Cable joints:**

Kit type joint shall be done and filled with insulating compound. The joint should be for 1.1 KV grade insulation.

### **Workmanship for cable termination**

Cable joints shall be done as per regular practice and check shall be carried out for loose connections and leakages. Insulation cutting shall be done properly taking care that no area of the conductor remains exposed. Crimping shall be done with the help of hydraulic tool.

### **Additional points to be noted and complied:**

**Meter Boards:** Meter boards shall be fabricated 14 SWG CRMS sheet. It should be of cubical construction, powder coated. Number of Energy meters to be accommodated in each meter board shall be equal to no. of quarters at each building. Each meter board shall be equipped with 4P MCB/SPNMCB of suitable rating as incomer and as decided by Engineer-in-charge and MCB of suitable rating for each compartment, digital type MFM, selector switches, LED type indication lamps etc. All energy meter should be with RS – 485 port/MODBUS and should be CT operated. Meter board shall be fabricated from a CPRI approved fabricator after approval of drawing from Engineer-in-charge.

1. The breaking capacity of MCCB for all types of panel boards except DBs shall be minimum 35KA for ratings upto 200A and 50KA for 250A ratings & above. The rated service breaking capacity should be equal to rated ultimate breaking capacities ( $I_{cs}=I_{cu}$ ). Where  $I_{cs}$  is service breaking capacity and  $I_{cu}$  is ultimate breaking capacity and they should be of approved make. The MCB/MCCB shall be same make of approved company.
2. LT Distribution Panels: In all buildings, the panel boards shall be of modular type and fabricated as per CPWD Specifications. The incomers, outgoing, bus bar, indicating instruments etc. shall be designed as per connected load and shall be got approved from Engineer-in-charge.
3. All types of panel shall be fabricated from CPRI approved firms and strictly as per CPWD specifications. The drawing of panel boards must be got approved from Engineer – in – charge before fabrication work. The panel board shall consist of MCCB/ACB as incomer and outgoing, Aluminium bus bar, digital type ammeter, voltmeter OR multifunction meter, selector switches, LED type indication lamps etc as per standard sound engineering practice. Every multi-function meter should have RS 485 port/MODBUS.
4. **Rising mains:** Upward transmission of power inside the buildings shall be done with factory made air insulated compact type rising mains with copper bus bar with all accessories i.e; adapter box, cable end box, tap-off box with MCCB. Rating of rising mains shall be decided as per connected load of the building and future expansion and as approved by Engineer – in – Charge. Rising mains shall be conforming to IS 8623, TEC 439 as amended up to date. Rating of rising mains in various building

shall be minimum of 200 amps (Sc rating for 1 sec. -15KA), 315 amps (Sc rating for 1 sec. - 20KA), 400 amps (Sc rating for 1 sec. - 25KA),630 amps (Sc rating for 1 sec. - 45KA),800 amps (Sc rating for 1 sec. - 50KA) as per design / connected load and future expansion.

5. Staircase lighting shall be group controlled. Lobby and Toilet lights shall be controlled by occupancy sensors. Configuration tool for sensor programming shall also be provided. There shall be arrangement of Bye pass switch so that in case of failure of sensor, the light can be operated after bypassing the sensor. Therefore, one control switch for common light shall be provided at each floor.
6. Minimum size of copper conductor for power wiring shall not be less than 4 Sq mm and that for light and fan points wiring shall be 1.5 sq mm.
7. The wiring and conduit route plan/drawings shall be submitted by the contractor and shall be got approved from the Engineer-in-charge.
8. To facilitate drawing of wires, 18 SWG GI fish wire shall be provided along laying of recessed conduit. Conduits laid for other services, like fire alarm etc., where wiring is not done along IEI works, fish wire shall be invariably drawn.
9. The connection between incoming switch / isolator and bus bar shall be made of suitable size of thimble and cable.
10. While laying conduits for fire alarm system, sufficient junction outlets are to be provided as per the direction of the Engineer-in-Charge for detectors as required.
11. After completing the work, necessary test results as envisaged in CPWD General Specifications Part-I (Internal)-2013 & Indian Electricity Rules 1956, shall be recorded and submitted to the department. The results shall be in the permissible limits. Test report forms duly signed by authorized person for obtaining electric connections (energy meters) by the agency shall be given to the allottees.
12. Lightning arresters shall be provided for all buildings irrespective of height as per IS 2309-1989 as amended up to date and CPWD specifications for internal work – 2013.
13. Isolator and RCCB of 30 ma sensitivity of suitable rating shall be provided as Incomer of each Distribution boards.
14. Lighting luminaries (LED type) in all buildings shall be decided as per functional requirement, design and drawing approved.
15. In each building, wherever lift is provided, power supply to DBs located in Lift shaft at suitable location as approved by Engineer-in-charge shall be done using suitable XLPE insulated armored cable. Supply of cable shall be in the scope of work.
16. Inside the lift shaft there shall be arrangement of one light point at each floor level and one light point at overhead, one light point in lift pit. All light points shall be in group controlled and wired with 2.5 sq mm FRLS copper conductor cable. 15-amp power plug and 5-amp power plug shall be provided at alternate floor. Wiring of these power plugs shall be done with 4 sq mm FRLS copper wires. LED Bulk head fittings of suitable rating to provide minimum lux of 100 shall be connected with each point of lift shaft.

17. For accommodating various size of cable incoming to the building, NP2 class light duty complete with RCC Collar jointing with cement mortar 1:2 pipes of suitable size shall be provided.
18. The scope of work includes 1.1 KV XLPE LT UG Armoured Aluminium cables (Confirming to IS 7098 Part-1) from main substation to all individual buildings for service connection as per the approved load details and drawings.
19. Size of distribution board shall be as per number of light / power circuits. All distribution boards shall be double door type RCBO of suitable rating shall be provided as main incomer in all DBs.
20. In vertical DBs used for power distribution main incomer shall be MCCB of suitable rating breaking capacity not less than 16KA,  $I_{cs}=I_{cu}$ .
21. LT panel shall be cubicle type with IP 54 protection class and fabricated from CPRI approved fabricator and shall be equipped with digital type measuring instruments like ammeter, voltmeter, frequency meter, watt meter, multi-function meter etc. as per drawing approved by Engineer – in – charge.
22. Each LT Panel shall be fabricated from 1.6 mm thick M.S. sheet powder coated 7 tank process and shall be equipped 4 pole MCCBs/ACBs, MCBs, Bus bar, digital voltmeter, ammeter, KWH meter, LED indicating lamp extended rotary handle and all accessories as required.
23. If used as incomer then it should have earth fault protection and time delay in addition to above protection. Earth leakage modules are not acceptable.
24. Earthing: Earthing system comprising of earth electrode, earth conductor, earth bus, protective conductor etc. for each building shall be as per provision laid down in CPWD Specifications Part – I 2013. Earthing system should be designed such as to maintain earth resistance as specified in CPWD specifications. Earth resistance shall be checked / tested in harsh climatic conditions.

### **Cable laying and Jointing**

(i) All Cables for external lights between pole to pole shall be laid through DWC HDPE pipes of required size with 50% space capacity and the main incoming cable from main panel to the feeder pillar panel shall be laid through RCC hume pipes. A Pipes shall be buried under ground at required depth as per direction of E-I-C. There shall be separate pipes for electrical cable and Data/signaling cable. Same pipe shall not be used to carry data and Electrical power cable

(ii) Cable shall have GI wire earthing not less than 6 SWG. Earthing can be looped for common run of wires.

(iii) The cable joint shall be weather and water proof connectors only. Twisted cable joint with electric tap will not be accepted.

(iv) At each pole about 1.5 R meter cable shall be kept extra for future maintenance.

(v) Before laying of cable, it will test for its continuity and physical damage.

(vi) Cable shall be laid with zero joints. If joint is unavoidable, it shall be planned in chamber. RCC / brick work chambers shall be provided at every 50 meters to facilitate cable drawings and maintenance.

### **Format of Completion Certificate for Internal Electrification works**

I/We certify that the installation detailed below has been installed by me/us and tested and that to the best of my/our knowledge and belief it complies with Indian Electricity Rules, 1956, as well as the C.P.W.D. General Specifications of Electrical Works Part I Internal 2013.

Electrical installation at .....  
Voltage and system of supply .....

### I. Particulars of work:

- |  |                                     |
|--|-------------------------------------|
| (a) Internal Electrical Installation No.   | Total Type or system Load of wiring |
| (i) Light point  |                                     |
| (ii) Fan point   |                                     |
| (iii) Plug Point   |                                     |
| (a) 3 pin 5 Amp.   |                                     |
| (b) 3 pin 15 Amp.  |                                     |
| (b) Others Description HP/KW Type of Starting (a)Motors:                         |                                     |
| (i)  |                                     |
| (ii)   |                                     |
| (iii)  |                                     |
| (b) Other plants:  |                                     |
| (c) If the work involves installation of overhead line and/or underground cable. |                                     |
| (d) (i) Type & description of overhead line.                                     |                                     |
| (ii) Total length and no. of spans.  |                                     |
| (iii) No. of street lights and its description.                                  |                                     |
| (e) (i) Total length of underground cable & its size.                            |                                     |
| (ii) No. of joints: End joint : Tee joint: St. through joint:                    |                                     |

### II. Earthing

- (i) Description of earthing electrode.
- (ii) No. of earth electrodes.
- (iii) Size of main earth lead.

### III. Test results:

- (a) Insulation resistance
  - (i) Insulation resistance of the whole system of Conductors to earth –Mega ohms
  - (ii) Insulation between the phase conductor and neutral Between Phase R and neutral – Mega ohms Between Phase Y and neutral –Mega ohms Between Phase B and neutral – Mega ohms
  - (iii) Insulation resistance between the phase conductors in case of poly phase supply. Between Phase R and Phase Y – Mega ohms Between Phase Y and Phase B –Mega ohms Between Phase B and Phase R – Mega ohms
- (b) Polarity test  
Polarity of linked single pole branch switches.
- (c) Earth continuity test  
Maximum resistance between any point in the earth continuity conductor including metal conduits and main earthing lead Ohms
- (d) Earth electrode resistance of each earth electrode
  - (i) Ohms
  - (ii) Ohms
  - (iii) Ohms
  - (iv) Ohms

(e) Lighting protective system

Resistance of the whole of lightning protective system to earth before any bonding is effected with earth electrode and metal in/on the structure ..... Ohms.

**Signature and name of Contractor**

**Signature and Name of the Junior Engineer (E) / AE (E)**

**UNDERTAKING LETTER FROM MANUFACTURERS OF LED FITTINGS**  
**(ON THEIR LETTER HEAD)**

**We hereby agree that:**

- 1. All the LED fittings supplied by us are guaranteed for five years including drivers from the date of handing over.**
- 2. In case of discontinuation of model and non-availability of spares, we will replace the fittings with equivalent/high end model in case of manufacturing defect during the warranty period of 5years.**

**For M/S.....**

**Authorized signatory of manufacturer of LED  
luminaries)**

**Counter Signature,**

**Major contractor**

**LOWEST BIDDER TO SUBMIT THIS MAC**  
**Manufactures' Authorization Certificate (MAC) (to be filled by OEMs)**

To  
The Engineer-in-Charge,  
Construction and Maintenance Division  
IIT Hyderabad

**Subject: Manufactures' Authorization Certificate for Bid Number/Tender Ref No.:**

Sir,

We.....**OEM Name** ..... having our registered office  
..... who are established and reputed original equipment  
manufacturers (OEMs) having factories at {addresses of manufacturing location} do hereby authorize  
..... **Bidder name and address** ..... who is our {distributor / Channel Partner /retailer  
/other <please specify>} to bid, negotiate and conclude the contract with you against and aforementioned  
reference for the following Hardware / Software manufactured by us.

We also hereby declare that we will support fully for supply of all genuine spares components and  
software up gradation for the installed system for five years from the date of commissioning of system  
and also attend any manufacturing defect for five years on behalf of the bidder.

Yours faithfully,

For and on behalf of M/s (Authorized signatory)

Name, designation & contact no. Email Id:

Address:

Seal



**Scope of work and Technical specifications for External Service Connections, MV Panels at Substation side and DG sets, Earthing System—for the following sub heads mentioned in the payment schedule.**

- 1 . Sub-head A7 (Annexure A7)
- 2 . Sub-head B7 (Annexure B7)
- 3 . Sub-head C7 (Annexure C7)
- 4 . Sub-head D8 (Annexure D8)
- 5 . Sub-head E8 (Annexure E8)
- 6 . Sub-head F8 (Annexure F8)
- 7 . Sub-head G8 (Annexure G8)
- 8 . Sub-head H8 (Annexure H8)

## **SCOPE OF WORK AND SPECIFICATIONS FOR L.T. POWER DISTRIBUTION AT SUBSTATIONS AND BUILDINGS LEVELS**

### **Scope:**

#### **1. For Faculty Residential Buildings.**

The scope of work includes Design, supply, installation, commissioning, testing and handover of Power distribution system to supply electricity through LT cables to make Faculty Towers buildings E&M services functional complete as per approved design and drawings and instructions of E-I-C.

#### **A) Main Power Distribution from Substation (SV-7):**

1. The Power supply to Faculty residential buildings will be given from the existing emergency power supply and normal power supply panels at SV-7 substation by augmentation of these existing panels.
2. Augmentation of existing both Emergency and Normal LT Panels at SV-07 substation including Design, fabrication, Supplying, Installation, testing and commissioning of cubical type LT panel with suitable rating of bus bar extension at SV-07 substation.
3. The necessary switchgears i.e., MCCBs, ACBs, relays etc. shall be provided as per the approved drawings by the Engineer-In-charge. All the MCCBs, ACBs shall be provided with microprocessor based release having overcurrent, short circuit and earth fault protection.
4. Sufficient length, multiple runs of suitable size LT cable shall be laid from the SV-07 substation to the proposed LT Panels located at the Proposed Faculty towers in cable tray, RCC Humes pipes wherever required. The cables shall be with multiple runs.
5. Decision of laying LT cable in cable tray, RCC Hume pipe etc shall be on complete discretion of Engineer-In-charge and same shall be binding on the contractor, hence bidders are requested to quote accordingly. In case of cable laying through RCC hume pipes then Man hole at every 25mtrs. of distance shall be provided.
6. Also the contractor shall measure the actual required length of cables on site and quote the rates accordingly.

#### **B) LT Distribution:**

<b>S.No.</b>	<b>Name of Building</b>	<b>Type of Building</b>	<b>Quantity</b>	<b>Scope of Work</b>
1	Proposed Faculty Residential Buildings	C Type	2	a) Design, supply, installation, testing and commissioning of LT Panels which shall be feeding the Faculty Housing towers (2 nos.) which is having 4P, 415V, microprocessor based MCCB/ACB incomer and MCCB/ACB outgoing of suitable rating for feeding E&M service requirements of respective block as per the Internal Power distribution scheme given in this tender document. b) Each Flat should have independent 3 Phase Distribution Board with suitable protection system to cater power requirement of the flat.

## 2. Staff Residential Buildings:

The scope of work includes Design, supply, installation, commissioning, testing and handover of Power distribution system to supply electricity through LT cables to make Staff Residential buildings E&M services functional complete as per approval of E-I-C.

### A) Main Power Distribution from Substation (SV-8):

- i) The Power supply to Staff Housing Towers will be given from the existing emergency power supply and normal power supply panels at SV-8 substation by augmentation of these existing panels
- ii) Augmentation of both Emergency and Normal LT Panels at SV-8 substation including Design, fabrication, Supplying, Installation, testing and commissioning of cubical type LT panel with suitable rating of bus bar extension at SV-08.
- iii) The necessary switchgears i.e., MCCBs, ACBs, relays etc. shall be provided as per the approved SLD by the Engineer-In-charge. All the MCCBs, ACBs shall be provided with microprocessor-based release having overcurrent, short circuit and earth fault protection.
- iv) Sufficient length, multiple runs of suitable size LT cable shall be laid from the SV-08 substation to the proposed LT Panels located at the Proposed Staff tower in cable tray, RCC Humes pipes wherever required. The cables shall be with multiple runs.
- v) Decision of laying LT cable in cable tray, RCC Hume pipe etc shall be on complete discretion of Engineer-In-charge and same shall be binding on the contractor, hence bidders are requested to quote accordingly. In case of cable laying through RCC hume pipes then Man hole at every 25mtrs. of distance shall be provided.
- vi) Also the contractor shall measure the actual required length of cables on site and quote the rates accordingly.

### C) LT Distribution:

S. No.	Name of Building	Type of Building	Quantity	Scope of Work
1	<b>Proposed Staff Residential Buildings</b>	Type -D	1	c) Design, supply, installation, testing and commissioning of LT Panels shall be feeding the Staff Housing towers (03 nos.) which is having 4P, 415V, microprocessor based MCCB/ACB incomer and MCCB/ACB outgoing of respective rating for feeding E&M service requirements of respective block as per the Internal Power distribution scheme given in this tender document. a) Each Flat should have independent 3 Phase Distribution Board with suitable protection system to cater power requirement of the flat.
		Type- E	2	

3. **Student Hostel Buildings:** The scope of work includes Design, supply, installation, commissioning, testing and handover of Power distribution system to supply electricity through LT cables to make Student buildings E&M services functional complete as per approval of E-I-C.

**A) Main Power Distribution from Substation (SV-18):**

- i) The Power supply to Students Hostel blocks will be given from the existing emergency power supply and normal power supply panels at SV-18 substation by augmentation of these existing panels.
- ii) Augmentation of both Emergency and Normal LT Panels at SV-18 substation including Design, fabrication, Supplying, Installation, testing and commissioning of cubical type LT panel with suitable rating of bus bar extension at SV-18 substation.
- iii) The necessary switchgears i.e., MCCBs, ACBs, relays etc. shall be provided as per the approved SLD by the Engineer-In-charge. All the MCCBs, ACBs shall be provided with microprocessor based release having overcurrent, short circuit and earth fault protection.
- iv) Sufficient length, multiple runs of suitable size LT cable shall be laid from the SV-18 substation to the proposed LT Panels located at the proposed Hostel buildings in cable tray, RCC Humes pipes wherever required. The cables shall be with multiple runs.
- v) Decision of laying LT cable in cable tray, RCC Hume pipe etc shall be on complete discretion of Engineer-In-charge and same shall be binding, hence bidders are requested to quote accordingly. In case of cable laying through RCC hume pipes then Man hole at every 25mtrs. of distance shall be provided.
- vi) Also the contractor shall measure the actual required length of cables on site and quote the rates accordingly.

**B) LT Distribution:**

S.No.	Name of Building	Type of Building	Quantity	Scope of Work
1	Proposed Students Hostel Buildings		3	<p>(i) Design, supply, installation, testing and commissioning of LT Panels shall be feeding the Student hostel buildings (3 nos.) which is having 4P, 415V, microprocessor based MCCB/ACB incomer and MCCB/ACB outgoings of respective rating for feeding E&amp;M service requirements of respective block as per the Internal Power distribution scheme given in this tender document.</p> <p>(ii) DBs shall be placed at 2 locations in corridor i.e. at each floor. Size and current rating of sub main LT cable shall be minimum 25% above the required current.</p> <p>(iii) Each Room shall have One number single phase MCB DB of suitable rating as per</p>

				approved design by E-I-C to cater power requirement of the Room.
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This Section covers the detailed requirements of medium voltage switch panel for 433 V, 3 phase, 50 Hz, 4 wire system. These shall be branded and/or assembled/ fabricated from a factory of repute. All switchgears shall be fully rated at an ambient of 40°C.

#### 4. TYPE OF PANEL

The medium voltage switch board panel shall comprise of any one of the following types of switchgears or combination thereof as specified.

- (a) Air Circuit breakers draw out or fixed type.
- (b) MCCBs of suitable ICS ratings. MCCBs shall invariably be Current Limiting type. Features like Double Break, Positive Isolation functions shall be preferred.

The Panel shall be indoor type having incoming sectionalization and outgoing switchgears as specified. The design shall be cubical type. The degree of enclosure protection shall be IP 42 as per IS 13947 (Part-I).

<p><b>Main L.T. Panels (both Normal Power Panel and Emergency Power panel)</b></p>	<p>Main Panels for Emergency supply, Normal supply, Utility supply (Lifts, corridor lights, stair case lights, common area lights)</p> <p>Type: Extensible type</p> <p>Bus bars : Aluminium bus bar</p> <p>Incomer : Air circuit breaker of designed capacity</p> <p>No. of ACBs : As per design</p> <p>No. of Bus coupler : As per design</p> <p>Outgoings: ACBs &amp;MCCBs as per load requirement with spare ACBs/MCCBs provision</p> <p>All MCCBs protection release should be Microprocessor based having inbuilt adjustable protections against Over Load (L), Short Circuit (S) and Earth fault with communication port. The breaking capacity of MCCB shall be minimum 36KA for ratings upto 200A and 50KA for 250A ratings &amp; above. The rated service breaking capacity should be equal to rated ultimate breaking capacities (Ics=Icu). 2 amp MCB shall be used for protection of indication lamps / Meters etc. All incoming outgoing ACBs/MCCBs shall be provided with communicable Multi-function meter with RS-484 port showing parameters such as V,I, F, PF, kWh, kVAh, kVA, KW etc.</p> <p>No. of outgoing ACBs and MCCBs shall be as per design and requirements. For future use, number of MCCBs kept in spare shall be equal to 25% of connected MCCBs (Rating wise). Other criteria like protection, interlocking, cable termination, internal wiring, selector switches, multifunction meters etc., shall be as per CPWD specifications and sound engineering practice.</p>
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<b>Out door Feedar Pillars</b>	<ul style="list-style-type: none"> <li>(i) Protection Class : IP 65</li> <li>(ii) Type : Free standing, double door type</li> <li>(iii) Material of enclosure : 2 mm MS sheet</li> <li>(iv) Incomer : MCCBs of designed rating</li> <li>(v) Bus Bar : Aluminium conductor</li> <li>(vi) Outgoing : MCCBs/MCB's</li> <li>(vii) Other accessories like Digital timers for auto operation of street lights, voltmeter, voltmeter selector switch, indicating lamps, selector switch etc., shall be as per CPWD specification, IS code and approved make list.</li> </ul>
<b>L.T. cables</b>	<p>Various sizes of L.T. cables for feeding power to various buildings /services shall be designed and laid between L.T. panel and various buildings / services. Cable route indicators to be provided wherever it is necessary.</p>
<b>Earthing</b>	<p>Earthing work for Body and Neutral earthing of LT Panels shall be done in accordance of provision laid down in CPWD specification for internal EI and substation buildings.</p>

## ADDITIONAL CONDITIONS

### 1.0 GENERAL

#### 1.1 ACCEPTABLE MAKES OF VARIOUS EQUIPMENT

The acceptable makes of various equipment's/components/accessories have been indicated in "List of Approved/Preferred Makes"

#### 1.2 DATA MANUAL AND DRAWINGS TO BE FURNISHED BY THE CONTRACTOR

- a) The contractor shall furnish detailed technical data sheets, literature, pamphlets and performance data after award of work for approval of the Department.
- b) The successful contractor would be required to submit the following drawings before first milestone for approval.
  - (i) General arrangement drawing of the equipment's like LT panels in the buildings with complete dimensions for approvals by the Engineer in charge.
  - (ii) Any other drawings necessary for the job.

- 1.3 The successful tenderer should furnish well in advance three copies of detailed instructions and manuals of manufacturers for all items of equipment's regarding installation, adjustments operation and maintenance including preventive maintenance & trouble shooting together with all the relevant data sheets, spare parts, catalogue etc. all in triplicate.

### 2.0 EXTENT OF WORK

- 2.1 The work shall comprise of SITC of all Equipment complete with entire labour including supervision and all materials necessary to make a complete installation and such tests and adjustments and commissioning, as may be required by the department. The term complete installation shall not only mean major items of the plant and Equipment covered by specifications but all incidental sundry components necessary for complete execution and satisfactory performance of installation all layout charts whether or not those have been mentioned in details in the tender document in connection this contract as this is a turnkey job.

- 2.2 The LT cables shall be brought at site after taking correct measurements since no cable joints shall be permissible during execution of the work.

- 2.3 In addition to supply, installation, testing and commissioning of Equipment, following works shall be deemed to be included in the scope of work to be executed by the tenderer as this is a turnkey job-

- (a) Minor building works necessary for installation of Equipment, foundation, making of opening in walls or in floors and restoring them to their original condition/finish and necessary grouting etc. as required. The opening in the RCC floor/Slab shall have to be carried diamond core cutting machine and resealing shall have to be done by the tenderer.
- (b) All supports for over head bus ducts, cables and MS channels for erection of panels & transformers etc. as are necessary.
- (c) Testing of PTs/CTs for metering and protection purpose and relay calibration and setting.

### 3.0 INSPECTION AND TESTING

- a) All major Equipment i.e. LT panel and feeder pillar boxes etc. shall be offered for initial inspection at manufacturer's works. The contractor will intimate the date of testing of Equipment at the manufacturer's works before dispatch. The successful contractor shall give advance notice of minimum two weeks regarding the dates proposed for such tests to the department's representative to facilitate his presence during testing. Equipment will be inspected at the manufacturer/Authorized Dealers premises, before dispatch to the site by the contractor if so desired by the Engineer-in-Charge.
- b) Copies of all documents of **routine and type** test certificates of the equipment, carried out at the manufacturer's premises shall be furnished to the Engineer-in-Charge and consignee.
- c) After completion of the work in all respects the contractor shall offer the installation for testing and operation.

### 4.0 TRAINING

The contractor shall arrange for at site training by the supplying company of Equipment to the staff deployed by him for proper and effective maintenance of the Equipment.

- 5.0 Sufficient trained and experienced staff shall be made available to meet any exigency of work during the guarantee period of one year from the handing over of the installation.

### 6.0. LT Distribution – GENERAL

6.1. For feeder pillars for street light, ancillary blocks, security blocks and terrace LT panels, shall be PTTA (partially type tested panels), enclosures shall be of non-corrosive materials and shall be made up of at least 2 mm CRCA sheet manufactured by reputed firm and should not be less than IP-42 for indoor applications and IP-65 for outdoor applications with canopy.

6.2. The connection between incoming switch / isolator and bus bar shall be made with suitable size of thimble and cable.

6.3. RCBO of 30 mA/ 300ma sensitivity of suitable rating as per approved design shall be provided as Incomer of each Distribution boards.

6.4. All the switchgears (ACBs) must have Motorized operation and shall be electrical draw out type. In order to ensure the same, required number of potential free NO/NC contacts for both input and output shall be provided with each switchgear.

6.5. For accommodating various size of Power cable/Telephone cable /Data cable incoming to the building/out going from the building sufficient number of GI/ NP2 pipes of suitable size shall be provided.

6.6. Size of distribution board shall be as per number of light / power circuits coming on each floor as per the occupancy. All distribution boards shall be double door type made of minimum 1.6 mm thick sheet and RCBO of suitable rating shall be provided as main incomer in all DBs.

6.7. In MCB DBs used for power distribution, main incomer and outgoing shall be of suitable rating breaking capacity not less than 16KA,  $I_{cs}=I_{cu}$ .

6.8. If MCCB used as incomer then it should have earth fault protection and time delay in addition to above protection. Earth leakage modules are not acceptable.

6.8. For routes carrying both power and communication cables, it is required to lay both the pipes using spacers of not less than 600mm at spacing of 6 meters to ensure the separation in both lines and disturbance shall not be there in communication cables.

6.9. The energy meters for monitoring as per GRIHA norms are required to be with IBMS compatibility and shall be having provision of meter reading by RS485/Ethernet/TCP/IP communication port which shall be communicating required parameters to a required DCU or gateway feeding the IBMS software.



The energy meters of each panel shall be looped with RS 485 ports, and the communication shall be done by laying CAT 6A cables which will be terminating to the GATEWAY required for wireless/wired communication. Near every panel where communication via RS 485 is required, a LAN port shall be provided for ethernet connectivity to gateways.

6.10. The LT Panels as described in substation chapter shall be designed verified/ Totally Type Tested (TTA) as per the standards IEC 61439-1 & 2. The drawing of panel boards must be got approved from Engineer-in-charge before fabrication work. The panel board shall consist of ACB/MCCB as incomer and outgoings, copper bus bars, digital type ammeter, voltmeter OR multifunction meter, selector switches, LED type indication lamps etc as per standard sound engineering practice. As part of GRIHA 3-star requirement for calculating energy consumption of every service, all the outgoings shall be provided with Energy Meter with a communication port.

6.11. All MCCBs and ACBs coming at the level of LT panels, Distribution boards, end feed units, feeder pillars etc shall be controllable and monitored from IBMS software of the building for ensuring the same, the switchgears shall be electrically operated with either soft points communication through RS 485 ports or using field devices (if controlling is not inbuilt in required current rating).

## DG SETS

### 1.0 GENERAL

The localized DG Power back up is required for 01Nos. LIFT each in Staff Towers Bldg. as well as Faculty Towers Bldg. only as per the below mentioned table:

**a) 2 no. Faculty Towers DG Set Rating Calculation:**

Sl. No.	Name of the Building	Rating of Lift	DG Set Rating proposed
1	Construction of G+12 Faculty Housing – Tower FT1A (Type – C) Floors at IITH	20 passenger	82.5 KVA
2	Construction of G+12 Faculty Housing – Tower FT1A (Type – C) Floors at IITH	20 passenger	

**b) 3 no. Staff Towers DG Set Rating Calculation:**

Sl. No.	Name of the Building	Rating of Lift	DG Set Rating proposed
1	Construction of G+12 Staff Housing – Tower ST2A (Type – D) at IITH	20 passenger	100 KVA
2	Construction of G+12 Staff Housing – Tower ST2A (Type – D) at IITH	20 passenger	
3	Construction of G+12 Staff Housing – Tower ST1A (Type – E) Floors at IITH	20 passenger	

**Accordingly, the contractor shall supply, install, testing and commissioning of 01Nos.x82.5kVA DG set and 01Nos.x100kVA DG set as per the specifications provided in the tender document. All the DG set works shall be executed in accordance with CPWD General Specifications for Internal works Part VII DG sets-2013**

Work covered by this contract shall conform to latest CPCB norms effective from July 1, 2004 & up to date include design, manufacture, supply, transportation, delivery, installation, testing and commissioning of automatic start direct coupled Diesel Generator Sets suitable for continuous round the clock operation at up to rated output with permissible overload along with associated works. PLC based DG control Panel for Automatic operation of the DG sets is incorporated in the Main LT Panel. Items included (but not limited to) in the contract are abstracted as below.

- a) Diesel engines directly coupled with alternators mounted on a rigid fabricated steel base frame with resilient anti vibration mountings.
- b) Exhaust piping with Silencer to provide 25 dBA insertion loss
- c) Electric starting equipment including batteries and battery chargers.
- d) Fuel supply system without Bulk Oil Storage and automatically operated Fuel Transmission System.
- e) Statutory approvals including permission from Electric Supply Authority for operation of DG sets, clearance from Electrical Inspector, approval from Pollution Control Board and necessary approvals from Department of Explosive.
- f) Coordination with PLC logic panel manufacturer

## 2.0 STANDARDS

The equipment offered shall conform to the latest revision of relevant Indian or British Standard (BSS.) and Codes together with the requirements of the Local Supply Authority and Department of Explosive etc.

## 3.0 ENGINE AND ACCESSORIES

### 3.1 Engine

The engine shall have the following characteristics:

Type	-	Suitable for generating set application, turbo charged, multi-cylinder, cold starting. The engines shall be provided with electronic fuel injection system
Cycle	-	Four stroke.
Speed	-	1,500 R.P.M.
Speed Variation	-	Within 2% for operation between 10% and 100% load
Method of Starting	-	Battery
Net site output under ambient	-	The engine shall be suitable to deliver the stipulated rating conditions given in clause 3.3 special conditions of contract as net output.

The engine rating shall be stated in the tender in accordance with the latest revision of relevant I.S. or B.S codes. Adequate precautions shall be taken to safeguard the sets against low lubricating oil pressure, high water temperature, over speed and overcurrent.

### 3.2 Fuel Consumption

The engine shall be suitable for satisfactory operation on H.S.D. as locally available. The tenderers shall declare the guaranteed fuel consumption in liters/hr, in accordance with relevant I.S. or B.S codes. at 50%, 75% and 100% of rated load at 0.8 pf. Fuel consumption shall be low so as to deliver minimum 4 units per liter at 75% load.

Such guaranteed fuel consumption is also to be expressed in liters per unit (after supplying the requirements of auxiliaries) at 50%, 75% and 100% of rated load at 0.8 pf.

If guaranteed fuel consumption is exceeded, the Contractor shall make such modifications or alterations as are necessary to bring the consumption to within the guaranteed figures.

Tolerance of + 5% as defined in BSS-649-1958 shall be allowed.

### 3.3 Lubricating Oil Consumption

The tenderers shall state the guaranteed lubricating oil consumption in liters per hour.

### 3.4 Governing

The governor shall be of electronic type **Governor of Class A1 as per ISO 3046/BS5514 with actuator shall be provided as per standard design of manufacturer.** The governor shall be capable of regulating the speed of the engine within the limits approx. 10% of the rated speed within 4 sec due to the sudden application or removal of full load.

### 3.5 Mounting and Foundations

The engine and direct coupled alternator shall be rigidly secured to a common rigid base frame

fabricated from MS sections. The DG set shall be placed on the RCC Floor with GERB or any other approved make antivibration mountings. A lifting hook of required capacity shall be provided above the finalized location of the DG set to facilitate installation and subsequent maintenance of the DG sets. The design of mounting arrangements with antivibration mountings shall be as recommended by the DG manufacturers and shall be such that a maximum of 5% vibrations are transmitted to the building structure. The tenderer shall confirm the type and make of mountings offered and the vibration isolation efficiency in the tender. All rigid pipe / bus bar connections to the DG set shall be made through flexible couplings.

### **3.6 Exhaust System**

#### **3.6.1 Silencer**

The engine shall be fitted with Critical Silencers of design approved by manufacturer to provide minimum 25 dBA insertion loss through the Silencers.

#### **3.6.2 Exhaust Piping**

Silencer outlets shall be connected to exhaust piping carried to the top of the building through shafts provided for the purpose. Exhaust piping shall be fabricated as per IS from MS pipes of size suitable to limit back pressure to within permissible limit. **Contractor shall submit design calculation in support of the back pressure being within limits along with the tender.**

It is important to ensure that the surface temperature of the exhaust piping does not exceed 50°C. For this purpose, the entire length of exhaust piping shall be insulated with minimum 125 mm thick layer of mineral wool or white glass fiber wool (96 kg /m<sup>3</sup> density ) held with chicken wire mesh covered with 0.80 mm (24 SWG) thick aluminium cladding as required. Flanged joints in the exhaust piping shall be covered with removable insulation at suitable intervals for permitting access to the joint if and when required.

Exhaust piping shall be connected to the engine by means of flexible section or an expansion joint and shall also be graded to a drain pocket inside the building (to drain-out water due to condensation and entry of rain water in the exhaust). The pocket shall be fitted with a drain cock.

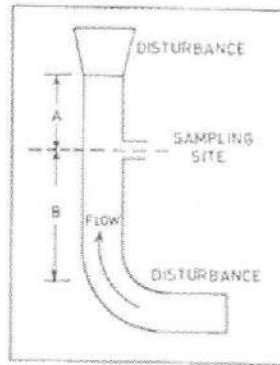
Provision of testing port shall be provided on exhaust pipe line.

##### **3.6.2.1 Sampling provision in the D.G exhaust system shall be made**

**Port type :** Pitot tube, temperature and sampling probe are to be inserted together in to the sampling port for monitoring purposes.

Sampling port should be standard flanged pipe of 0.10 m inside diameter (ID) with 0.15-m bolt circle diameter. An easily removable blind flange should be provided to close the port when not in use. Port should be installed at a height between 0.90 m and 1.2 m above the floor of the working platform.

**Location of sampling point :** To ensure laminar flow, sampling ports shall be located minimum 8 times chimney diameter down stream and 2 times upstream from any flow disturbance.



### 3.7 Air Filters

The engine air intake shall be fitted with a substantial air cleaner of oil bath/ paper element type. The filter shall be suitable for operation under dusty conditions.

### 3.8 Crank Case Breather

The crankcase breather outlet of the engine shall be fitted with a filter cap capable of preventing entry of dust.

### 3.9 Fuel and Lubricating Oil Filters

Filter for fuel and lubricating oil systems shall be of simplex type. Lubricating oil filters shall be of an efficient full flow type of ample capacity and suitable for use with detergent oils. They shall be capable of removing all foreign matter above a particle size of 5 microns.

### 3.10 Lubricating Oil System

The engine shall be of the totally enclosed type and fitted with a positive pressure system of lubrication to all working parts. Lubricating oil shall be circulated in the engine by an engine driven pump. There shall be no moving part requiring lubrication by hand prior to the starting of the engine or while in operation.

### 3.11 Safety Controls

The engine shall be complete with all controls to render the operation of the engine reliable and totally safe including but not restricted to the following

- **Low Lubricating Oil Pressure**

Pressure sensors shall be fitted such that in the event of a fall in the lub oil pressure, an alarm and indication shall be actuated. In addition, the engine shall be automatically shut down in the event of lub oil pressure dropping to a predetermined low value. Potential free contacts for conveying the signal to BMS shall be provided

- **High Water Temperature**

An alarm shall be given if the close loop engine jacket cooling water temperature exceeds safe limits stipulated by the engine manufacturer due to any reason (including low level of water in secondary cooling system cooling tower). The engine shall be shut down when a pre-determined set water temperature is reached. Potential free contacts for conveying the signal to BMS shall be provided.

- **Over Speed**

Speed control shall be so arranged that a 12-1/2% increase over normal rated speed shall cut off fuel supply, thus stopping the engine. Potential free contacts for conveying the signal to BMS shall be provided.

- **Overload Protection**

The engine shall be adequately protected against operating under overload conditions. The requirements shall be met by the provision of a fixed overload limit stop on the fuel pump rack control rod to prevent the set being subject to a load exceeding the site rating plus 10%. Potential free contacts for conveying the signal to BMS shall be provided

### 3.12 Accessories, Instruments and Safety Controls for Engine

Accessories, instruments and safety controls to be provided with the engine shall be (but not limited to) as below. All accessories shall be of design compatible with the design and /or operation of the engine

a. Accessories:

- Flywheel with flywheel housing
- Coupling with guard.
- Mechanical guarding of all moving parts
- Air cleaner oil bath/paper element type.
- Corrosion resistor.
- Heat exchanger.
- Governor - electronic.
- Fuel injection
- Fuel filter
- Lub. oil filter.
- Automotive Batteries 24 V, 360 AH with leads and float cum boost battery charger along with battery stand painted with acid proof black paint with minimum 3mm thick rubber mat below the battery
- Stainless Steel Bellows
- Exhaust Silencer
- Interconnection wiring, cabling and piping as required
- Set of standard tools
- Anti-vibration mounting pads.

b. Instruments and Gauges:

- Lub. oil pressure gauge.
- Water temperature gauge.
- Battery charging ammeter.
- Hour meter (digital) to show total engine hours run 10,000 hr capacity
- R.P.M. indicator of the tachometer type (digital)
- Starting switch with key

c. Safety controls for

- Low lub oil pressure
- High water temperature
- Over speed Protection/Speed Governor
- Audio visual alarm

### 3.13. Compatibility & Coordination With PLC / BMS

A microprocessor based PLC panel for Automatic Mains Failure, Auto Changeover/ Interlocking and Auto Load Searching & Auto Load Management Functions of the DG sets is incorporated in

the Main LT Panel of the system. All parts of the DG set installation shall be compatible for being integrated with the PLC operation. The Contractor shall coordinate the work for achieving a fully coordinated and trouble free operation of the DG sets and their sub-systems through the PLC panel.

### 3.14 Alternator

The Alternator shall have the following characteristics

Type	-	Brushless, rotating field design alternator rated for 660 volt / 50 Hz complying to IS 4722-1992, BS 5000 Part-III and IFC 34
Excitation system	-	Permanent magnet generator (PMG) powered excitation system
Speed	-	1500 RPM
Net Site Output	-	Rated continuous at ambient conditions and as per schedule of quantities.
Voltage Regulation	-	Within 0.5% of the rated voltage
Overload	-	More than 10% of the nominal for 1 hour every 12 hours without exceeding permissible temperature rise.
Harmonics	-	Maximum 1% between phase and neutral and total maximum 3%

### Construction

The alternator shall be of air ventilated screen protected drip proof design with IP 23 protection having adequate air intake / outlet areas to enable designed air quantity to flow within permissible pressure drop. The dynamic balancing of the rotor assembly shall be carried out as per IS 12075 : 1987 and BS 6861 Part-I Grade-II to ensure vibration limit to be within as per IS 12075 or BS 4999. Double bearing alternator shall be provided with substantial bed plate with engine / generator mounting pads to ensure a good base for accurate alignment. A flexible coupling, designed to suit the specific engine – generator combination shall be provided to minimize torsional effects. The alternator shaft and coupling shall be designed to withstand torsional vibrations even at certain critical speed. The terminal arrangement of the alternator of DG sets shall be suitable for receiving a bus duct with flexible interconnection with rubber bellows. The termination details shall be finalized in coordination with the electrical contractor and got approved from (consultant) before execution. All alternator neutral shall be solidly earthed and each neutral and body shall be connected to 2 nos copper plate earth stations by means of 50 mm x 6 mm copper strip.

The combined Engine Alternator unit shall be mounted on a common rigid fabricated base frame. The alternator shall have its windings star connected with the neutral connection brought out to a separate terminal. The alternator shall fully comply with the latest Standard BS 2613 and BS 269 in respect of winding insulation and fast response to maintain steady voltage.

### Temperature Rise

The maximum temperature rises of the various components of the alternator shall not exceed those permitted under I.S. with full output and under the ambient temperature conditions specified

### Rating

The alternator shall be continuously rated to deliver the rated output at 0.8 pf lagging, on a 3 phase 4 wire 415 volts 50 cycle system with neutral solidly earthed. The earthing system conforming to Indian TNS.

### **Alternator Insulation**

The alternator should have class H insulation suitable to withstand tropical conditions.

### **Acoustic Insulation Enclosure:**

The sound proofing acoustic insulation should be conforming to IS 8528 and acoustic foam shall be fire retarded and fire resistant.

## **4. STARTING BATTERY AND BATTERY CHARGER**

### **4.1 24 Volt DC Batteries**

To provide 24 volt batteries for each set shall comprise of standard lead acid stationary batteries consisting of required no. of cells, each of 2 volts, to build up AH capacity as required for satisfactory starting of diesel engines. One hour rate of discharge to attain voltage of 1.85 volt per cell to 2 volts shall be provided. Battery shall be complete with inter cell connectors and acid level indicating floats. Battery cells shall conform to IS 1651 with up to date amendments. The electric start battery shall be of adequate capacity for 10 successive starts. Time delay relay shall be incorporated to provide a rest period of 1 – 5 sec (adjustable) before each successive start and a time by period of 19 -100 sec. (adjustable ) before the system lock out due to failure of the 5<sup>th</sup> start to crank up the engine . The battery bank shall be provided with the following accessories.

- Battery stand
- Set of connectors with ends take off suitable for connections.
- Cell insulator and stand insulators
- Spring type hydrometer
- Thermometer with specific gravity correction scale
- Cell testing voltmeter
- Set of tools consisting of spanners, rubber syringe, acid resisting funnel and acid resisting tube of 2 litres capacity – one set
- Potential free contacts for conveying signals to BMS.

### **4.2 Battery Charging Equipment (Trickle and Boost Charging)**

Battery trickle and boost charge required capacity designed to operate on single phase 230 volts, 50 cycles supply system and suitable for charging current shall be provided as a part of PLC panel. The battery charger shall be provided with the following accessories.

- AC and DC "ON" and "OFF" switches with MCB & no HRC fuses
- Indicating lamps for indicating mains "ON" and battery charging
- Ballast to give charging
- Single phase double wound (copper conductor ) impregnated natural air cooled mains transformer for rectifier stack.
- Rotary switch to give step control.
- Single phase full wave bridge connected silicon rectifier stack
- Digital ammeter to indicate charging current
- Digital voltmeter with a selector switch to measure the battery/charger voltage
- Silicon blocking diodes connected to a suitable tap to maintain continuity of DC supply.
- AC and DC contactors of suitable rating as required.



All the components for battery charger shall be adequately rated and housed in a well ventilated sheet steel cubicle with input and output terminals. Proper cable glands shall be provided for incoming and outgoing cables.

#### **5. RADIO INTERFERENCE**

All equipment provided under this specification shall be so designed that it will not cause interference with radio equipment. In the event of the inherent characteristics of the equipment being such that radio interference is possible, efficient devices to nullify the same shall be provided. Suppressers shall be as per the relevant I.S./B.S. Standards.

#### **6. NOISE AND EMISSION LEVELS**

Noise from DG sets as also emission levels of pollutants in exhaust shall comply with the requirements of and Environmental (Protection) Second Amendment Rules 2002 notified as per Central Government Notification dated May 17, 2002 as implemented by Central Pollution Control Board. The noise emission level shall also comply to the relevant up to date Euro norms.

#### **7. TOOLS**

Tenderer shall submit a list of the tools along with the tender. The tools will be required and procured after two years of DLP

#### **8. PRE-COMMISSIONING CHECKS**

All standards checks including the ones elaborated in the specifications to ensure that the installation of the DG sets and associated systems has been carried out satisfactorily shall be done on completion of installation.

These shall include.

- DG sets
- Checking of piping interconnections
- Checking electrical interconnections
- Checking of insulation resistance
- Checking of earthing
- Checking of instruments and controls.
- Checking of alignment
- Checking of vibration transmission to building a structure.
- Checking of expansion joints.
- Cooling water system
- Checking of piping interconnections
- Checking electrical interconnections
- Checking of insulation resistance of electric motors with pumps
- Checking of earthing
- Pressure testing of piping
- Exhaust system
- Checking of silencer operation
- Checking of surface temperature of exhaust piping
- Fuel system
- Checking of automatic operation of fuel transfer pumps.

## 9.0 INSPECTION AND TESTING

### a) Performance Tests

### b) Trial Run/- Running in period

#### a) Performance Tests:

DG set will be tested on load of unity power factor for the rated kW rating. During testing, each of the DG sets covered under scope of work, shall be operated for a period of 12 hrs on the rated kW at DG set's kW rating including one hour on 10% overload after continuous run of the 12 hrs. During testing all controls/operating safeties will be checked and proper record will be maintained. Any defect / abnormality noticed during testing shall be rectified. The testing shall be declared successful only when no abnormality /failure are noticed during testing.

The DG set will be cleared for dispatch to the site only when testing is declared successful by authorised representative / Engineer in charge.

The contractor will arrange staff/fuel/POL for test run at his cost.

#### b) Trial run / Running in period.

After successful testing of the DG set, a trial run at available load will be carried out for 120 hrs or 15 days whichever is earlier at site after installation of DG sets. The DG set will be operated and a log of all relevant parameters will be maintained during this period. The arrangement of staff for trial run/running in period will be made by the contractor. However, diesel shall be provided by the Owner. The contractor will be free to carry out necessary adjustments. The DG set will be said to have successfully completed the trial run, if no break down or abnormality /unsatisfactory operation at any component of the entire installation included in the scope of work of the contract occurs during this period. After this the DG sets will be made available for beneficial use. After the DG set has operated without any major break down/trouble, it shall be taken over by the Owner subject to guarantee clause of the contract. This date of taking over of DG set, after trouble free operation during the trial run. /running in period, shall be the date of acceptance/ taking over It is the prerogative of the owner to wave off the inspection at manufacturer place

However, In case the performance test of the DG sets are to be carried out at site of work, DG set shall be operated for a period of 4 Hrs as explained above with a running period trial run to be carried out for 120 Hrs or 15 days whichever is earlier.

## **BREAK DOWN MAINTENANCE**

The Contractor shall also undertake to provide a comprehensive breakdown service whereby qualified technicians shall attend to each breakdown as soon as practicable after a breakdown is reported and carry out immediate remedial work at a reasonable speed according to the nature of the breakdown. Any faulty equipment or components shall be quickly replaced.

In circumstance such that the Contractor fails to attend the breakdown within four normal working hours after notification of the breakdown and where remedial work is interrupted during normal working hours for purposes other than obtaining replacement parts, the employer reserves the right to order such action as may be necessary to expedite completion of remedial work which shall be at the Contractors expense without abrogation of the Contractors responsibilities.

### **1. GENERAL**

The Contractor shall keep sufficient spare parts during the maintenance period to ensure that replacement work for defect can be carried out immediately

A competent engineer shall be provided to investigate the fundamental cause of a fault temporary quick fix solution will not be accepted.

The employer shall at his discretion, take action to recover all losses incurred rising from the failure of the contract to perform the duties either wholly or in part as detailed in this section.

## **COMMERCIAL AND ADDITIONAL CONDITIONS- DG SETs**

### **1.1. Specification:-**

The work shall be executed as per CPWD's general specification for Electrical Works part-I (2013) & Part-II (1994) & Part-VII (2013) for DG Set Work, IE Rules, Indian Standards amended up to date and as per direction of Engineer-in-Charge. The additional specifications are to be read with above and in case of any variations, specifications given in the tender shall apply.

### **1.2. Inspection by CEA/TSSPDCL & CPCB/SPCB:**

After completion of the work, the contractor will offer the same for inspection of Central Electricity Authority/TSSPDCL, Central Pollution Control Board & State Pollution Control Board if required. The contractor will extend all help including test facilities to the representative of Central Electricity Authority/TSSPDCL, Central Pollution Control Board & State Pollution Control Board. In case the contractor fails to make desired facilities available during inspection, the department reserve the right to provide the same at the risk & cost of the contractor. The observation of Central Electricity Authority/TSSPDCL, Central Pollution Control Board & State Pollution Control Board which are a part of agreement will be attended by the contractor promptly. The installation will be commissioned only after receiving clearance(if required) from Central Electricity Authority/TSSPDCL. Inspection fees of Central Electricity Authority/TSSPDCL, Central Pollution Control Board & State Pollution Control Board will be borne by the department.

1.3. The material required to be used in the work shall be got approved from the Engineer in- charge before its use at site. The Engineer-in-charge shall reserve the right to instruct the contractor to remove the material which, in his opinion, is not as per specifications.

1.4. Contractor shall preserve the copies of invoices, test certificates, gate passes etc. To prove the genuineness of material/purchases. The responsibility of procurement, genuine material of specialized works shall rest with the contractor.

1.5. The contractor shall offer inspection call at factory premises before dispatch of DG set to carry out test as per CPWD specification & fuel charge & other charges of testing of DG set for 13 hours shall be borne by the agency. To & fro journey fare of the CPWD officers for inspection of DG set shall be borne by the department.

1.6. The contractor shall submit the following after award of work:

- (i) Submission of GA drawing of DG set for approval
- (ii) Written commitment from OEM/OEA to supply the DG Sets and delivery schedule as per requirement of department.
- (iii) Certificate from OEM/OEA or authorized service provider of engine manufacturer of satisfactory installation and commissioning of DG Set after completion of the work.
- (iv) The defect liability period shall be reckoned from the date of handing over of the installation to the department.
- (v) An undertaking that mandatory free service shall be carried out during the Defect liability period as per this agreement by the authorized service provider.

### **Earthing:**

Earthing system comprising of earth electrode, earth conductor, earth bus, protective conductor etc. for the building shall be as per provision laid down in NBC 2016 / BIS Standards IS 3043:2018 and IS 732:2019 and CPWD specifications. Earthing system should be designed such as to maintain required earth resistance as specified in the above standards.

Scope :

The scope of this section covers supply installation and testing of earthing system for all non-current carrying metal parts of electrical installation.

The type and number of earth electrodes shall be as indicated and shall comply with clauses as appropriate.

### **Earthing System & Equipment Bonding:**

- i. Unless otherwise indicated, earth plates shall be 600 mm x 600 mm minimum, of solid or lattice copper not less than 3.15 mm thick and of GI not less than 6.3 mm.
- ii. Earthing system shall comprise of earth electrode near sub-station. Test link boxes shall be provided at each electrode for periodical resistance measurement. All such earth electrodes shall be interconnected forming a main grid.
- iii. Where the earth electrodes are formed with tape, the tape shall be to relevant IS, of the size, length, depth below ground level and layout as indicated.
- iv. If due to very hard rock plate earthing will not be possible as per direction of E-I-C copper bonded rod will be executed. It shall consist Supply, Installation & testing of Earthing Station, consist of 3Mtr Copper Bonded Rod of minimum 17.2mm diameter. with minimum 25Kg Resistance lowering compound Earthing. Copper Bonded Earth Rod made from high tensile low carbon steel and each rod should molecularly bonding 99.9% pure electrolytic copper to the low carbon steel core in accordance with national and international standards such as BS6651, BS7430 and UL467. comprises specifically selected compounds, which possess excellent electrical conductivity. The earth electrode shall be provided in 100 mm dia boring, and providing masonry enclosure with cover plate having locking arrangement and watering pipe etc complete as required.

## **2.0 Conductors:**

- i. Earthing conductors, main earthing bars and main equi-potential bonding conductors shall be of the type, size and conductor material as indicated and shall comply with the following clauses.
- ii. Tapes shall comply with relevant IS. Where used to interconnect copper electrodes the tape may be bare, but for interconnecting pipe electrodes and for all other purposes the tape shall have an extruded PVC sheath.
- iii. Main earthing bars shall comply with IS 3043 and shall be bare.
- iv. Cables shall comply with IS 3043, without sheath, unless otherwise indicated.

## **2.1 Joints and Connections:**

- i. Joints in conductors shall be kept to a minimum.
- ii. All contact surfaces shall be thoroughly cleaned and coated with an anti-corrosive electrical jointing compound suitable for the conductor materials. For bi-metallic joints, a separate abrasive shall be used to clean each metal.
- iii. Connections shall be made as follows:
  - a. To main earthing bars by phosphor bronze set screws and nuts;
  - b. To earth rods by bronze, gunmetal or copper clamps with phosphor bronze. Edges of clamps shall be rounded;
  - c. To earth pipes by phosphor bronze bolts and nuts, direct to the flange of the pipe;
  - d. To earth plates by bolting, riveting or welding.
- iv. Termination of cables shall be by connectors jointed to the cable conductor by the thermit welding process or by compression joints complying with BS 4579.
- v. Joints which are indicated as test points shall be bolted or clamped. Joints in tape, other than at test points shall be made by the riveting and sweating. Overlap of conductors shall be not less than 100 mm.
- vi. Joints and connections shall be protected by a coating which will form a seal and exclude moisture in all weather conditions. At connections to earth electrodes, the coating shall cover all exposed conductors and in the case of earth pipes, to top surface of the flanges. Protective coatings shall be of a waterproof, inert, tenacious material and of one of the following forms:
  - (a) solvent cutback thixotropic corrosion preventative forming a film of resilient matt petroleum wax;
  - (b) a fast drying durable rubberised sprayed coating;
  - (c) a heat shrink clear sheathing
- vii. Screws, nuts, washers and rivets for copper conductors shall be of phosphor bronze, naval brass or copper silicon; for aluminium conductors, they shall be of stainless steel. The minimum provision shall be
  - (a) for flat strip--- two M8 bolts or four 5 mm diameter rivets;
  - (b) for sheet metal--two M8 bolts; where the sheet metal is less than 2 mm thick, it shall be backed for an area of at least 1000 mm<sup>2</sup>.

## **2.2 Inspection Pits:**

2.2.1 Unless otherwise indicated, connection between an earth conductor and its associated earth electrode system shall be in an enclosure.

2.2.2 The enclosure shall have a removable top cover which shall be flush with finished ground level. The enclosure shall be a purpose made concrete inspection pit, a galvanized steel inspection pit embedded in concrete, an earthenware pipe or similar, as indicated. The earth electrode connection shall be just below the lid of the inspection pit with adequate access for testing purposes.

## **2.3 Supports And Fixings:**

2.3.1 Cables shall be supported and fixed in accordance with Section Cable laying

2.3.2 Tapes and bars shall be fixed by spacer bar saddles which shall be of non-metallic material or corrosion resistant alloy compatible with the conductors. Fixing of saddles shall comply with relevant clauses in Cable Laying section. The maximum spacing of fixings shall not exceed 600 mm unless otherwise indicated.

2.3.3 Main earthing bars shall be supported on insulators; they shall be not less than 25mm clear of the building fabric.

2.3.4 For general areas inside buildings, screws and nuts shall be of cadmium electroplated steel or stainless steel; outside buildings, in plant rooms or other locations as indicated, they shall be of stainless steel.

2.3.5 No shot firing shall be used and no drilling or welding structural steelwork shall be done without the approval of the Engineer-in-Charge.

## **2.4 Installation:**

2.4.1 Electrodes shall be installed in undisturbed ground. The distance between any two electrodes shall be not less than 1.25 times the depth of the longer electrode.

2.4.2 Excavations shall be carried out in accordance with BS 6031 and shall comply with the construction (General Provisions) Regulations, 1961. Excavations shall be kept free of water and protected against damage or collapse. The safety of persons and the protection of structures, buildings, roads, sewers and services from damage shall be ensured; all necessary sheeting, timbering, strutting and shoring shall be supplied, erected and subsequently removed.

2.4.3 Trenches shall be backfilled in layers and each layer shall be rammed. The first two layers shall be 100 mm deep and rammed by hand the remaining layers shall be not more than 200 mm deep and power ramming may be used. Warning tapes and covers shall be included as specified in relevant clauses in Cable laying section. Where applicable, top soil and turf shall be replaced and the final level shall be level with or not more than 25 mm above the adjacent ground level.

2.4.4 **The earth resistance should be less than 1.0 Ohms.** Earth Pits shall be treated with salt, charcoal /chemicals to be achieve the required result.

The components to be connected to the earth system shall include:

- (i) The enclosure of High voltage switchgear & control gear from the terminal provided for the purpose.
- (ii) The enclosure of Panel body.
- (iii) The metal screen & the high voltage cable earth conductor,
- (iv) The transformers,
- (v) The LT and HT cables (as per the laid length).
- (vi) The frame &/or enclosure of low voltage switchgear,
- (vii) Minimum earthing requirements (Less than 1 Ohm) subjected to CPWD specifications:

- (a) HT Panel Body earthing – 2X2 Nos. (looped)
- (b) LT Panel Body earthing – 2X2 Nos. (looped)
- (c) Transformers body earthing – 2 X2 Nos. (looped)
- (d) Transformer Neutral earth -2X2 Nos. (each transformer)
- (e) DG set body -2X 2 Nos. (looped)
- (f) DG set Neutral earthing – 2X2 Nos. (each)
- (g) Synchronization Panel Body earthing -2X 2 Nos
- (h) UPS shall be specifically provided with Copper plate earthing.
- (i) As per requirement of various LT panels in each Buildings

## **Scope of work and Technical specification for LIFTS**

The following sub heads mentioned in the payment schedule.

- 1 . Sub-head A8 (Annexure A8)
- 2 . Sub-head B8 (Annexure B8)
- 3 . Sub-head C8 (Annexure C8)
- 4 . Sub-head D9 (Annexure D9)
- 5 . Sub-head E9 (Annexure E9)
- 6 . Sub-head F9 (Annexure F9)
- 7 . Sub-head G9 (Annexure G9)
- 8 . Sub-head H9 (Annexure H9)



## SCOPE OF WORK and SPECIFICATIONS FOR LIFTS

The requirement of lift shall be worked out as per the traffic analysis and as per the requirement of local byelaws and NBC – 2016. However, following minimum number of lifts shall be supplied and installed by the contractor in buildings as detailed below:

Sl. No.	Name of the Building	No. of Floors	No. of Blocks/ Buildings	Capacity of Lifts.	No. of Lifts.
1	Construction of Faculty Housing – Tower FT1A (Type – C)	G + 12	1	20 passenger	2
2	Construction of Faculty Housing – Tower FT1B (Type – C)	G + 12	1	20 passenger	2
3	Construction of Staff Housing – Tower ST2B (Type – D)	G + 12	1	20 passenger	2
4	Construction of Staff Housing – Tower ST2A (Type – D)	G + 12	1	20 passenger	2
5	Construction of Staff Housing – Tower ST1A (Type – E) Floors	G + 12	1	20 passenger	2
6	336 Boarders Pre-cast Hostel-1	G+6	1	13 Passenger	1
				20 passenger	1
7	336 Boarders Pre-cast Hostels-2	G+6	1	13 Passenger	1
				20 passenger	1
8	336 Boarders Pre-cast Hostels-3	G+6	1	13 Passenger	1
				20 passenger	1

Note:

- i) All LIFT works shall be carried out in accordance with CPWD General Specifications for Electrical works -Part III-LIFTS and Escalators-2003.
- ii) The car size of minimum one lift each in every building shall be adequate to accommodate one stretcher in case of any medical emergency.

## GENERAL

### 1. STANDARDS

The following Indian Standard Specifications and Codes of Practice, currently applicable and updated as of date irrespective of dates given below, shall apply to the Equipment and the work covered by this contract. In addition the relevant clauses of the Indian Electricity Act 1910 and Indian Electricity Rules 1956 as amended upto date shall also apply. Wherever appropriate Indian Standards are not available, relevant British and/or IEC Standards shall be applicable

1.	Code of Practice for installation, operation and maintenance of electric passenger & goods lifts.	IS-14665 (Part 2) Sec-1 : 2000
2.	Code of practice for installation, operation and maintenance of electric service lift.	IS-14665 (Part 2) Sec-2 : 2000
3.	Safety Rules Section-1 Passenger and Good lifts	IS-14665 (Part 3) Sec-1 : 2000
4.	Safety Rules Section-2 – Service Lifts	IS-14665 (Part 3) Sec-2 : 2000
5.	Outline dimension for electric lifts.	IS-14665 (Part-1) : 2000
6.	Inspection Manual for Electric Lifts	IS-14665 (Part 5) : 1999
7.	Electric Traction Lifts – Components	IS-14665 (Part 4) Sec-1 to 9: 2001 IS 15330 :2003
8.	Installation And Maintenance of Lifts For Handicapped Persons (Code of Practice)	
9.	Specification for lifts cables.	IS-4289 (Par-1) : 1984 Reaffirmed 1991
10.	Specification for hot rolled and slit steel tee bars.	IS-1173-1978 Reaffirmed 1987
11.	Method of loading rating of worm gear.	IS-7443-1974 Reaffirmed 1991
12.	Code of practice for selection of standard worn and helical gear box.	IS-7403-1974 Reaffirmed 1991
13.	Isometrics screw threads.	IS-4218-(Part-II)1976 Reaffirmed 1996
14.	Degree of protection provided by enclosure for low voltage switchgear and control gear.	IS-2147-1962
15.	Classification of insulating materials for electrical machinery and apparatus in relation to their thermal stability in service.	IS-1271-1985 Reaffirmed 1990
16.	Code of practice for earthing.	IS-3043-1987
17.	Electrical installation Fire Safety of Building.	IS-1646-1997
18.	PVC insulated electric cable for working voltage upto and including 1100 volts.	IS-694-1990
19.	Code of practice for electrical wiring and installation	IS-732-1989
20.	PVC insulated (Heavy Duty) electric cables for working voltage upto and including 1100 volts.	IS-1554-1988 (Part-1)
21.	Flexible steel conduits	IS-3480-1966
22.	Accessories for rigid steel conduit for electrical wiring	IS-3837-1976

23.	Boxes for the enclosure of electrical accessories	IS-5133-1969 (Part 1)
24.	Guide for safety procedures and practices in electrical work.	IS-5216-1982 (Part-1)
25.	Conductors for insulated electric cables and flexible cordes	IS-8130-1984
26.	Miniature Circuit Breakers	IS-8828-1996
27.	Rigid steel conduits for electrical wiring (Second revisions)	IS-9537-1981
28.	Methods of test for cables	IS-10810-1998
29.	Earth Leakage Circuit Breakers.	IS-12640-1988
30.	Moulded Case Circuit Breakers	IS-13947-1993
31.	General requirement for switchgear and control gear for voltage not exceeding 1000 volts.	IS-13947-1993
32.	1100 volt grade XLPE insulated armoured cables	IS 7098
33.	Specifications for hoistway door-locks	IS 7754-1975
34.	Rules for design, installation, testing and operation of lifts, escalators and moving parts.	IS 1735-1975

In addition the relevant clauses of the following, as amended upto date shall apply.

- The Indian Electricity Rules 1956
- The Indian Electricity Act 1910
- Fire safety regulations pertaining to lifts

The tenderers shall also take into account local and State regulations as in vogue for the design and installation of lifts.

Wherever appropriate Indian Standards are not available, relevant British and/or IEC Standards shall be applicable. BIS certified equipment shall be used as a part of the Contract.

## 2. ELECTRIC SUPPLY

The available system of electric supply is 415 volts +10% -20%, -3 phase 4 wire AC 50 Hz system and 240 volts between phase and neutral. Any equipment /component operating at other than the above mentioned power supply shall be provided with necessary transformers/voltage stabilizers. The amount of power required for lifts shall be indicated in the tender. Power shall be provided at one point to be indicated by the tenderer. All subsequent electrical systems shall be deemed to be included in the scope of this contract.

## 3. BMS COMPATIBILITY

All the elevators shall be communicable to third party BMS. All the necessary hardware/SNMP cards/communication ports, cards, software etc. for establishing BMS communication shall be provided by the LIFT contractor Necessary potential free contacts to be provided in the electrical system control panels. Elevator supplier shall be required to coordinate with BMS vendor for software compatibility between BMS & elevator system.

## TECHNICAL PARAMETERS

1	INSIDE SIZE OF LIFT WELL	As per the CPWD specification/NBC or manufacturer requirement whichever is maximum.
2	POSITION OF MACHINE	Inside the lift shaft. (Machine Room Less)
3	(a) TYPE OF CONTROL/DRIVE	A.C. Drive variable voltage variable frequency (ACVVVF WITH REGEN DRIVE) control with microprocessor based group control system.
	(b) TYPE OF OPERATION	Automatic group supervisory control with/without attendant.
4	SPEED GOVERNOR	The car safety shall be operated by a mechanical centrifugal speed governor located in the overhead & at the top of the hoist way. The governor shall actuate a switch when excessive descending speed occurs, disconnecting power to the hoist motor and applying the brake prior to deployment of the safeties. Governor sheave in elevator pit shall be enclosed in a wire cage to a height of 2.40 m.
5	VOLTAGE FLUCTUATIONS	All electrical equipment supplied by the lift contractor shall withstand an incoming supply voltage fluctuations of +10% - 20%
6	PIT SWITCH	An emergency stop switch shall be located in the pit which when operated shall stop the car regardless of position in the hoist way.
7	BUFFERS	Buffers shall be provided in the pit in compliance with ANSI/ASME/CENEN-81 or local code if more stringent. Clearance from underside of car resting on a fully compressed buffer shall be not less than 1.20m. Buffer shall be designed for design speed + 15%. Oil buffers shall be provided for the passenger elevators for speeds of more than 1.7 mps and spring buffers for lower speeds or in case of specifically asked for in technical data. The oil buffers shall be self-resetting type and shall be provided with means for determining the oil level.
8	GUIDE RAILS	Steel guide rails shall be installed to guide the car and counterweight, erected plumb and securely fastened to the building structure, fitted to ensure smooth joints. The guide rail shall be minimum 16 mm, tongued and grooved type.
9	GUIDES	Rubber encased coil spring tension adjusted roller guides shall be provided for passenger elevators with speed of 1.7 mps or greater, mounted on top and bottom of the car frame, and on top and bottom of the counterweight frame to engage their respective guide rails. Service elevators and low speed elevators can have sliding guides on car and

		counterweights
10	CABLE ANCHOR	Cable shall conform to ANSI/ASME/CENEN-81 and shall anchor to the frame by means of an equalizing device to insure uniform cable loading. Cable safety shall conform to ANSI/ASME/CENEN-81 or governing code if available.
11	TRAVELLING CABLE	Travelling cable shall be secured to the cars underside. Cable shall be clear of all obstructions while car is in motion. Cable jacket shall be suitable for immersion in water, salt water and oil. Jacket shall minimize strain on conductor
12	INTERLOCKS	Hoist way openings shall be provided with electro-mechanical locks
13	COMPENSATING ROPE	Compensating ropes shall be furnished and installed for all elevators with speed over 2.0 m/sec, and travel in excess of 30 m, to compensate for the shifting weight of the hoist ropes. A device shall be provided to tie the car and counterweight together to limit the jump of the car or counterweight. Compensating chain where provided shall be enclosed in a plastic flame resistant jacket to minimize noise.
14	COUNTER WEIGHT	A structural steel frame with cast iron or steel plate filler weights shall be furnished to provide proper counterbalance for smooth operation.
15	COUNTERWEIGHT GUARD	A metal counterweight guard shall be furnished and installed at the bottom of the hoist way, and shall wrap around counterweight rails for a height of no less than 1.80 m in order to protect accidental contact.
16	ROPES	Hoist ropes shall be traction steel of size, construction and number to insure proper operation of the elevator and give satisfactory and safety assurance. Governor ropes shall be steel. All ropes shall consist of at least eight strands wound about a hemp core centre. All ropes shall conform to ANSI/ASME/CENEN-81 or more governing codes or regulations. The minimum factor of safety for ropes shall be 10.

17	PLATFORM	The car platform shall be of Aluminium/ Stainless steel plate as asked for in the BOQ. The entire platform shall rest on rubber pads, so designed to form an isolating cushion between the car and car frame. Platform deflection shall be limited to maximum 3 mm under maximum normal operating conditions. Platform shall conform to ANSI/ASME/CENEN-81 or more stringent local codes.
18	OVER-LOAD FEATURE	Elevators shall be fitted with the load weighing feature to illuminate "Over-Load" and defeat the car's operating circuits when car load reaches 110% or more of rated load. Car platform may require stiffening to minimize margin of error resulting from excessive deflection. Overload feature and / or circuit defeat for elevators shall conform to governing code.
19	CAR SPEED	Car speed shall be based on the travel distance and number of floors however minimum 1.5m/sec speed of LIFT shall be ensured by the contractor.
20	NOISE LEVELS (PASSENGER ELEVATOR)	Noise from moving equipment including door operation, car motion, fan, etc. shall not intrude into adjoining spaces by more than 20 dB and adjoining occupied areas by not more than 10 db. (All octave bands). Noise level inside the car shall not exceed 50 db. without car cabin fan running. Noise level inside the car shall not exceed 55 db. in case of door opening / closing. The noise level shall be measured at 'Zero Activity'.
21	EMERGENCY LIGHTING & INTERCOM CAR	Provision shall be made in the car for emergency lighting, low speed and low noise fan, status indication and communication. Wiring cabling for the above facilities shall be provided along with travelling cable. Elevator contractor shall provide and install hand free communication unit above the car operation panel. Fan shall be four speed and low noise and shall be approved by the Engineer-In-Charge. Speaker shall be provided for emergency announcement and background music.
22	CAR POSITION INDICATOR (PASSENGER CARS)	Scrolling alpha numeric car position indicator shall be installed above each operating panel. The position of the car in the hoist way shall be shown by illuminating the corresponding landing at which the car is stopped or passing.
23	Car Entrance door	

	(a) Number	Center opening stainless steel sliding door in the Dama/ Moon rock/Matt Finish.
	(b) Type of door	Horizontal Sliding - Centre opening.
	Car open in front only or open through	Open in front only
	Power or manual operation	Automatic door operation both infrared screen based and pressureswitch shall be provided for door opening.
24	Construction Design & finish of Car body work	Car body shall be fabricated from stainless steel with Dama/ Moon rock/ Matt Finish as per approved drawings. Car shall be complete with anti skid flooring and toe guard of adequate depth. The car shall be with false ceiling, LED fittings, stainless steel hand rail on three sides. For handicapped person, the lift shall be disabled friendly and shall have railing and controlling switch etc. at the appropriate height.
25	Type of signal system	Digital floor position indicator, Digital display in the car and at all landings Travel direction indicator, Dot matrix type, in the car and at all landings.
		Gongs / Car chime & visual indication through directional arrows on all landings for pre arrival of the car at all floors. Overload warning Audio & Visual indicator, inside the car (lift should not start on overload). Battery operated alarm bell and emergency light duly fed by suitable inverter SMF batteries for 30 minutes backup. Car operating panel luminous buttons in car and intercom (3ways – at car, lobby, controller). Luminous hall buttons at all landings. Landing call registered indicator at all floors. Voice annunciation system. This will announce the position of the car landing. Protection against over-voltage, under-voltage and single phasing should be provided
26	Landing Entrance	
	Location of Landing entrance on different floors	All doors on the same side
	(b) Number	In each landing / floor
	(c) Size	As per drawings approved by Engineer-in-charge
	(d) Type of Doors	Horizontal Sliding - Centre Opening.
	Lift in Use/ Lift out of Order Sign	A suitable box on the landings LED illuminated sign of "LIFT OUT OF ORDER" coming up simultaneously on all floors.

27	Electric supply	Power: 415 V, A.C., 50 Hz, 3 phase, 4 wire system.  Lighting: 230 V, A.C., 50Hz, 1 phase.
28	Is neutral wire available for control circuits	Yes.
29	Period of completion	As per tender document.
30	Storage space provided	Yes.
31	Additional items-	
	(a) Location of main switch	Top floor
32	Dimensions of car platform	Conforming to IS:14665
	Ventilation opening in the Car Body	Required fans. The fan should be auto switch off when there is no passenger inside the lift car
	Operating panel inside Car	Automatic cum manual flush mounted luminous brail button suitable for barrier free environment for physically challenged persons
	(e) Fireman's Switch	Required for all lifts at ground floor.
	Emergency power supply	Available
	(g) Miscellaneous	The firm's offer should include beam and all structural steel required for the work.
	Automatic Rescue Device (ARD)	Provisions of Automatic Rescue Device for the purpose of bringing the lift car to the nearest floor should be provided, one for each individual lift. This shall consist of:  Control panel necessary interface/ integration of device with the main controller, Inverter of required capacity, Maintenance free batteries of required Ampere-hours capacity, Battery charging unit, "Rescue Operation on" indicator in the lift car. Free maintenance for a period of one year from the date of commissioning after completion of work.
	(i) Fire resistance	Landing doors in lift enclosures shall have a fire resistance of not less than one hour.



	(j) Manual Switch	Manual switch shall be provided in controller located on top floor nearer to landing door to operate the lift manually
	(k) Features for physically challenged persons	The lift shall be equipped with a braille system, stainless steel mirror finish hand rail on 3 sides inside the car and other additional special features for use by physically challenged persons.
33	Car Fittings	Overload Device, Emergency Car Light Unit, Emergency Alarm Button, Door Open/Close Button, Manual Rescue Operation, Belt Inspection Drive.
34	Intercom system	In each lift for communication between the passengers in the elevator & fire control room & machine room (press & speak type) with rechargeable maintenance free battery backup.
35	Emergency /Panic alarm	The sounder/Hooter for emergency alarm shall be installed outside the lift shaft in lift lobby on four floor/ Two floor levels out of G+12 /G+6 levels. The final scheme shall be decided by the E-I-C.

**(1) DATA MANUAL AND DRAWINGS TO BE FURNISHED BY THE TENDER:**

- a) After award of work: The contractor would be required to submit the following documents within 15 days of award of work for approval of the Engineer-In-Charge.
- General arrangement drawing of the equipment like lift car, rail, controls, doors, supporting arrangements,
  - Details of fixing arrangements for the equipment and the weights of assembled equipment.
  - Cable/ layout between each equipment etc.
  - Any other drawings necessary for the job.

The Contractor should furnish well in advance three copies of detailed instructions and manuals of manufacturers for all items of equipment regarding installation, adjustments operation and maintenance including preventive maintenance & trouble shooting together all the relevant data sheets, spare parts catalogue etc. all in triplicate.

**(2) INSPECTION AND TESTING**

- a) All major equipment i.e. lift shall be offered for initial inspection at manufacturer's works. The contractor will intimate the date of testing of equipment at the manufacturer's works before dispatch. The successful tenderer shall give advance notice of minimum two weeks regarding the dates proposed for such tests to the department's representative to facilitate his presence during testing. The Engineer-in-charge may witness such testing. The cost of the Engineer's visit to the factory will be borne by the Department. Equipment will be inspected at the manufacturer/ Authorized Dealers premises, before dispatch to the site by the contractor if so desired by the Engineer-in-charge.
- b) Copies of all documents of routine type test certificates of the equipment, carried out at the manufacturer's premises shall be furnished to the Engineer-in-charge and consignee.

- c) After completion of the work in all respects the contractor shall offer the manual fortesting and operation.

3. The following tests, in addition to those mentioned in the CPWD specifications, shall be carried out to the satisfaction of the Engineer-In-Charge.

- (i) The car shall be loaded until the weight on the rope is twice the combined weight of the car and the specified load. The load must be carried on for about 30 minutes, without any sign of weakness, temporary set or permanent elongation of the suspension rope strands.
- (ii) The following items shall be tested.
  - (a) No load current and voltage readings both on 'Up' and 'Down' Circuit
  - (b) Full load current and voltage readings both on 'Up' and 'Down' Circuit
  - (c) One and quarter load current and voltage readings both on 'Up and 'Down' Circuit Stalling current and voltage and time taken to operate overload.
  - (d) Overload protection.
  - (e) Car and counterweight buffers with contract load and contract Speed.
  - (f) Manual operation of elevator at mid-way travel
  - (g) Emergency operation
  - (h) Tests on completion shall also be performed to the satisfaction of Inspector of Lifts.

#### **4. ERECTION TOOLS:**

No tools and tackles either for unloading or for shifting/erection of the Equipment and for execution purposes would be made available by the department. The successful tenderer shall make his own arrangement for all these facilities. No T&P shall be issued by the Department and nothing extra shall be paid.

#### **5. VERIFICATION OF CORRECTNESS OF EQUIPMENT AT DESTINATION:**

The contractor shall have to produce all the relevant records to certify that the genuine equipment from the manufacturers has been supplied and erected.

#### **6. PAINTING:**

This shall include cost of painting of the entire installation where ever required. The car body, doors, panels etc shall be factory final finish painted. The agency shall be required to do only touching to the damages caused to the painting during transportation, handling & installation at site, if there is no major damage to the painting. However, hangers, supports etc. shall be painted required shade including painting two coats of anticorrosive primer paint at site.

All exposed metal work furnished in these specification, except as otherwise specified shall be given one shop coat of anti-corrosive primer after approved surface treatment of metal surfaces and two coats of approved enamel paint of approved shade.

#### **7. TRAINING:**

The scope of works includes the technical training of two persons of The Client Department at site. Nothing extra shall be payable on this account.

## **TRACTION MACHINE AND DRIVE**

The motor shall be controlled by a variable voltage variable frequency (V.V.V.F.) micro-processor control system which shall control and monitor every aspect of elevator operation at all stages of the car motion cycle on real time basis.

The A.C. V.V.V.F. drive system shall control A.C. voltage and frequency concurrently with the hoist motor to regulate the elevator's actual performance to match closely the ideal speed pattern to obtain maximum efficiency of operation and provide a very smooth ride. Frequency shall range fully between zero and rated value.

The Controller shall be provided with a self-diagnostic programme to keep downtime to a minimum possible.

The controller shall intelligently adjust door times in response to car calls, hall calls and "Door Open" button operation.

An Inspector's changeover switch and set of test buttons shall be provided in the controller. Operation of the Inspector's changeover switch shall make both the car and landing buttons inoperative and permit the elevator to be operated in either direction from machine room for test purposes by pressing corresponding test buttons in the controller. It shall not however interfere with the emergency stop switches inside the car or on the top of the car.

**The braking of machine shall be of regenerative type.**

## **SAFETY**

In the addition to other specifications the Lifts shall be provided with safety devices as follows:

- (i) Safety gear on car so that in the event of rope breaking or loosening the car will be brought to rest immediately by means of grips on the guides.
- (ii) The over speeding car shall be automatically brought to a gradual stop on guide rails and power supply to the hoist motor shall be switched off.
- (iii) Car gate lock so that in the event of car gate gets opened when passengers are in the car, the elevator shall be brought to rest.

## **CAR**

### **a. Cabin Size**

The internal **clear** dimensions of the cabin shall not be less than those specified in IS 14665-Part I and as per CPWD specifications.

### **b. Car Display Panel**

The Car Display panel shall be of LCD. This shall indicate the Car capacity, floor indication, direction of travel, current time and date at the minimum.

### **c. Frame and Safety Device**

The car frame shall consist of steel channel top and bottom securely riveted or bolted and substantially reinforced and braced so as to relieve the car enclosure of all strains when the safety device comes into action due to over speed or when the capacity loaded car is run on the buffer springs at normal speed.

The safety device mounted on the bottom members of the frame operated by a centrifugal speed governor shall be arranged to bring the car to a gradual stop on the guide rails in the event of excessive descending speed; and provision shall be made to shut off the power supply to the motor.

**d. Doors**

Provision shall be made of SS and central opening

**e. Door Operators**

The door operators shall be VVVF inverter controlled heavy duty A. C. motor, allowing variable opening and closing speeds, and with full synchronization of car and landing doors.

**f. Emergency Lighting**

Emergency lighting with battery backup shall be provided.

**g. Evacuation**

An emergency key shall be provided on each landing to unlock the doors for evacuation and maintenance.

The doors shall be capable of being opened manually during power failure from inside the car when the car is within a landing zone.

**h. Intercom**

The intercom system in the lifts shall be capable of two way communication.

Necessary arrangements shall be provided for communication between the lift cars, Fire Control Room, Reception and the room of other security as per direction of Engineer-in-charge.

The main control for the Intercom shall be placed at Fire control room. The intercom system shall be provided with a power backup of at least 30 minutes.

**i. Manual Cranking Facility**

Manual cranking facility shall be provided in the machine to facilitate evacuation of passengers in case of power failure. The manual mode shall be in addition to automatic car failure operation specified elsewhere.

**j. Emergency Stop Switch**

A stop switch in the top of car shall be provided for use by maintenance crew to cancel all car and landing calls for a particular lift.

**k. Maintenance Switch**

On operation of the maintenance switch located on top of the car by the maintenance crew, the car shall travel at slow speed not exceeding 0.85 m / sec by continuous operation of a button

**l. Overload Indicator**

An overload indicator with buzzer shall be provided in the cabin to indicate to the passengers that the car will not start as it is overloaded.

**m. Operating Panels, Buttons & Switches**

All buttons and switches shall be clearly legible with fade-proof text and figures, and shall be easily accessible, especially for disabled persons.

## **ADDITIONAL FEATURES REQUIRED**

### **1.1. Fireman's Switch**

A fireman's toggle switch shall be provided in a break glass for the specified elevator at ground floor to enable firemen to bring the elevator non-stop to ground floor from any location and to cancel hall calls until the car is operated on attendant control.

### **1.2. Anti – Nuisance**

If number of calls registered is in excess of corresponding car load, all car calls shall be cancelled.

### **1.3. Home Landing Facility**

A car shall return to a pre-determined landing after the last call is answered

### **1.4. Load Non stop**

When the car load exceeds a predetermined limit the lift shall not respond to hall calls.

### **1.5. Separate door times**

When a car responds only to hall calls or only to car calls, the door shall open for a shorter time than when responding to both car and hall calls.

### **1.6. Door Failure Operation**

When an obstruction prevents a door from opening, the controller shall attempt its removal by repeated opening and closing, failing which the car shall travel to the next floor.

### **1.7. Nudging Door Operation**

When the doors remain open for more than a predetermined period a buzzer shall sound and the door shall close automatically. The door sensing device shall be rendered inoperative but the Door Open button and the safety shoe shall remain operative

### **1.8. Self - Diagnostic Facility**

The Controller shall perform self - diagnostic tests and report the health of the system. The system shall take care of minor faults like door operation and motor overheating.

### **1.9. Car Failure Operation**

In case of car mal-function, the system shall make a self - diagnostic check and then allow the car to travel to the nearest floor at slow speed, if safe.

### **1.10. Selective floor Service**

Programming for selective floors services shall be software driven.

### **1.11. Auto Fan Off**

In case no calls are registered for pre-set time, the cabin fan shall be automatically switched off.

### **1.12. Automatic Rescue Device**

In case of mains power failure and elevator control system failure, the elevator's own rechargeable and maintenance free battery power shall move the car to the nearest floor and the door shall open automatically for automatic rescue of passengers. A battery run- down indicator shall be provided. Automatic Rescue Device shall be provided for all the Lifts.

## **NOTE:**

1. The lifts shall be design for clear entry and movement of wheelchair and suitable for Especially abled people in accordance with the provisions of NBC-2016.
2. Quality of Service for all Lifts should be Good.
3. The number, capacity and speed of Lifts mentioned in scope of work are minimum however contractor/ consultant will design capacity, speed, quality of service, handling capacity etc. based on detailed traffic analysis.
4. The specifications are indicative and better specifications shall be installed as per the direction of Engineer in charge.
5. The scope of work includes SITC, handing over to client dept. and liasoning with local bodies, nothing extra will be paid in that regards. Bidders are requested to quote accordingly. Bidder are also requested to read the architectural drawings and verify the site conditions before quoting.
6. Scope of work also include Lift panel / DB required for distribution of power among the lifts and installation of lighting and power point sockets inside lift shaft.
7. The minimum operating speed of each LIFT shall be 1.5m/sec.

## **Scope of work and Technical Specifications for Fire Fighting System, Automatic Fire Alarm System, Fire Extinguishers & water supply pump sets**

The following sub heads mentioned in the payment schedule.

- 1 . Sub-head A9 (Annexure A9)
- 2 . Sub-head B9 (Annexure B9)
- 3 . Sub-head C9 (Annexure C9)
- 4 . Sub-head D10 (Annexure D10)
- 5 . Sub-head E10 (Annexure E10)
- 6 . Sub-head F10 (Annexure F10)
- 7 . Sub-head G10 (Annexure G10)
- 8 . Sub-head H10 (Annexure H10)
- 9 . Sub-head A12 (Annexure A12)
- 10 . Sub-head B12 (Annexure B12)
11. Sub-head C12 (Annexure C12)
- 12 . Sub-head D12 (Annexure D12)
- 13 . Sub-head E12 (Annexure E12)
14. Sub-head F12 (Annexure F12)
15. Sub-head G12 (Annexure G12)
16. Sub-head H12 (Annexure H12)

## **CONDITIONS AND SPECIFICATIONS FOR FIRE DETECTION, ALARM AND CONTROL SYSTEM (FAS)**

### **SCOPE AND GENERAL SYSTEM DESCRIPTION**

This section of the specification includes the Supply, Installation, Testing and Commissioning of the microprocessor controlled, intelligent reporting fire alarm equipment required to form a complete, operative, coordinated system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, Fire Alarm Control Panel (FACP), auxiliary control devices, annunciators, and wiring as specified herein.

Scope of Contractor shall also include the integration of Fire alarm system with Fire Dampers, Smoke Exhaust Fans, Access control doors, Elevators, PA equipment and HVAC electrical panel such as for AHU VFDs etc. (wherever required), for necessary activation/deactivation of systems during fire. Interfacing of Fire alarm panel with BMS (Building Management System) for alarms monitoring is also included in the scope of Contractor.

An intelligent reporting, Intelligent addressable microprocessor-controlled fire detection system shall be installed in accordance to the project specifications and drawings.

The fire alarm system shall comply with requirements of NFPA Standard 72(2013), IS 2189(2008) and NBC 2016 for Protected Premises Signalling Systems. The system shall be electrically supervised and monitor the integrity of all conductors.

The fire alarm system shall be manufactured by an ISO 9001 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994

The system and its components shall be UL/FM/EN/VdS listed/approved and CE Certified standard certified for fire alarm applications.

The panel shall be supplied with all accessories, control modules and power supplies in the required quantities as per site requirements for all types of field devices to make the system fully operational.

The FAS shall be supplied with necessary hardware and software so as to ensure networking of all panels. This shall include all devices such as modules and interfaces for providing fiber-optics based connectivity between panels and any licences, as applicable.

The detectors and devices connected to the fire alarm panel's loop(s) shall be auto-addressable via panel or software or manually addressable via a rotary switch or DIP switch.

The detectors shall provide dual alarm and power LED's. Both LED's shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel. Both LED's may be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. An output connection shall also be provided in the base to connect an external remote alarm LED.

The FAS system shall be supplied with all functionality including hardware, software and licences for integration with a third party IBMS system for real-time monitoring, supervision and control. The necessary interfaces and functionality for such networking protocols as BaCNet/IP shall be provided.

The FAS system shall be supplied and installed in all the Faculty Housing Towers-1 &2, Staff housing towers-1,2 &3 as well as Hostel blocks-1,2 and 3.

### **SCOPE OF WORK:**

The scope of work inclusive of supply, Installation, Testing, Commissioning of addressable Fire Detection/Alarm system with suitable panel, detectors, hooters, strobe, MCP & sub control panel (Mimic)



with all cable and required accessories as per the approved design and directions of Engineer-In-charge in following buildings:

- Faculty Housing- 02 Towers of G+12
- Staff Housing- 03 Towers of G+12
- Hostels- 03 Towers of G+6

**All the Fire Alarm system works shall be carried out in accordance with CPWD General Specifications for Electrical works -Part VI Fire Detection and Alarm system -2018**

**EQUIPMENT AND MATERIAL, GENERAL:**

All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approval agency for use as part of a protective signalling system, meeting the National Fire Alarm Code.

All equipment and components shall be installed in strict compliance with manufacturers' recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation.

All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

**MAIN FIRE ALARM CONTROL PANEL OR NETWORK NODE:**

Main FACP or network node shall contain a microprocessor based Central Processing Unit (CPU) and power supply. The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable detectors of various types, addressable modules, printer, annunciators, and other system-controlled devices.

**CENTRAL MICROPROCESSOR**

The microprocessor shall be a state-of-the-art, high speed, 16-bit RISC device and it shall communicate with, monitor and control all external interfaces. It shall include an EPROM for system program storage, Flash memory for building-specific program storage, and a "watch dog" timer circuit to detect and report microprocessor failure.

The microprocessor shall contain and execute all control-by-event programs for specific action to be taken if an alarm condition is detected by the system. Control-by-event equations shall be held in non-volatile programmable memory, and shall not be lost even if system primary and secondary power failure occurs.

The microprocessor shall also provide a real-time clock for time annotation of system displays, printer, and history file. The time-of-day and date shall not be lost if system primary and secondary power supplies fail. The real time clock may also be used to control non-fire functions at programmed time-of-day, day-of-week, and day-of-year.

A special program check function shall be provided to detect common operator errors.

An auto-program (self-learn) or a pre-configuration from software function shall be provided to quickly install initial functions and make the system operational.

For flexibility and to ensure program validity, an optional Windows (TM) based program utility shall be available. This program shall be used to off-line program the system with batch upload/download, and have the ability to upgrade the manufacturers (FLASH) system code changes. This program shall also have a verification utility, which scans the program files, identifying possible errors. It shall also have the ability to compare old program files to new ones, identifying differences in the two files to allow complete

testing of any system operating changes. This shall be in compliance with the NFPA 72 requirements for testing after system modification.

## **OPERATOR CONTROL**

### **1. Acknowledge Switch:**

Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from flashing mode to steady-ON mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the LCD display to the next alarm or trouble condition.

Depression of the Acknowledge switch shall also silence all remote annunciator piezo sounders.

### **2. Alarm Silence Switch:**

Activation of the alarm silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition after an alarm condition. The selection of notification circuits and relays that are silence-able by this switch shall be fully field programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto-silence timers.

### **3. Alarm Activate (Drill) Switch:**

The Alarm Activate switch shall activate all notification appliance circuits. The drill function shall latch until the panel is silenced or reset.

### **4. System Reset Switch:**

Activation of the System Reset switch shall cause all electronically-latched initiating devices, appliances or software zones, as well as all associated output devices and circuits, to return to their normal condition.

### **5. Lamp Test:**

The Lamp Test switch shall activate all local system LEDs, light each segment of the liquid crystal display and display the panel software revision for service personal.

#### **Basic Performance:**

- Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded on Class A Signalling Line Circuits (SLC).
- Initiation Device Circuits (IDC) shall be wired Class A as part of an addressable device connected by the SLC Circuit.
- Notification Appliance Circuits (NAC) shall be wired Class A as part of an addressable device connected by the SLC Circuit.
- On Class A configurations a single ground fault or open circuit on the system Signalling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
- Alarm signals arriving at the FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.

## **SYSTEM CAPACITY AND GENERAL OPERATION SIGNALING LINE CIRCUITS (SLC)**

Each loop of the fire alarm panel shall provide power to and communicate with up to a minimum of 127 intelligent addressable detectors and 127 intelligent addressable modules (monitor or control) or a mix of up to 250 detectors and devices in any combination.

Type 1: The control panel or each network node shall be equipped with 4 installed loops with each loop having a capacity of a minimum 127 addressable detectors and 127 addressable modules or a mix of up to 250 detectors and devices in any combination with max. 80% of loop loading in a single loop. It shall

be modularly expandable up to minimum 12 loop capacity with each loop having a capacity of minimum 127 addressable detectors and 127 addressable modules or a mix of up to 250 detectors and devices in any combination with max. 80% of loop loading in a single loop. However, the number of loop cards can be done as per the OEM configuration.

Type 2: The control panel or each network node shall be equipped with 5 installed loops with each loop having a capacity of a minimum 127 addressable detectors and 127 addressable modules or a mix of up to 250 detectors and devices in any combination with max. 80% of loop loading in a single loop. It shall be modularly expandable up to minimum 12 loop capacity with each loop having a capacity of minimum 127 addressable detectors and 127 addressable modules or a mix of up to 250 detectors and devices in any combination with max. 80% of loop loading in a single loop. However, the number of loop cards can be done as per the OEM configuration.

Type 3: The control panel or each network node shall be equipped with 7 installed loops with each loop having a capacity of a minimum 127 addressable detectors and 127 addressable modules or a mix of up to 250 detectors and devices in any combination with max. 80% of loop loading in a single loop. It shall be modularly expandable up to minimum 12 loop capacity with each loop having a capacity of minimum 127 addressable detectors and 127 addressable modules or a mix of up to 250 detectors and devices in any combination with max. 80% of loop loading in a single loop. However, the number of loop cards can be done as per the OEM configuration.

Type 4: The control panel(s) or each network node shall be equipped with minimum 14 installed loops either in same panel or combined, each loop having a capacity of a minimum 127 addressable detectors and 127 addressable modules or a mix of up to 250 detectors and devices in any combination with max. 80% of loop loading in a single loop. It shall be modularly expandable by minimum additional 4 loops with each loop having a capacity of minimum 127 addressable detectors and 127 addressable modules or a mix of up to 250 detectors and devices in any combination with max. 80% of loop loading in a single loop. However, the number of loop cards can be done as per the OEM configuration.

Type 5: The control panel or each network node shall be equipped with 1 installed loop with each loop having a capacity of a minimum 127 addressable detectors and 127 addressable modules or a mix of up to 250 detectors and devices in any combination with max. 80% of loop loading in a single loop.

Class A (NFPA Style 6/7) type cabling structure.

The FACP or each network node shall provide the following features:

- Drift compensation to extend detector accuracy over life. Drift compensation shall also include a smoothing feature, allowing transient noise signals to be filtered out.
- Detector sensitivity test, meeting requirements of NFPA 72
- Maintenance alert, with two levels (maintenance alert/maintenance urgent), to warn of excessive smoke detector dirt or dust accumulation.
- Detectors shall be programmable as application specific, selected in software for a minimum of eleven environmental fire profiles unique to the installed location. These fire profiles shall eliminate the possibility of false indications caused by dust, moisture, RFI/EMI, chemical fumes and air movement while factoring in conditions of ambient temperature rise, obscuration rate changes and hot/cold smoke phenomenon into the alarm decision to give the earliest possible real alarm condition report.
- The ability to display or print system reports.
- Alarm verification, with counters and a trouble indication to alert maintenance personnel when a detector enters verification 20 times.

- Positive Alarm Sequence - PAS pre signal, meeting NFPA 72 3-8.3 requirements.
- Rapid manual station reporting (less than 3 seconds) and shall meet NFPA 72 requirements for activation of notification circuits within 12 seconds of initiating device activation.
- Periodic detector test, conducted automatically by the software.
- Self optimizing pre-alarm for advanced fire warning, which allows each detector to learn its particular environment and set its prealarm level to just above normal peaks.
- Cross zoning with the capability of counting: two detectors in alarm, two software zones in alarm, or one smoke detector and one thermal detector.
- Walk test, with a check for two detectors set to same address.
- Control-by-time for non-fire operations, with holiday schedules.
- Day/night automatic adjustment of detector sensitivity.
- Device blink control for sleeping areas.

## **SYSTEM DISPLAY**

The system shall be supplied with a LCD display or a VGA colour LCD display with touch screen.

The system shall include a full featured operator interface control and annunciation panel that shall include a backlit Liquid Crystal Display (LCD) or a VGA colour LCD display with touch screen, individual colour coded system status LEDs, and an alphanumeric keypad for the field programming and control of the fire alarm system.

The display shall provide all the controls and indicators used by the system operator such as ACKNOWLEDGE, ALARM SILENCE, ALARM ACTIVATE (drill), SYSTEM RESET, and LAMP TEST.

The display shall annunciate status information and custom alphanumeric labels for all intelligent detectors, addressable modules, internal panel circuits, and software zones.

The LCD display or VGA colour LCD display with touch screen shall provide Light-Emitting-Diodes (LEDs) that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM WARNING, SECURITY ALARM, SUPERVISORY EVENT, SYSTEM TROUBLE, ALARM SILENCED, DISABLED POINTS, OTHER EVENTS, CPU FAILURE and Controls Active.

The LCD display or VGA colour LCD display with touch screen shall provide a set of "soft" keys for screen navigation or to accomplish dedicated programming functions. Full programming access shall require use of a laptop and the proper programming utility.

## **NETWORKCOMMUNICATION AND INTERFACES**

The FACP shall be capable of communicating with each other on a Local Area Network (LAN) over UTP CAT5/CAT6 cabling or RS485 or fiber optic cable connectivity, utilizing a peer-to-peer protocol.

The system shall include min. two serial EIA-232 interfaces. Each interface shall be a means of connecting respected certifications or standards (UL/CE/FM/EN/VdS).

Besides, the system shall include interfaces for connecting devices such as printers, LAN interface, RS485, Fiber Optics based connectivity interface, BacNet/IP for 3rd party communication.

The system shall be capable to integrate with ELV and other 3rd party services like Access Control system, Public Address system, Lifts, Fire dampers, AHU VFDs/HVAC Electric panel etc.

**ENCLOSURES:**

The control panel shall be housed in a standardized cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.

The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators. For convenience, the door may be site configured for either right or left hand hinging.

**POWER SUPPLY:**

An off-line switching power supply shall be available for the fire alarm control panel or network node and provide 6.0 amps of available power for the control panel and peripheral devices.

Provisions will be made to allow the audio-visual power to be increased as required by adding modular expansion audio-visual power supplies.

Positive-Temperature-Coefficient (PTC) thermistors, circuit breakers, or other over-current protection shall be provided on all power outputs. The power supply shall have an integral battery charger for use along with batteries. The power supply shall continuously monitor all field wires for earth ground conditions, and shall have the following LED indicators:

- Ground Fault LED
- AC Power Fail LED

The main power supply shall operate on 230 VAC, 50Hz and shall provide all necessary power for the FACP.

The main power supply shall provide a battery charger using dual-rate charging techniques for fast battery recharge and be capable of charging batteries up to 120 AH.

System shall be proposed with backup power from UPS and also independent power backup through Sealed Maintenance Free (SMF) Lead acid Batteries with backup of 24 hours under Normal working condition & 30 minutes under emergency condition of operation under alarm condition with adequate spare capacity overhead.

The system shall be provided with requisite power supplies, including additional power supplies for the operation of devices such as sounders.

**SYSTEM COMPONENTS - ADDRESSABLE DEVICES ADDRESSABLE DEVICES - GENERAL**

- Addressable devices shall use simple to install and maintain decade, decimal address switches.
- Detectors shall connect with two wires to the fire alarm control panel signalling Line Circuits.
- The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. The panel on a time-of-day basis shall automatically adjust sensitivity.
- Detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance.
- The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Bases shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Style 6/7 applications.

- Addressable devices shall store an internal identifying code that the control panel shall use to identify the type of device.
- Addressable modules shall mount in a 4-inch square (121.6 mm square), 2-1/8 inch (54 mm) deep electrical box.

#### **INTELLIGENT MULTI SENSING DETECTOR**

- The intelligent multi-sensing detector shall be an addressable device that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to determine its environment and choose the appropriate sensing settings. The detector design shall allow a wide sensitivity window, no less than 1 to 4% per foot obscuration. This detector shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device.
- The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).
- The addressable multi-sensing detector shall be capable to configure and to be addressed manually or from software or remote locations also.

#### **INTELLIGENT THERMAL OR HEAT DETECTORS**

Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signalling line circuit.

The detector shall be capable to configure and to be addressed manually or from software or remote locations also.

#### **BEAM SMOKE DETECTORS**

Sensing Range: 5 to 50 meters

Adjustment Angle:  $\pm 12^\circ$  horizontal and vertical.

Typical sensitivity levels:

Level 1 — 25%.

Level 2 — 30%.

Level 3 — 40%.

Level 4 — 50%.

Fault Condition (trouble):

96% or more obscuration blockage.

In alignment mode.

Improper initial alignment.

Self-compensation limit reached.

Alignment Aid using optical gun sight or integral signal strength indication or Two-digit display.

## **HYDROGEN DETECTOR**

The Hydrogen detector shall have high sensitivity and selectivity to hydrogen.

Shall have fast response and recovery time

Shall have minimum spans of 0.25 to 4.0 % to detect H<sub>2</sub> in Air.

Input Voltages: 12 to 24 VDC

Output sensing Range: 1 to 4.5 VDC

Power Consumption: minimum 0-12 A

Minimum Response Time: < 5 seconds

The detector shall have hazardous location approvals and certifications

## **ADDRESSABLE MANUAL CALL BOX**

- Addressable manual fire alarm boxes shall on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
- All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
- All entrances and stair levels shall be equipped with a pull type manual call point to activate an alarm. Manual call points shall be located in a manner so as to give an easy access to occupants in emergency; these shall be at entry/exits and within 30meters distance.
- Manual Call Points shall be provided with Weatherproof IP rating with minimum IP 52 for indoor applications.

## **SOUNDER AND STROBE:**

- Shall follow NFPA 72 2013.
- Electronic sounders shall operate on 24 VDC nominal.
- Electronic sounders shall be field programmable without the use of special tools, at a sound level of at least 90 dBA measured at 3 meters from the device. It shall be capable to produce different signals/tones.
- Sounders and strobes shall be provided with Weatherproof IP rating with minimum IP 52 for indoor applications.
- Shall be capable to broadcast pre-programmed Voice Message also Shall be flush or surface mounted as shown on plans.
- Shall produce broad band directional sound with 20 Hz to 20 Khz frequency band to guide occupants to safe exists even in complete darkness.
- Strobe lights shall meet the requirements of the Americans with disabilities Act (ADA), be fully synchronized, and shall meet the following criteria:

- The maximum pulse duration shall be 2/12 of one second.
- The flash rate shall be minimum 1 flash per second.
- Field Wiring Terminal Blocks
- For ease of service all panel I/O wiring terminal blocks shall be removable, plug-in types and have sufficient capacity for #18 to #12 AWG wire. Terminal blocks that are permanently fixed are not acceptable.

#### **ADDRESSABLE RELAY MODULE**

- Addressable Relay Module shall provide a dry potential contact o/p for activating a variety of auxiliary devices and other services equipment (i.e. Smoke Exhaust Fans, Fire Dampers, Access control doors, elevators, PA equipment and HVAC electrical panel such as for AHUs).
- It shall have a various current handling capability of 1A/2A/3A (as required) @ 30 VDC to integrate with third party system.

#### **ADDRESSABLE CONTROL MODULE (WHETHER APPLICABLE SEPERATELY)**

- Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered polarized audio/visual notification appliances.
- Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised remote power supply from the same OEM.
- The control module shall be suitable for pilot duty applications and rated for a minimum of 2.0 amps at 24 VDC.

#### **ISOLATOR MODULE (WHETHER APPLICABLE SEPERATELY)**

- Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. In case of UL/FM listed panel shall have isolator module after every 20 detectors to protected zone of the building. In case VdS/EN every detector or device shall be equipped with inbuilt isolator module.
- If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.
- The isolator module shall not require address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
- The isolator module shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

#### **MONITOR MODULE**

Nominal operating voltage: 15 to 32 VDC.

Maximum current draw: 5.0 mA (LED on).

Average operating current: 350 mA (LED flashing, once every 5 seconds)



Maximum IDC wiring resistance: 40 ohms.

EOL resistance: 47K ohms.

## **RESPONSE INDICATOR**

- Remote Response Indicator shall be provided for detectors above false ceiling and shall be installed outside the areas normally kept closed to identify the detectors response even if the room is locked. These indicators shall be able to indicate the status of the corresponding detectors in these areas.

## **FIREFIGHTER TELEPHONE JACK AND HANDSET**

Fire-fighter telephone jack is semi-flush mounted receiving plate with a single-gang box. The plate has a single phone jack mounted on an attractive, single-gang, stainless steel plate. Colour coded wires, approx. 6 inches long, are prewired to the jack to enable fast and accurate wiring to the system

Fire-fighter telephone handset comes with a coiled cord. The attached plug fits Fireman's Phone Jack and it is allowing fire-fighters to make direct communication with a central control area

## **SYSTEM OPERATIONS**

### **BASIC SYSTEM FUNCTIONAL OPERATION**

When a fire alarm condition is detected and reported by one of the system initiating devices, the following functions shall immediately occur:

- The system alarm LED on the system display shall flash.
- A local piezo electric signal in the control panel shall sound.
- A backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
- Printing and history storage equipment shall log the information associated each new fire alarm control panel condition, along with time and date of occurrence.
- All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.

### **SPECIFIC SYSTEM OPERATIONS**

- Smoke Detector Sensitivity Adjust: A means shall be provided for adjusting the sensitivity of any or all addressable intelligent detectors in the system from the system keypad. Sensitivity range shall be within the allowed standard window and have a minimum of 11 application specific sensitivity levels.
- Alarm Verification: Each of the intelligent addressable smoke detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification delay shall be programmable from 5 to 30 seconds and each detector shall be able to be selected for verification. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.
- Point Disable: Any addressable device or conventional circuit in the system may be enabled or disabled through the system keypad.
- Point Read: The system shall be able to display or print the following point status diagnostic functions:
  - a. Device status
  - b. Device type
  - c. Custom device label

- d. View analog detector values
- e. Device zone assignments
- f. All program parameters

- System Status Reports: Upon command from an operator of the system, a status report will be generated and printed, listing all system status.
- System History Recording and Reporting: The fire alarm control panel shall contain an events buffer that will be capable of storing a minimum of 5000 events. Up-to 1200 events shall be dedicated to alarm and the remaining events are general purpose. Each of these activations will be stored and time and date stamped with the actual time of the activation. The contents of the history buffer may be manually reviewed, one event at a time, or printed in its entirety. The history buffer shall use non-volatile memory. Systems that use volatile memory for history storage are not acceptable substitutes.
- Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent detector and shall analyse the detector responses over a period of time. If any intelligent detector in the system responds with a reading that is above or below normal limits, then the system will enter the trouble mode, and the particular detector will be annunciate on the system display, and printed on the optional printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.
- Pre-Alarm Function: The system shall provide pre-alarm levels of warning to give advance notice of a possible fire situation. Both pre-alarm levels shall be fully fielded adjustable. The first level shall give an audible indication at the panel. The second level shall give an audible indication and may also activate control relays. The system shall also have the ability to activate local detector sounder bases at the pre-alarm level, to assist in avoiding nuisance alarms.
- Software Zones: The FACP shall provide minimum 70 software zones, minimum 5 additional special function zones, minimum 5 releasing zones, and minimum 12 logic zones.
- The fire alarm control panel shall include a walk test feature. It shall include the ability to test initiating device circuits and notification appliance circuits from the field without returning to the panel to reset the system. Operation shall be as follows:
  - Alarming an initiating device shall activate programmed outputs, which are selected to participate in walk test, for 3 seconds.
  - Introducing a trouble into the initiating device shall activate the programmed outputs for 8 seconds.
  - All devices tested in walk test shall be recorded in the history buffer.

#### **SUPERVISORY OPERATION**

An alarm from a supervisory device shall cause the appropriate indication on the system display, light a common supervisory LED, but will not cause the system to enter the trouble mode.

#### **SIGNAL SILENCE OPERATION**

The FACP shall have the ability to program each output circuit (notification, relay, speaker etc) to deactivate upon depression of the signal silence switch.

#### **NON-ALARM INPUT OPERATION**

Any addressable initiating device in the system may be used as a non-alarm input to monitor normally open contact type devices. Non-alarm functions are a lower priority than fire alarm initiating devices.

#### **CODES AND STANDARDS:**

All the following codes & standards shall follow and conform to the latest editions, amended to date.

- National Building Code of India – 2016
- Bureau of Indian Standards (BIS) Codes: IS 2189 (2008)

- NFPA-72 (2013)
- Local Fire Code, Comply with Local Fire Authorities requirements.
- Listing and/or Approvals:
  - UL (Underwriters Laboratories Inc.)
  - FM (Factory Manual)
  - CE (European Conformity)
  - EN (European Norms)
  - VdS

## INSTALLATION

All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

## TEST

The service of a competent, factory-trained engineer or technician authorized by the OEM of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with NFPA 72/ IS 2189/Local Fire Code

- Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
- Open initiating device circuits and verify that the trouble signal actuates.
- Open and short signalling line circuits and verify that the trouble signal actuates.
- Open and short notification appliance circuits and verify that trouble signal actuates.
- Ground all circuits and verify response of trouble signals.
- Check presence and audibility of tone at all alarm notification devices.
- Check installation, supervision, and operation of all intelligent smoke detectors using the walk test.
- Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.
- When the system is equipped with optional features, the manufacturer's manual shall be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

## FINAL INSPECTION

At the final inspection, a factory-trained representative of the OEM of the major equipment shall demonstrate that the system functions properly in every respect.

## 2-CORE 1.5 SQ MM (15AWG) FRLS FLEXIBLE CABLE OR ARMOURED CABLE

All Cables shall follow the general IS Cable Standard IS 1554.

### Conductor:

Nos. of cores x size in sq. mm:	2 X 1.5
Material:	Plain annealed copper (Cu)
Type of pair:	Shielded twisted pair
Copper as per Class 2 of IS:	8130/84
Max. d.c. resistance of conductor at 20° C:	12.12 (ohm/km)
Shape of the conductor: Stranded Circular	
Outer Sheath colour:	RED

**Insulation:**

Material:	XLPE as per IS 7098(Pt-1)/88, Latest
Nominal thickness (mm):	0.7
Minimum thickness (mm):	0.53
Core Identification:	Red, Black

**Armouring:**

Material:	Galvanised Steel
Type of armouring:	Round Wire
Nominal size of armour (mm):	1.40

**Electrical Parameters:**

Approx. overall diameter of the cable (mm):	12
Minimum bending radius:	12 times Overall diameter

**PUBLIC ADDRESS SYSTEM (PAS) - DIGITAL****SCOPE & SYSTEM DESCRIPTION**

- The suggested Public Address System (PAS) and Emergency Evacuation System (EVAC) must meet and comply with all the requirements of IEC60849 standards for emergency sound systems, EN 60849/54, BS5839 and IS 1881 & IS 1882 standards. The public address and emergency system shall be using digital audio transportation and processing. The system shall provide a very user-friendly user interface and the system design shall be based on a network-based concept.
- The Digital PA system shall also provide extensive audio processing facilities. The equipment shall be provided with digital audio processing facilities for all audio inputs and outputs. The call stations shall also be provided with audio processing facilities. The audio transport from the call stations to the power amplifier shall be achieved by using digital audio technology right up to the amplifying circuits, before which the digital audio is converted to analog audio.

**Web-based technology**

- The Public Address system network controller shall be a web server, which can be accessed by any properly authorized workstation connected to the network.

**The functional combination**

- Various functions shall be combined and incorporated in each system unit, such as audio processing and speaker line monitoring in the power amplifier. Delay function amplifier channel which shall be incorporated in the power amplifiers.

**Software**

- The system shall be provided with configuration and diagnostic & logging software as standard which shall be used to configure all system parameters.
- The diagnostic & logging software shall provide extensive diagnostic and logging functions. This software shall enable the user to find details of any status changes in the system. The same software shall also be used to display call status in either text or graphic form.

**Display on Equipment**

- The system units shall have a minimum 2 x 16-character display for user interaction. The navigation control shall enable the user to view any change in status of that particular equipment on the display. The user shall be able to carry out enquiries on the status of all units for faults and calls from the network controller.

### **External Interfaces**

- The network shall have three types of interfaces; namely RS232, Ethernet and control inputs/outputs for interfacing with other systems. In the public address and emergency systems, the fault status and other status changes have to be reported to a central building management system.
- PA Controller shall have provision to interface with Fire alarm system and EPABX Exchange through open protocols.
- The system shall be able to accept large numbers of control inputs, which can be used to initiate actions in the system. The system shall be provided with control outputs, which can be used to interface with external systems.

### **MAIN UNIT / NETWORK CONTROLLER**

- The unit shall be capable of routing minimum 20 audio channels, delivering power to the system, fault reporting and controlling of the system and such that a variety of audio inputs shall be supported such as - calls from call stations, background music or local audio inputs.
- The controller shall have an in-built web-server for configuration and management and not require a client program for installation.
- The unit shall be capable of working either in stand-alone mode or with a PC connected to it and be configured for any complex public address configuration via the PC. The PC connected to the network controller unit shall be able to show all status changes in the system with the configuration and diagnostic & logging software. The unit must be supplied with user-friendly configuration and diagnostic & logging software. The unit shall be certified to be compliant to IEC60849.
- The unit shall support either freestanding or a 19" rack mounting installation. It should have the following functions:
  - The network controller shall have minimum 4 analogue audio inputs. Two of these inputs shall be selectable between microphone and line. The other 2 inputs shall be fixed as line inputs.
  - There shall be minimum 8 control inputs, which are freely programmable. These can be programmed for actions to be done in the system and assigned priorities.
  - Minimum 5 x control outputs (of which two dedicated fault contacts)
  - Minimum 1 x internal speaker
  - Minimum 1 x headphone output
  - The network controller shall have minimum 4 analogue audio line outputs.
  - The audio line outputs shall have a selectable 20 KHz monitoring signal.
  - The control output shall be freely programmable for faults and calls.
  - The network controller shall be supplied with a switch mode power supply.
  - The network controller shall have a redundant network wiring capability.
- The network controller shall have the capability to handle up to 256 priorities and minimum 120 zones. The priorities shall be classified based on the nature of call, i.e., type of calls, such as:

- Emergency Calls, such as during event of fire or other such trigger, which shall take the highest priority
  - Normal Calls such as announcements
  - BGM Routing, which shall take the lowest priority
- It shall be possible to assign different priority levels to different paging microphones/call stations
  - The front panel shall have a minimum 2 x 16-character LCD display and a rotary control for selection of system enquiry mode, change in volume for the headphone or internal speaker and to navigate through the menu.
  - The network controller shall be provided with a storage facility for the last 200 fault messages in the system.
  - The network controller shall have a socket for the flash memory card, which is available commercially as the storage device for the pre-recorded audio messages. The user shall be able to select the memory size of the compact flash memory card according to his storage requirements for the audio messages. The network controller shall be capable of playing four messages simultaneously. The status of the digital audio storage and the messages shall be monitored. The audio messages (stored as a set of wav files) can be downloaded from a computer via the Ethernet link.
  - The network controller shall monitor the status of all equipment in the system and report status changes.
  - The network controller shall monitor the microphone capsule of a call station microphone and report any fault.
  - The external cables connected to the control inputs shall be monitored for short and open circuits.
  - Attention and alarm tone definitions shall be stored in the network controller. These tones can be accessed by any call stations or control inputs for announcement broadcast or alarm broadcast
  - The network controller shall have an internal real time clock.
  - The network control unit shall have extensive audio processing possibilities for audio inputs and audio outputs. Parametric equalization, limiter, and gain can be adjusted with the configuration software.

#### **POWER AMPLIFIERS**

- The Digital PA System amplifiers shall be Class D amplifiers. It shall be possible to select the output voltage between 120V, 70V or 50V by changing jumpers. The power amplifiers shall be provided with a minimum 2 x 16-character display for status display.
- The Class D amplifiers shall be available for various capacities, such as:
  - 1x500W: Single zone for up to 500 watts.
  - 2x250W: Two zones for up to 250 watts per zone.
  - 4x125W: Four zone for up to 125 watts per zone.
- The power amplifiers shall be equipped with amplifier monitoring and change-over relays. The amplifier shall provide short-to-ground and short-circuit detection functions.
- The power amplifiers shall have 2 auxiliary audio inputs with microphone/line level selection.
- The audio input of the power amplifier can be selected as automatic volume control input.

- Minimum 8 freely programmable control inputs shall be available for actions that can be initiated in the system and these shall have priorities.
- Minimum 4 freely programmable control outputs shall be available that can be programmed for faults and calls.
- Minimum 2 x 16-character display and rotary control on the front panel for status enquiries and monitoring functions. The display shall show the VU meter reading when the audio monitoring mode is selected. The audio output can be monitored by connecting a headphone to the headphone socket. Status changes of the unit shall be monitored continuously and reported to the network controller for fault/status reporting.
- The control input can be programmed for momentary or toggle operation. This selection can be made in the configuration software.
- The control input shall have the ability to monitor the cable between the control input and the external switch against open and short circuits.
- The power amplifier shall be designed for redundant network wiring.
- The amplifier monitoring and changeover facility shall be incorporated in the power amplifier. The changeover relays shall be included in the unit.
- The unit shall incorporate digital audio processing possibilities for 3 sections of parametric equalization and 2 sections of shelving equalization and audio delay.

#### **Interfaces**

- Minimum 2 x system network connection

#### **Indications and controls**

- Minimum 2 x 16-character LCD display for status display
- Rotary control for selection of system enquiry mode and headphone volume
- Power supply ON/OFF switch on the back

#### **Inputs**

- Minimum 8 x control inputs
- Minimum 2 x audio inputs

#### **Outputs**

- Selectable 120V, 70V or 50V outputs for each amplifier channel. An additional fixed 50V output shall be provided for each amplifier channel
- Minimum 4 x control outputs
- Minimum 4 x amplifier channel outputs
- Minimum 1 x headphone output

#### **PA MICROPHONE**

- The call station shall be used for making a manual or pre-recorded call to any pre-assigned zones or executing a predefined action. The call station shall have one key. The call station shall have a fixed

microphone to transmit speech over the network and a press-to-talk key. The call station shall also have a headset socket. Once the headset is connected the microphone will be muted.

- The call station shall have minimum six zone capacity.
- The call station shall have a speech filter with a cut-off frequency at 340Hz to improve intelligibility and prevent clipping of the audio input on low-frequency signals.
- It should be possible to connect the unit with minimum 12 call station keypad units via serial data communication links.
- The power supply to the call station keypad units shall be provided from the call station.
- The call station shall have a volume control for the monitoring loudspeaker at the call station. The volume control shall also control the volume of the headset.
- The call station shall be programmable for momentary actions on make contact and toggle actions without repeat on make contact.
- It shall be possible to assign minimum 200 priorities.
- Analogue-to-digital audio conversion shall be performed at the call station.
- The call station shall also have a digital signal processor, which can be used for audio processing. It can be used to adjust sensitivity, limiter and parametric equalizer.
- The monitoring loudspeaker shall be on when that particular call station activates a chime or pre-recorded message, and will be switched off when its own live audio channel is open.

### **Interfaces**

- system network connection
- Serial data and power supply interfaces for call station keypad units
- Headset socket
- Number of connectors: 1
- Position: Front
- Type: 3.5 mm jack
- Maximum cable length: 1.5m
- Audio: Mono microphone signal, mono earphone signal

### **Indications and controls**

- The call station shall have three 2-color LEDs for indications such as:
  - Power on and no system/call station fault
  - Power not available
  - Fault in the system and power on



- Call station fault and power on
  - Chime on or pre-recorded message playing
  - Ready to talk/live speech
  - No call status to display
  - Emergency announcement being ON in the system. Possible to make normal calls to the zones which are not involved (emergency) indication has priority over other indications)
- Lower-priority calls are ON or RESERVED (to all or some of the pre-assigned zones of the PTT key of the call station and selected zones of the call station keypad unit if installed)
  - Calls with higher or the same priority (not emergency) are ON or RESERVED (to all or some of the pre-assigned zones of the PTT key of the call station and selected zones of the call station keypad unit if installed)
  - No predefined or selected zones are in use or reserved by the system, nor is an emergency announcement being made.
  - Volume control for loudspeaker/headset.

#### **PA MICROPHONE KEYPAD – ADDITIONAL 6 ZONES**

- The call station keypad shall have 8 keys.
- The call station keypad keys can be programmed for various actions such as:
  - Control system functions: recall of selection, live speech call, cancel selection, BGM off, BGM volume control, programmable key for any action.
  - Select resources: BGM selection, pre-recorded message selection, attention and alarm tone selection.
  - Zone selection, system control output selection.
- Each key at the call station keypad shall have 2 color LEDs.
- The call station keypad shall be provided with in and out connections for serial data and power supply.
- The keys shall be provided with a label slot for indicating the name of the action assigned to that particular key.
- The power supply for the call station keypad shall be provided from the call station basic unit.
- The call station keypad key can be programmed for momentary or toggle operation.

#### **Interfaces**

- Serial data and power supply interfaces for call station keypad units/call station basic.

#### **Indications and controls**

- The call station keypad shall have a 2-color LED per key for various functions.

#### **CEILING LOUDSPEAKER (6-WATT)**

- The Ceiling Loudspeaker shall be an ergonomic, flush-mounting ceiling loudspeaker for general-purpose applications. It shall be a full range loudspeaker for speech and music reproduction.

- The Ceiling Loudspeaker shall be a single-piece, 6W, dual-cone loudspeaker with a 120 V matching transformer mounted on the back of the frame. It shall have a circular metal grille as an integral part of the front. The loudspeaker shall have built-in protection to ensure that, in the event of a fire, damage to the loudspeaker shall not result in failure of the circuit to which it is connected.
- The loudspeaker will have ceramic terminal blocks, thermal fuse and heat-resistant, high temperature wiring. It can also be fitted with an optional fire-dome to increase protection of the cable termination.
- Max. Power – 9 W
- Rated Power – 6 Watts
- SPL at 1 KHz, 1m, 1w: 94dB/86 (SPL)
- Rated Voltage: 120 volts
- Rated impedance: 1667 ohms
- Effective frequency range (-12dB) :( 80 Hz to 16000 Hz)
- IEC 60849 compliant

#### **WALL MOUNTED BOX SPEAKER (6- WATT)**

- The loudspeaker will have ceramic terminal blocks, thermal fuse and heat-resistant, high temperature wiring. It can also be fitted with an optional fire-dome to increase protection of the cable termination.
- Max. Power – 9 Watts
- Rated Power – 6 Watts,
- Rated Voltage: 120 volts, 70 volts, 50 volts
- Effective frequency range :( 80 Hz to 16000 Hz).
- Minimum SPL @ 1Khz(1W/1m) : 96dB / 90dB

#### **WALL MOUNTED BOX SPEAKER (15- WATT)**

- The loudspeaker will have ceramic terminal blocks, thermal fuse and heat-resistant, high temperature wiring. It can also be fitted with an optional fire-dome to increase protection of the cable termination.
- Max. Power – 25 Watts
- Rated Power – 15 Watts,
- Rated Voltage: 120 volts, 70 volts, 50 volts
- Effective frequency range :( 80 Hz to 16000 Hz).
- Minimum SPL @ 1Khz(1W/1m) : 96dB / 90 dB

## NETWORK CABLE ASSEMBLIES / FIBER INTERFACE

The system shall be supplied inclusive of Network cables assembly and OEM's fiber optics interfaces, any other applicable adaptors / interfaces / cards / supervision modules for main controller, amplifier & paging microphone and any other devices as applicable.

### CODES AND STANDARDS:

All the following codes & standards shall follow and conform to the latest editions, amended to date.

- EN60849/54
- IS 1881 & IS 1882
- IEC60849
- BS5839

### Software

- Web based Software Application for System Configuration, Management & Diagnostics. It shall not be necessary to install any software client application on computer for configuration, management and operation of the system.

### TESTING AND INSTALLATION:

- System installation, commissioning and testing shall be carried out as per the OEM's guidelines.

## 2-CORE 1.5 SQ MM (15AWG) FRLS FLEXIBLE CABLE OR ARMoured CABLE

All Cables shall follow the general IS Cable Standard IS 1554.

### Conductor:

Nos. of cores x size in sq. mm:	2 X 1.5
Material:	Plain annealed copper (Cu)
Type of pair:	Shielded twisted pair
Copper as per Class 2 of IS:	8130/84
Max. d.c. resistance of conductor at 20° C:	12.12 (ohm/km)
Shape of the conductor:	Stranded Circular
Outer Sheath color:	Black

### Insulation:

Material:	XLPE as per IS 7098(Pt-1)/88, Latest
Nominal thickness (mm):	0.7
Minimum thickness (mm):	0.53
Core Identification:	Red, Black

### Armoring:

Material:	Galvanised Steel
Type of armoring:	Round Wire
Nominal size of armour (mm):	1.40

### Electrical Parameters:

Approx. overall diameter of the cable (mm):	12
Minimum bending radius:	12 times Overall diameter

## UNDERTAKING FROM THE OEM OF FIRE ALARM SYSTEM

We, as manufacturer of.....fire alarm system & accessories, do hereby confirm that all the products supplied under this tender will be UL listed. Moreover, we will provide all technical support & backup to M/s..... during the execution of fire alarm work. In addition to it, we will provide all technical support to the department/agency approved by department in maintaining the fire alarm system on payment basis in future.

**Signature & Stamp of contractor Signature & Stamp of Manufacturer (F/A System)**

## **GENERAL**

The work shall be executed as per CPWD General Specifications for Electrical Works Part-I (Int.) 2013, Part-II (Ext.) 1994, CPWD General Specifications for Electrical Works Part VI Fire Detection and Alarm System – 2018, relevant I.E Rules, BIS/IEC and as per directions of Engineer-In-Charge. These additional specifications/ conditions are to be read in conjunction with above in case of variations; Specifications given in these additional conditions shall apply. However, nothing extra shall be paid on account of these additional specifications and conditions, as the same are to be read along with schedule of quantities for the work.

This specification covers manufacture, testing as may be necessary before dispatch, delivery at site, all preparatory work, assembly and installation, commissioning putting into operation of Fire Alarm system and allied works.

- Location: The equipment will be installed **at IIT Hyderabad, Kandi, Sangareddy**
- The tenderer should in his own interest visit the site and get familiarize with the site conditions before tendering.
- No T&P shall be issued by the Department and nothing extra shall be paid on account of this.

All sundry equipment, fittings, unit assemblies, accessories, hardware items, foundation bolts, termination lugs for electrical connections, and all other items which are useful and necessary for efficient assembly and installation of equipment and components of the work shall be deemed to have been included in the tender irrespective of the fact whether such items are specially mentioned in the tender documents or not.

### • **After award of work:**

The Contractor would be required to submit the following drawings within 15 days of award of work for approval of Engineer- In-Charge.

(a) General arrangement drawing of the equipment like detectors, R.I., LT Panel etc. in the building with complete dimensions.

(b) Any other drawings necessary for the job.

- The successful tenderer should furnish well an advance three copies of detailed instructions and manuals of manufacturers for all items of equipment regarding installation, adjustments operation and maintenance including preventive maintenance & trouble shooting together with all the relevant data sheets, spare parts catalogue etc. all in triplicate.

### • **EXTENT OF WORK**

The work shall comprise of entire labour including supervision and all materials necessary to make a complete installation and such tests and adjustments and commissioning as may be required by the department. The term complete installation shall not only mean major items of the plant and equipment covered by specifications but all incidental sundry components necessary for complete

execution and satisfactory performance of installation with all layout charts whether or not those have

been mentioned in details in the tender document in connection with this contract as this is a turnkey job.

- In addition to supply, installation, testing and commissioning of FAS/AFAS including intelligent addressable FAS equipment, following works shall be deemed to be included within the scope of to be executed by the tenderer as this is a turnkey job –

(a) Minor building works necessary for installation of equipment, foundation making of opening in walls or in floors and restoring them to their original condition/ finish and necessary grouting etc. as required.

(b) All supports for cables and MS Channels for erection as are necessary.

(c) Getting CFO inspection done & obtaining approval for energizing the installation. However, necessary fees for inspection shall be borne by the Department.

### **INSPECTION AND TESTING**

Copies of all documents of panels, detectors and other components shall be furnished to the Engineer-in-Charge and consignee.

- **TECHNICAL SPECIFICATIONS**

The work shall be carried out as per CPWD General Specifications for Electrical works Part VI- Fire Alarm system as amended upto date and CPWD General Specifications for Part I and Part II, as amended upto date, relevant IE rules, and as per directions of Engineer-in- charge.

### **FIRE FIGHTING SYSTEM:**

#### **TECHNICAL SPECIFICATIONS**

**All the Fire Fighting system works shall be carried out in accordance with CPWD General Specifications for Electrical works Part V Wet Riser and Sprinkler systems-2020**

#### **SCOPE OF WORK:**

Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install Wet riser, Sprinkler, First Aid Fire Protection system as required for all floor as per the drawings and specified here in after ~~or given in the Bill of Quantities.~~

System designed shall be in accordance with NBC-2016 & state fire act & rule.

#### **FACULTY TOWERS**

For this building below mentioned Firefighting system has been considered:

- Fire Extinguishers
- Hose Reel
- Wet Riser
- Yard Hydrant
- Sprinkler system
- Underground Fire water tank & pumps
- Over Head Fire Water tank

#### **STAFF TOWERS**

For this building below mentioned Firefighting system has been considered:

- Fire Extinguishers
- Hose Reel

- Wet Riser
- Yard Hydrant
- Sprinkler system
- Underground Fire water tank & pumps
- Over Head Fire Water tank

### **STUDENT HOSTEL**

For this building below mentioned Firefighting system has been considered:

- Fire Extinguishers
- Hose Reel
- Down Comer
- Over Head Fire Water tank
- Terrace pump

### **Fire Fighting works**

Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install Wet riser, Down comer, fire hydrant system/fire extinguishing as required as per CPWD specifications and requirement of Local body Fire & Emergency Service by the drawings and specified hereinafter or given in the Bill of Quantities.

Note: Suitable temperature sensitive sprinklers to be installed in all rooms in each flat of Faculty Housing and Staff Housing Towers based on the approved design.

Without restricting to the generality of the foregoing, the work shall include but not limited to the following:

-  
Fire Pumps, Motor, Engine and Accessories:

1. Electrically operated firefighting pumps with motors, base plate and accessories.
2. Pressure gauge with isolation valves.
3. M.S./Galvanized Pipes, fittings, valves, suction strainers, suction & delivery headers & accessories.
4. Foundations, vibration eliminator pads and foundation bolts.
5. Pressure vessel, pressure switches etc.

ii. Fire Hydrant System:

1. Piping for Down comer /hydrant systems.
2. Fire Hydrant valves, canvas hose pipes, hose reels, hose cabinets, connections to fire mains.

iii. Inspection & Testing assemblies.

iv. Hand Appliances /Fire Extinguishers:

v. Supply and installation of fully charged and tested fire extinguishers hand appliances water CO<sub>2</sub>, foam, dry chemical powder type, ABC stored pressure type, CO<sub>2</sub> gas cartridge type as required as per by these specification and drawings.

### **Pump**

i) The pump shall be horizontal /vertical type, as per design described in the Schedule of Quantities.

ii) The impeller shall be secured to the shaft and shall be retained against circumferential movement by keying, piping or lock rings.

iii) All screwed fasteners shall tighten in the direction of normal rotation.

iv) Pump shall be provided with approved type of mechanical seals.

### **Pumps Casing**

(i) The casing of horizontally /vertically pumps shall be hydrostatically tested to 1.5 times the maximum working pressure but in no case less than 250 PSI.

(ii) Pressure classification of flange connections shall correspond to casing working pressures.

(iii) Casing material shall be close grained, accurately machined, cast-iron, and precision manufactured for best performance and long-term duty and fitted with gunmetal wearing ring.

(iv) Water discharge diffusers shall be included to reduce radial torque to impellers.

### **Wearing Ring:**

Wearing rings shall be suitable for an individual application. Rings shall be replaceable, and positively keyed to prevent rotation.

**Bearing:**

Bearings shall be heavy-duty ball bearings with a minimum average life of 120,000 hours. The bearings shall be self-sealed, and housed in malleable-iron housing aligned to bearing bracket by means of large precision registers. Bearings shall be removable without dismantling any rotating element or pumps.

**Impeller:**

- (i) Impeller shall be one-piece, phosphor bronze, and the bush of gun metal. The impeller shall be hydraulically and dynamically balanced.
- (ii) Impellers of pumps shall be fully enclosed suction type and hydraulically balanced.
- (iii) Impellers shall be accurately keyed to the shaft and positioned axially by shaft sleeves and separate snap rings.
- (iv) Impellers shall be fully protected against damage from reverse rotation.

**Pump Shaft-Motor Shaft Coupling:**

All shafts shall be connected with adequately sized flexible couplings of suitable approved design. Necessary guards shall be provided for the couplings.

**Base Plate:**

- (i) A common base plate mounting both for the pump and drive shall be provided. The base plate shall be rigid construction, suitably ribbed and reinforced.
- (ii) Base plate and pump supports shall be so constructed and the pumping unit so mounted as to minimize misalignment caused by mechanical forces such as normal piping strain, hydraulic piping thrust etc.

**Vibration & balancing:**

The rotating elements shall be so designed to ensure least vibration during start and throughout the operation of the equipment. All rotating components shall be statically and dynamically balanced at workshop.

**Installation:**

Installation of the Fire Fighting Pump set shall be carried out exactly as per manufacturer recommendation.

**Foundation:**

The foundation of Fire Fighting Pumps & Electrical motor shall be constructed as per the requirement/recommendation of manufacturer of Fire Fighting Pumps / motor /Diesel Engine.

**Anti-vortex Plates:**

Anti-vortex plates shall be installed at the end of the Fire Pump suctions inside tanks.

**Instruction Manual & Tools/Spares:**

A comprehensive instruction manual shall be provided by the contractor indicating detailed requirements for operation, dismantling and periodic operation and maintenance procedures.

**Electric Motors**

- i) Electrically driven pumps shall be provided with totally enclosed fan cooled induction motor. The motor shall be full load duty & shall be capable of handling the required starting torque of the pumps. Speed of motor shall be compatible with the speed of the pump. All electrical motors for pumps inside Fire Pump Room shall be IP 54 rating enclosure.
- ii) Motors shall have a dust tight construction with suitable means of breathing.
- iii) All Components shall be of adequate mechanical strength and robustness and shall be constructed of metal unless otherwise approved.
- iv) The rating and design shall conform to (IS : 325) specification.
- v) The motors shall be wound for Class-F insulation and the winding shall be vacuum impregnated with head and moisture resisting varnish and glass wool insulated to withstand tropical conditions.

- vi) Two independent earthing points shall be provided on opposite sides of the motor for bolted connections.
- vii) Volt power terminals shall be suitable for receiving 1.1 KV grade armoured power cables.
- viii) The cable boxes and terminations shall be designed to enable easy disconnection and replacement of cables.
- ix) Provide other specific requirements required by governing energy conservation codes.

**Motors shall comply with the following:**

- (i) **Three** phase induction motors shall conform to Indian Standard (IS) 12615 and shall fulfil the following efficiency requirements:
  - ECBC+ Buildings shall have IE 3 (premium efficiency) class motors or higher class
- (ii) All permanently wired polyphase motors of 0.375 kW or more serving the building and expected to operate more than 1,500 hours per year and all permanently wired polyphase motors of 50kW or more serving the building and expected to operate more than 500 hour per year, shall have a minimum acceptable nominal full load motor efficiency not less than levels specified in the latest version of IS 12615.
- (iii) Motors of horsepower differing from those listed in the table shall have efficiency greater than that of the next listed kW motor.
- (iv) Motor horsepower ratings shall not exceed 20% of the calculated maximum load being served.
- (v) Motor nameplates shall list the nominal full-load motor efficiencies and the full-load power factor.

**Codes And Standards For Pumps, Motors And Diesel Engine**

**PUMPS:**

- The pumps shall conform to the standards and codes as given below:
- i) IS: 1520 Horizontal centrifugal pumps for clear, cold and fresh water.
  - ii) BS: 599 methods of testing pumps.
  - iii) PTC: 8 ASME Power test Codes – Centrifugal Pumps.

**MOTOR**

- The following codes shall be applicable for the motor :-
- i) IS: 325 Induction motor, three – phase.
  - ii) IS: 900 code of practice for induction motors, installation and maintenance.
  - iii) IS: 7816 guide for testing insulation resistance of rotating machines.
  - iv) IS: 4029 guide for testing three phase induction motor.
  - v) IS: 3043 code of practice for earthing.
  - vi) Further to those stated above, the design, manufacture, installation and performance of motors shall conform to the latest Indian Electricity Act and Indian Electricity Rules.

The following Fire fighting equipments scheme shall be followed for FTs, STs and Hostel blocks:

Building	Jockey Pump	Sprinkler Pump	Hydrant Pump	Terrace Pump	Fire DG pump
Tower FT1A , (Type – C)	Required	Required	Required	Required	Required
Tower FT1B , (Type – C)	Required	Required	Required	Required	Required
Tower ST2A (Type – D)	Required	Required	Required	Required	Required
Tower ST2B (Type – D)	Required	Required	Required	Required	Required
Tower ST1A (Type – E)	Required	Required	Required	Required	Required
336 Boarders Pre-cast Hostels-1,2,3	-----	-----	-----	Required	-----



## **M.V. Panels and Sub Panels for Fire fighting system**

### **Scope**

The scope of this section covers design, manufacture, supply/installation, testing and commissioning of Power Distribution Panels including ACBs/ MCCBs/ MCBs .The panel should be Totally type tested Assembly (TTA) / Design verified as per IEC 61439, Part 1 and 2 and other relevant code.

### **General**

Electrical characteristics of Factory Built Assemblies:

When the components are mounted in the enclosures, appropriate de-rating factors shall be allowed for the effect of other components and interconnections

- i. Enclosures of factory Built Assemblies:
- ii. Unless otherwise indicated, enclosures shall provide a minimum degree of protection of IP 42 when located within buildings and IP54 when located outside building.
- iii. Door shall have adequate fastenings with provision for locking in the closed position.
- iv. Fixing holes for equipment may be inside or outside the enclosure.
- v. Earthing terminals shall be fitted to each enclosure, suitable for internal and external connection to enable the exposed conductive parts of the protective conductor.
- vi. Where the enclosure has a painted finish, provision shall be made for earthing terminal to be electrically connected to the enclosure without need to remove any paint from ferrous metal.
- vii. Cable terminals shall be suitable for the number, size and type of cables as indicated. Adequate spacing shall be allowed for spreading of cable tails to avoid stress on the insulation or terminals; if necessary, extension boxes shall be fitted to standard enclosures. Terminals for neutral conductors for three phase and neutral circuits shall be the same size as for phase conductor, except where reduced section neutral cable cores are indicated.
- viii. Nos. of Gland Plates for cable entry made of 3 mm thick CRCA sheet ( each cable gland plate in two halves), complete with required Knock Outs shall be provided at top or bottom with number and size of knock outs to be sufficient for the incoming and outgoing as specified in the panel details as per site conditions.
- ix. Metallic enclosures for location within buildings shall have a stove dried painted finish of the manufacturer's standard colour, unless otherwise indicated. Ferrous parts shall be degreased and adequately rust protected immediately prior to painting.
- x. The compartment door shall be interlocked mechanically with the switch so that the door cannot be opened unless the switch is in OFF position. Means shall be provided for releasing this interlock at any time.
- xi. All MCCBs shall be provided with Rotary handle on the front door unless specifically mentioned otherwise.

### **Construction:**

#### **Basic Structure:**

- i. All electrical panels will be fabricated from 2mm thick CRCA sheet steel for robust construction properly supported with angles and channels.
- ii. The covers and doors shall be very well gasketed with neoprene rubber gaskets so as to obtain dust proof enclosure.
- iii. The cubicle will be floor-mounted type unless specified otherwise.
- iv. The cabinet will be welded construction and not of jointing construction.

#### **Doors:**

- 1) Door shall be made of 2mm sheet steel, with foamed seal polyurethane gasket, square section under tabular frame with punching in DIN pitch pattern.
- 2) The door will be provided with concealed hinges and panel locks of superior quality. The hinges will be union joint type to facilitate easy removal of the doors when necessary. Neoprene gaskets shall be provided beneath all doors and corners and also between adjacent sections, and on gland plates.
- 3) The doors will be provided in a similar fashion as generally provided for the outdoor cabinet, where water cannot enter in the cabinet from the door.

- 4) The door will be provided with strengthening arrangement to avoid wobbling and distortion. Doors shall have provision for earthing.
- 5) Wherever the doors are opened on horizontal hinges, an arrangement will be provided to latch the doors in an open condition for inspection of the wiring.
- 6) Generally, meter, relays push buttons, signal lamps and control components will be provided on a separate compartment for in-comer feeders only.
- 7) The circuit components will be mounted on sectionalized 3 mm thick CRCA sheet with suitable threading in the sheets to facilitate easy maintenance, future addition etc.
- 8) The panels shall be manufactured with separate busbar chamber isolated from unit feeder chambers and cable alleys, to provide extra safety for working personnel.

**Dimensions:**

Based on the SDL approved by E-I-C, Contractor shall prepare panel diagram. The height of the panel will be as per the drawing but not be more than 2120 mm. Depth of the panel will not be less than 300 mm and width of the panel will be given in the particulars of panel specifications or as per actual site conditions. Shop drawings shall have to be approved by the Engineer-in-charge before fabrication is taken up by hand.

**Adaptor Chambers for all cable entries:**

Wherever necessary, sheet metal adaptor chambers with angle frame and minimum depth of 300 mm will be supplied with panel. All the covers of adaptor box will be removable type. The box can be mounted horizontally or vertically. The pattern of cable entry, wherever not specified will have to be confirmed by the manufacturer/ Supplier/ Contractor in writing after placement of order. The cable entry shall be as per actual site conditions and approved.

**Powder Coating Treatment:**

- 1) The cubicle will undergo the process of Powder Coating treatment to the satisfaction of the Engineer-in-Charge.
- 2) The panels shall be treated for degreasing, de-rusting, phosphatizing and passivizing by adopting seven/nine tank process. As per the Indian Standard Specification. Powder coating process with a final coating shall be of 80-120 microns.
- 3) The painting of panel shall be carried out in a dust free atmosphere then baked in oven.

**Busbars:**

- 1) The bus bars will be of copper with a current density of 1.0 Amp per Sq. mm. The bus bars will be insulated with heat shrinkable sleeves and properly supported. All live parts shall be shrouded by means of acrylic / steel /FRP sheets to ensure no accidental contact with live parts during maintenance and provide simultaneous inspection. The busbar supports will be designed to withstand short circuit current equivalent to 35 MVA at 415 volts. The bus bars will be adequately insulated and protected to prevent accidental contact during operation and maintenance.
- 2) Non-hygroscopic SMC supports shall be used for busbar to give better mechanical and electrical strength and to ensure capability to withstand specified fault current.

**Insulation:**

The insulation between phases and between phases and ground of the power conductors will be made of synthetic resin board/molding, resistant to dust and dampness. All insulating material will be non-hygroscopic, fungus-proof and treated with suitable synthetic varnishes. All live exposed busbar inside the panel shall be guarded with insulating sheet like hylum sheet to protect direct contact of any person after opening of panel door.

**Terminals:**

Upto 35 sq. mm cables, the terminal will be provided of clip-on type and above 35 sq. mm, cable end terminals will provide of brass stud type designed of rugged construction.

**Wire ways:**

PVC extruded wire ways of required size will be provided for wiring in the control panel.

**Ferruling and colour code:**

Cabling for power circuit should be red, Yellow and blue or otherwise proper coloured sleeving will be provided at both ends of cables. For control cables every conductor will be provided with the identification ferrule matching with the one in the drawing.

All power and control wiring shall be done by using thimbles ferrules of proper size and quality at both ends for identification. The wiring shall be neatly bunched for easy identification.

**Cable Termination:**

Every cable, either for control or power duty will be provided with crimped type of lugs of suitable size as specified.

All power and control wiring terminals shall be brought out in the cable Alley for easy Cable Termination.

**Cables (Internal Wiring)**

All the cables will be PVC insulated FRLS of ISI approved and reputed make. The cables will be copper conductor as specified in the drawings and will be stranded and minimum number of strands will be three. The ratings will conform to IEE regulations.

All internal wiring inside the cubicle shall be carried out with 1120V grade, PVC insulated copper wires duly ferruled at either end. The power wiring above 120A shall be carried out through the PVC insulated aluminium links.

**Earthing:**

The earth busbars should be GI/Al unless otherwise specified. Bolts to be of cadmium plated with washers. Earth busbars will be provided all around the cubicle at the bottom with duplex external earth connection arrangement.

**Cable Glands and Lugs:**

The cable glands will be of brass cone grip type. These glands will be provided for all the outgoing connections at both the ends for power as well as control circuits provided in the panel and also for the incoming cable or cables. Lugs will be crimped for termination of outgoing cable at both ends (i.e., load end and panel end) with each outgoing feeder.

**Feeder Units:**

1) The feeder units shall be of compartmental design comprising of cubicles assembled together and shall incorporate cubicle MCCB and MCB having rupturing capacity of minimum 25 KA and 12 KA at 440 volts respectively unless specifically mentioned.

2) The MCCB shall be quick break and trip free type with magnetic thermal release or as specified in the BOQ. Protection Devices shall be as specified in BOQ.

3) Individual MCCB (with ammeter, selector switch, CTs) small wiring where provided should be easily removable from the front of the switchboard for servicing and maintenance. The connections to MCCBs from the busbars and cables should be terminated in pressure bolted joints inside the switch contacts.

4) The MCCB on main LT Panel shall have ratings: 63A, 120A, 125 A, 160 A, 200 A, 250A, 320A, 400A / 630A with 36 KA (minimum) rupturing capacity unless specifically mentioned in the BOQ.

5) Bus bar should have sufficient mechanical strength to with stand the effects of short circuit until it can be cleared by appropriate protecting device. All bus bars should be clearly marked with appropriate colour code to enable immediate identification of the phase and neutral. (Mechanical strength upto 70KA/1 Sec).

6) The vertical bus bar should have a number of laminations to give appropriate current rating and can be graded to suit the current rating required at each point by omitting laminations at the points of current decrease.

7) Arrangements should be provided to receive PVC cables either from the topside or from the bottom (as specified). End plates should be mounted inside the busbar at unit level for cables from above or below

8) All sheet-steel parts used in the construction of a cubicle board should have undergone rigorous rust proofing process which must comprise of alkaline degreasing descaling in dilute sulphuric acid and a recognized phosphatizing process. The steel work shall be finished with powder coating paint.

9) The equipment when assembled shall form a neat and compact unit and shall be complete with supporting framework, mounting channels, and foundation bolts etc. and shall be designed so as to ensure complete interchangeability of component.

### **Pipe, Fittings, Valves, Supports and Other Accessories:**

#### **Pipes, Fittings & Supports:**

i. General:

a. All materials shall be new of the best quality conforming to the specifications and subject to the approval of the Engineer-in-Charge.

b. Pipes and fittings shall be fixed truly vertical, horizontal as required in a neat workman like manner.

c. 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.

d. 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.

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

iii. For MS/Galvanised pipes upto and including 50 mm dia screwed jointing shall be adopted, while for pipes 65 mm and above welded connections shall be used for MS and screwed connection for Galvanised. Only Electro Galvanised nuts /bolts shall be used.

iv. The piping system and components shall be capable of withstanding 150% of the working pressure including water hammer effects and test pressure upto 16 kg/cm<sup>2</sup>.

v. Flanged joints shall be used for connections to vessels, equipment, flanged valves and also, on suitable straight lengths of pipeline of strategic points to facilitate erection and subsequent maintenance work.

vi. Flange thickness shall be as per table below IS: 6392 – 1971. Table – 17/18.

250 mm dia : 26 mm

200 mm dia : 24 mm;

150 mm dia : 22 mm;

125 mm dia : 22 mm;

120 mm dia : 20 mm;

80 mm dia : 20 mm;

65 mm dia : 18 mm.

vii. M.S./GI Fittings for pipes above 65 mm or and upto 150 mm dia shall be fabricated from seamless pipe pieces of minimum 5 mm wall thickness. For tees and other fittings where seamless sections are not available, the fittings shall be fabricated from Electric resistant welded pipes as given in the Preferred Makes. However Galvanised

fitting will be screwed. The fittings shall have a minimum 5 mm wall thickness. The fittings shall with stand pressure of upto 21 kg/cm<sup>2</sup>.

viii. Fittings below 50 mm or shall be M.S./ Galvanised Forged Screwed ends. The fittings shall be threaded at both ends. The fittings shall withstand pressure of upto 21kg/cm<sup>2</sup>.

ix. For tapings of 50 mm/40mm/32mm/25mm from headers, half socket connections with one side threading shall be employed. The half socket shall be welded at the centre of the header, either on the side or on the top.

x. Wherever two horizontal headers are to run side by side, the two headers shall be located at different levels, if possible, so as to avoid unnecessary bends at tapping off from the headers. Accordingly, the supports shall also be staggered to support pipes at two levels.

#### **Pipe Support:**

i. All pipe clamps and support shall be mild steel.

ii. Pipe shall be hung by means of expandable anchor fastener of approved make and design (Dash Fasteners or equivalent). The hangers and clamps shall be fastened by means of galvanized nut and bolts. The size/diameter of the anchor fastener and the clamp shall be suitable to carry the weight of water filled pipe and dead load normally encountered.

iii. Hangers and supports shall be capable of carrying the sum total of all concurrently acting loads. They shall be designed to provide the required supporting effects and allow pipelines movements as

necessary. All guides, anchor, braces, dampeners, expansion joints and structural steel to be attached to the building/structure, trenches etc shall be provided by the contractor. Hangers and components for all piping shall be approved by the Client/engineer. Anchoring fasteners shall be rated to take minimum tons load and shall be of approved make.

iv. While all piping shall have clevis type hanger supports from the ceiling with fasteners, for pipe headers of 120 mm dia and above, additional wall/column mounted supports shall be taken. Clevis type hanger supports shall be at 3.0 m intervals and at every turn, at both ends. MS angle supports at wall and columns shall be at 18 m intervals. The angles shall be cut by gas cutter and evened out by grinder. All welding to angles shall also be cleaned by grinder. Angles shall not be less than 40 x 40 x 6 mm size.

v. For fixing clevis hanger and angle support, only dash fasteners shall be used. Exposing of steel reinforcement and welding to them shall not be permitted except in exceptional circumstances.

vi. Pipes in vertical shafts shall have MS angle brackets at alternate floor level. The bracket shall be mounted behind the pipe. A base plate of 50 wide x 6 mm thick shall be welded to the bracket. The base plate shall be fixed to the wall by means of fasteners GI U clamps shall be used to fix the pipe to the bracket.

vii. Each riser shall also be anchored to the floor slab with MS angles mounted on the slab. The angles shall be 40 x 40 x 5 size, one mounted before the pipes and the other after the pipes. Extra cleat pipe pieces shall be welded to the pipes at this point which shall be welded to the angle iron support.

viii. Wherever angle type supports are being used, profiled packing materials or wood or materials as approved by the Engineer shall be used. The packing materials shall be at least 25 mm thick and tight fitted with the pipe.

#### **Hose Reel:**

i. Wall mounting the swinging type first aid hose reel with drum shall conform to IS: 884-1985.

ii. The rubber tubing shall be 20 mm dia high pressure rubber hose 36.0 m long as per IS : 444 with gunmetal shut off nozzle having 6.5 mm dia orifice and control valve, shut off valve of approved make. The wall mounted bracket shall be fixed by means of fasteners. The hose reel shall have a gun metal nozzle.

iii. The hose reel shall be connected directly to the riser by means of 25 mm dia MS pipe with threaded bends, union & one no. ball valve.

iv. The drum can swing up to 180 degrees.

#### **Hose Cabinets:**

i. Hose cabinet shall be fabricated from 16-gauge MS powder coated sheet of fully welded construction with hinged single/double door partially glazed door with suitable locking arrangement, stove enameled fire red paint with 'Fire Hose' written on it prominently. Glass panes shall be 4 mm thick.

ii. The hydrant cabinet shall hold double headed hydrant, 2 nos. Hoses and 1 no. branch pipe.

iii. The cabinet shall have two pipe studs of 200 mm dia in MS with base which shall be fixed to the back of the cabinet and shall be used to hold the RRL hose.

#### **RRL Hoses:**

i. The hoses for the internal and external hydrant system should be rubber impregnated woven jacketed type conforming to IS:636 Type-A. Each fire hose shall be provided with quick coupling, branch pipes, nozzles, spanners etc.

ii. Hose pipes of all types shall be capable of withstanding an internal water pressure of not less than 35 Kg/Sq.cm without bursting. It must also withstand a pressure of 21 Kg/Sq.cm without undue leakage or sweating.

iii. Each hose shall be fitted with instantaneous spring lock type couplings at both ends. Hose shall be fixed to the coupling ends by copper rivets and the joint shall be reinforced by 1.5 mm galvanized mild steel wires and leather bands.

#### **Branch Pipes and Nozzle:**

Stainless steel Standard Branch Pipe shall be used conforming to IS : 903 with Stainless steel nozzle of 20 mm (nominal internal dia) to fit standard instantaneous type 63mm dia hose coupling. Suitable spanners of approved design shall be provided in adequate numbers for easy assembly and dismantling of various components like branch pipes, nozzles, quick coupling ends.

**Hydrant Valve:**

- i. Stainless steel Hydrant valve shall be of oblique pattern provided as per IS: 5290 complete with hand wheel, quick coupling connection, spring and blank cap and chain.
- ii. The hydrant shall have flanged inlet of 120 mm dia and 63 mm female instantaneous type outlet. The hydrant shall have a rubber plug with chain fixed to the main body of the Hydrant.

**Pressure Switch:**

- i. The pressure switches shall be employed for starting and shutting down operation of pumps automatically, dictated by lines pressure. The Pressure switch shall be diaphragm type, it shall be suitable for line pressures up to 15 kg/cm<sup>2</sup>.
- ii. The switch shall be suitable for consistent and repeated operations without change in values.
- iii. The enclosure shall be of aluminium and pressure element and wetted parts shall be of stainless steel. The switch shall be snap acting type with 1 no. N O/NC contact.

**Valves:**

- i. Sluice Valves: Sluice valve of 65 NB and above shall be flanged valve with cast iron body. The spindle, wall seat and wedge nuts shall be of bronze. They shall generally have nonrising spindle and shall be of the particular duty and design called for. All sluice valves will be provided with supervisory switch.

The valves shall be supplied with suitable flanges, non-corrosive bolts and asbestos fiber gasket. Sluice valves shall conform to Indian Standard IS:14846: 2000 and IS: 2906. Sluice valves for water works purposes suitable for seat test pressure of 16 Kg/Sq.cm.

- ii. Butterfly Valve:

- a. The butterfly valve shall be suitable for water works and tested to minimum of 15 Kg/Sq.cm pressure.
- b. The body shall be of cast iron to IS : 212 in circular shape and of high strength to take the water pressure of 12 Kg/Sq.cm. The disc shall be heavy duty cast iron with anti-corrosive epoxy or nickel coating.
- c. The valve seat shall be of high-grade elastomer or nitrile rubber. The valve in its closed position shall have complete contact between the seat and disc throughout the perimeter. The elastomer rubber shall have a long life and shall not give away on continuous applied water pressure. The shaft shall be EN 8 grade carbon steel.
- d. Butterfly valve shall be of best quality conforming to IS : 13095 of class specified.
- e. The valves shall be supplied with manual gear operated opening/closing by lever.
- f. The valves shall be supplied with supervisory switch.

- iii. Gun Metal Valves:

- a. Gun metal valves shall be used for smaller dia pipes, and for threaded connection. The valves shall bear certification as per IS: 778-1984 and shall be rated to 15 Kg/Sq.cm pressure.
- b. The body and bonnet shall be of gun metal to IS: 318. The steam gland and gland nut shall be forged brass to IS: 319. The hand wheel shall be of cast iron to IS: 212.
- c. The hand wheel shall be of high-quality finish to avoid hand abrasions. Movement shall also be easy. The spindle shall non rising type.
- d. All valves shall be approved by the Authority Representative before they are allowed to be used on the work.

- iv. Non-Return Valve:

- a. Non-return valves shall be cast iron dual plate type. An arrow mark in the direction of flow shall be marked on the body of the valve. The valve shall bear IS: 5312 certifications.
- b. The valve shall be of cast iron body and cover. The internal flap in the direction of water shall be of cast iron and hinged by a hinge pin of high tensile brass or stainless steel. Cast iron part shall be as per IS: 212.
- c. The gasket shall be of high-quality rubber and flap seat ring of leaded gunmetal. At high pressure of water flow the flapper shall sit tightly to the seat. The valve shall be capable of handling pressure up to 15 Kg/Sq.cm.

- v. Air Valves:

Provide 25 mm dia screwed inlet cast iron single acting air valves, on all high points in the system as shown on the drawing.

vi. Drain Valve:

- a. Provide 50 mm dia between steel pipe to IS : 1239 (heavy duty) with 50 mm gunmetal full way valve for draining any water in the system in low pockets.
- b. Drain valves shall be provided at low points of all water riser and mains to ensure that all sections of pipe works and plant can be drained.

vii. Foot Valve:

- a. Foot valves of water supply system shall be heavy duty construction with integrated flanges connection and have cast iron body, all bronze trims with stainless steel spring and stainless-steel strainer.
- b. The flow area on strainer shall be at least three times of Pipe size.

**Gate Valve Chamber:**

A masonry chamber of internal dimension 1.20m x 1.20m x 1.5m depth shall be built to accommodate sluice valves placed in external ring main, 230mm thick walls shall be of 75 class designation brick work in cement mortar 1:5 (1 cement : 5 fine sand) with CI medium duty manhole cover. The top slab RCC shall be of 1:2:4 mix (1 cement: 2 coarse sand : 4 graded same aggregate 20 mm nominal size) and inside plastering with cement mortar 1:3 (1 cement : 3 coarse sand ) 12 mm thick finished with a floating coat of neat cement all complete.

**Pressure Gauge:**

Pressure gauge shall be provided near all connections to hydrant system and isolation valves of sprinkler system and where required. Pressure gauge shall be stainless steel 120 mm dia gunmetal Burden type with a scale range from 0 to 15 Kg/cm<sup>2</sup> and shall be constructed as per IS 3624. Each pressure gauge shall have a siphon tube connection with ball valve, tapping and connecting pipe and nipple. The gauge shall be installed at appropriate level and height for easy readability.

**Branch Pipe:**

Gun Metal Standard Branch Pipe shall be used conforming to IS : 903 with gun metal nozzle of 20 mm (nominal internal dia) to fit standard instantaneous type 63mm dia hose coupling. Fire man's axe for firefighting purpose shall be used conforming to IS:926 – 1985

**Painting:**

All hydrant pipes shall be finished with post office red colour paint. All M.S. pipes shall first be cleaned thoroughly before application of primer coat. After application of 2 coats of Red oxide primer, two coats of enamel paint shall be applied. Wherever required all pipe headers shall be worded indicating the direction of the pipe and its purpose such as "TO RISER NO 1" etc.

**Testing:**

- i. All piping in the system shall be tested to hydrostatic pressure of 13.5 Kg/Sq.cm without drop in pressure for at least 2 hours.
- ii. Rectify all leakages, make adjustments and retest as required and directed.

**IS Codes For Design, Manufacture, Erection, Testing and Trail Operation of Piping Valves etc.:**

The following codes and standards and their subsequent modifications shall apply for the design, manufacture, shop testing, erection, fabrication at site, resting and trial operation of piping, valves and specialties requirements:

- IS: 554: Dimensions for pipe threads where pressure tight joints are required on the threads.
- IS: 638 : Sheet rubber jointing and rubber insertion jointing.
- IS: 778: Copper alloy gate, globe and check valve for water work purposes.
- IS: 14846 : Sluice valves for water –works purposes (50 mm to 1200 mm).
- IS: 901 : Couplings, double male and double female, instantaneous pattern for fire fighting.
- IS: 1239 : Mild steel tubes, tubular and other wrought (Part I & II ) steel fittings.
- IS: 884 : Swinging type wall mounted hose reel with drum.
- IS: 388 : Hose tubing.
- IS: 4038 : Foot valves for water-works purposes.
- IS: 5290 : landing Valves.

- IS: 12221 : Anti-corrosion treatment for underground MS pipes.
- IS: 5312 : Swing check type reflux (non-return) valves.

### **Fire Extinguishers:**

Without restricting to the generality of the foregoing the work shall inter-alia consist of the following:  
Installation of fully charged and tested fire extinguishing hand appliances CO2 and dry chemical powder type as required by these specifications and drawings.

Portable Fire Appliances Requirement, Type and Location as per Fire Authority:

Portable Fire appliances as mentioned below :-

- (i) ABC Dry Powder fire extinguisher IS : 15683 – 2006 -6 Kg & 9 kg capacity .
- (ii) CO2 Gas Fire extinguisher IS 15683 – 2006 – 4.5 Kg capacity.
- (iii) CO2 Water type Fire extinguisher IS 2878 9 litre capacity and
- (iv) K type Fire extinguisher – for Canteen
- (v) Fire bucket IS : 2546 4 Nos. shall be installed at following places :-
  - (a) Electric meter Rooms.
  - (c) Pump Rooms.

Hand appliances shall be installed in readily accessible locations with the appliance brackets fixed to wall by suitable anchor fasteners or by means of floor mounted supports.

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

All appliances shall be fixed in a true workman like manner truly vertical and at correct locations. Identical type of extinguishers shall be of same make and shall have similar method of operation.

### **COMMISSIONING & TESTING:**

#### **Down comer System**

- i. Switch on the terrace pump and test check. The diesel engine driven pump in the same **manner** as the electrically driven pump.
- ii. 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.

#### **Handing Over:**

All commissioning and testing shall be done by the contractor to the complete satisfaction of the Engineer-in-Charge, and the job handed over to the Engineer-in-Charge, or his authorized representative.

Contractor shall also handover, to the Engineer-in-Charge, all maintenance & operation manuals and all other items as per the terms of the contract.

#### **Guarantee:**

- The contractor shall submit a warranty for all equipment, materials and accessories supplied by him against manufacturing defects, malfunctioning or under capacity functioning.
- The form of warranty shall be as approved by the Engineer-in-Charge.
- The warranty of all the components shall be valid for a period of **two year (in DLP)** from the date of handing over.
- The warranty shall expressly include replacement of all defective or under capacity equipment. Engineer-in-Charge may allow repair of certain equipment if the same is found to meet the requirement for efficient functioning of the system.
- The warranty shall include replacement of any equipment found to have capacity lesser than the rated capacity as accepted in the contract. The replacement equipment shall be approved by the Engineer-in-Charge.



### LIST OF IS CODES (Relating to Fire Fighting works)

The following codes and Indian Standards shall be applicable with amendments up to date.

#### CODE OF PRACTICE

Code of practice for fire safety of building (general) fire-fighting equipment and maintenance.	IS : 1648
Code of practice for installation of internal fire hydrant in multistoreyed buildings	IS : 3844
Recommendations for providing first aid and firefighting arrangements in public buildings	IS : 2217
Code of practice for the selection, installation and maintenance of portable first aid and fire appliances	IS : 2190
<b>National building code.</b>	
<b>FIRE FIGHTING APPLIANCES</b>	
External fire hydrants	IS : 5290
Internal landing valves.	IS : 5290
2 & 3 way suction collecting heads	IS : 904
First aid hose reels	IS : 884
Dunlop high pressure rubber pipe	IS : 5132
Centrifugal pump	IS:1520
Electrical motors	IS:7538
Specification for horizontal centrifugal pumps for clear cold fresh water	IS : 1520
Specification for submersible pump sets for clear, cold, fresh water	IS : 8034
Specification for horizontal centrifugal self priming pumps	IS:8418

#### **Scope of work:**

The scope of firefighting system in various buildings to be constructed shall be as follow:

Fire Protection System including Sprinkler System, wet risers, Yard-hydrants and pumps coupled with suitable DG set, pre wired control panel etc., complete as required. wherever required shall be designed and provided as per NBC 2016, IS standard & Fire Bye Laws. Provisional NOC for the scheme from Telangana Fire Service shall be obtained by the agency before commencement of work and final NOC shall be obtained from the state authorities after completion of works.

#### **Scope of work shall be as under:**

I. All the buildings to be constructed and to be connected with Heavy duty (C–Class) M.S. pipe of suitable diameter, necessary NRV / sluice valve / butter fly valve as per drawing approved by Engineer

– in – charge as FIRE FIGHTING RING MAIN WATER LINE. The fire pump house and fire pumping sets shall be Supplied, Installed, tested and commissioned by the contractor as per the approved drawing and design.

II. One number 4.5 kg Co2 type fire extinguishers and/or one number 9.00 ltr water type extinguisher (gas pressure type) shall be installed at each floor near each staircase in all buildings (are as per NBC/Fire Services of TS Govt. norms). In addition to this Co2 type fire extinguishers and ABC type fire extinguishers of not less than 4.5 kg capacity shall also be installed in sub-station building, Electrical rooms, fire pump house, LT rooms. (are as per NBC/Fire Services of TS Govt. norms).

III. The agency must study specifications, provision for fire-fighting system for various buildings, NBC code – 2016, local byelaws and additional conditions carefully. The work shall be executed in close co-ordination with the progress of building work.

IV. Contractor shall provide all tools, equipment, metering and testing devices required for the purpose. On award of work, Contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract

V. All tests shall be made in the presence of the Engineer-in-charge or his representative or any inspecting authority. At least five working days notice in writing shall be given to the inspecting parties before performing any test.

VI. Water flow rates of all equipment and in pipe lines through valves shall be adjusted to design conditions. Complete results of adjustments shall be recorded and submitted.

VII. Contractor shall ensure proper balancing of the hydraulic system and for the pipes / valves installed in his scope of work by regulating the flow rates in the pipe line by valve operation. The contractor shall also provide permanent Tee connection (plug) in water supply lines for ease of installing pressure gauge, temperature gauge & rotameters. Contractor shall also supply all required pressure gauge, temperature gauge & rota meter for system commissioning and balancing. The balancing shall be to the satisfaction of Consultant / Project Manager.

VIII. Three copies of all test results shall be submitted to the Engineer in A4 size sheet paper into two weeks after completion of the tests.

#### **SPECIFICATION:**

The works shall be executed as per CPWD's General specification for Electrical Works, Part-I (Internal-2013); Part-II (External)-1994; Part-V (Wet Riser and Sprinkler System for Fire Fighting Installation)-2006, Part-VI (Fire Alarm System) IE Rules, provision laid down in NBC – 2016, and latest building byelaws of local body / Local Municipal Corporation and various Indian Standards amended up to date, and as per direction of Engineer-in-Charge. The additional specifications are to be read above and in case of any variations; specifications given along the tender shall apply.

#### **Indian standards:**

IS-8757 Glossary of terms associates Fire safety.

IS-884 Specification for first-aid hose reel for the fighting. IS-884 Specification for first-aid hose reel for the fighting.

IS-902 Specification for suction hose couplings for fire fighting purpose.

IS-903 Specification for fire hose delivery couplings, branch pipe, nozzles and nozzle spanner

IS-904 Specification for two-way and three – way suction collection heads for firefighting purposes.

IS-908 Specification for fire hydrant, stand post type

IS-636 Non percolating flexible firefighting equipment.

IS-1646 Code of practice for fire safety of buildings (general): Electrical installations. IS-5290 Specification for landing valves.

IS-8090 Specification for couplings, branch pipe, nozzle, used in hose reel tubing for fire fighting.

**Completeness of the work** - All sundry equipment, fittings, assemblies, accessories, hardware items, bolts, supports, termination lugs for electrical connection, cable glands, junction box and all other sundry items for proper assembly and efficient working of the various equipment and components of the work shall be deemed to have been included in the scope of work, irrespective of the fact whether such items are specifically mentioned in the tender document or not.

**Dispatch of Materials to Site and Safe Custody thereof:**

The contractor shall dispatch materials to site in consultation with the Engineer-in-Charge. Programme of dispatch of material shall be framed keeping in view the building progress. Safe custody of all machinery and equipment supplied by the contractor shall be the responsibility of the contractor till final taking over by the department Piping, cabling or any other work, which directly affect the progress of building work, shall be given priority.

**Quality of Materials and Workmanship:**

(i) The components of the installation shall be of such design so as to satisfactorily function under all conditions of operation.

(ii) The entire work of manufacture/ fabrication, assembly and installation shall conform to sound engineering practice.

(iii) All equipment and materials to be used in work shall be manufactured in factories of good repute having excellent track record of quality manufacturing, performance and proper after-sales service.

**Care of the Building:**

Care shall be taken by the contractor during execution of the work to avoid damage to the building. They shall also be responsible for repairing all such damages and restoring the same to their original finish at their cost.

They shall also remove all unwanted and waste materials arising out of the installation from the site of work from time to time.

**TENDER DRAWINGS, DRAWINGS FOR APPROVAL AND COMPLETION DRAWINGS**

- Drawings for approval on award of the work - The contractor shall prepare & submit three sets of following drawings and get them approved from the Engineer-in-charge before the start of the work. The approval of drawings however does not absolve the contractor not to supply the equipment/materials as per agreement, if there is any contradiction between the approved drawings and agreement. The decision of the Engineer-in-Charge shall be final & binding on the contractor.
- Lay out drawings of the equipment to be installed in pump room and terrace.

- Drawings showing the details of erection of entire equipment including their foundations.
- Plumbing drawings showing the layout of entire piping, dia. and length of pipes, hydrant, air vessel and isometric drawings showing connections to various equipment.
- Sprinkler drawing indicating layout and size of pipe, location of valves, sprinklers etc.
- Lay out and isometric drawings of the equipment and pipe work, valves, nozzles to be installed in various rooms.
- Drawings including section, showing the details of erection of entire equipment including their supports/ mountings etc.
- Electrical wiring diagrams for all electrical equipment and controls including the sizes and capacities of the various cables and equipment.
- Any other drawings relevant to the work.
- Completion Drawings: Three sets of the following laminated drawings shall be submitted by the contractor while handing over the installation to the Department. Out of this one of the sets shall be laminated on a hard base for display in the Control room. In addition, one soft copy will be given on compact disc/pen drive
- Installation drawings giving complete details of all the equipment, including their mountings/ supports.
- Plumbing layout drawings giving sizes and lengths of all the pipes and the sizes and locations of valves, nozzles and including isometric drawings for the entire piping including the pipes connections to the various equipment.
- Electrical wiring diagrams for all electrical equipment and controls including the sizes and capacities of the various cables and equipment.

### **Final Inspection and Testing**

Final Inspection and testing will be done by the Engineer-in-Charge or his representative as per details indicated in Chapter -11 of Specification.

The installation will be offered for inspection by local bodies (Chief Fire Officer). The contractor or his representative shall attend such inspection of the Chief Fire Officer, extend all rest facilities as are considered necessary, recently and comply all observations of the Chief Fire Officer which are part of the agreement and arrange for obtaining necessary clearance certificate in favour of the department. In case the contractor fails to attend the inspection and made desired facilities available during inspection, the department reserves the right to provide the same at the risk and cost of the contractor and impose penalty for the same. The installation will be accepted by the department only after receiving clearance from Chief Fire Officer for the work executed by the contractor under the agreement.

### **WORKS TO BE DONE BY THE CONTRACTOR:**

- Unless otherwise mentioned in the tender documents, the following works shall be done by the contractor and therefore, their cost shall be deemed to be included in their tendered cost- whether specifically indicated in the schedule of work or not.
- Foundations for equipment including foundation bolts and vibration isolation spring/pads Suspenders, brackets and floor/ wall supports for suspending/supporting pipes.
- Suspenders and/or cable trays for laying the cables.

- Excavation and refilling of trenches in soil wherever the pipes are to be laid directly inground, including necessary base treatment and supports.
- Sealing of all floor slab/ wall openings provided by the Department or contractor for pipes and cables, from fire safety point of view, after laying of the same.
- Painting of all exposed metal surfaces of equipment and components h appropriate colour.
- Making openings in the walls/ floors/ slabs or modification in the existing openings wherever provided for carrying pipe line, cables etc.
- All electrical works including cable/wires earthing etc. beyond power supply.
- Making good all damages caused to the structure during installation and restoring the same to their original finish.
- Approval from local fire authority/NOC from TS Govt. Fire Service as may be required as per local bye-laws.

#### **Verification of correctness of equipment at destination**

The contractor shall have to produce all relevant records to certify that the genuine equipment for the manufacturers

#### **After Sales Service:**

The contractor shall ensure adequate and prompt after sales service in the form of maintenance, spares and personnel as and when required and shall minimize the breakdown period. In case of equipment supplied by other manufacturers the firm shall furnish a guarantee from the manufacturer for the same before the installation is taken over.

#### **Documents to be provided on Completion of Work:**

Three sets of following documents shall be furnished to the department by the contractor on completion of work.

Completion drawings (As built drawings)

3sets of manufacturer's technical catalogues of all equipment and accessories.

Operation and maintenance manual of all major equipment, detailing all adjustments, operation and maintenance procedure

#### **Maintenance:**

Maintenance including free defects liabilities period, of one year from date of record of completion by Engineer-in-Charge and handing over of the installation.

The maintenance, routine as well as preventive, for one year from the date of taking over the installation as per manufactures recommendation shall be carried out.

#### **PRE-COMMISSIONING**

On completion of the installation of all pumps, piping, valves, pipe connections, insulation etc. the Contractor shall proceed as follows:

- Prior to start-up and hydraulic testing, the Contractor shall clean the entire installation including all fitments and pipe work and the like after installation and keep them in a new condition. All pumping systems shall be flushed and drained at least once through to get rid of contaminating materials. All pipes shall be rodded to ensure clearance of debris, cleaning and flushing shall be

carried out in sections as the installation becomes completed.

- All strainers shall be inspected and cleaned out or replaced.
- When the entire systems are reasonably clean, a pre-treatment chemical shall be introduced and circulated for at least 8 hours. Warning signs shall be provided at all outlets during pre-treatment.

The pre-treatment chemical shall:

Remove oil, grease and foreign residue from the pipe work and fittings;

Pre-condition the metal surfaces to resist reaction with water or air.

Establish an initial protective film;

- After pre-treatment, the system shall be drained and refilled with fresh water and left until the system is put into operation.
- Details and procedures of the pre-treatment shall be submitted to the Architect for approval.
- Check all clamps, supports and hangers provided for the pipes.
- Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specification. If any leakage is found, rectify the same and retest the pipes.

### **Fire Protection System**

- Check all hydrant valves by opening and closing: any valve found to be open shall be closed.
- Check all the piping under hydro test.
- Check that all suction and delivery connections are properly made for all pump sets.
- Check rotation of each motor after decoupling and correct the same if required.
- Test run each pump set.
- All pump sets shall run continuously for 8 hours (if required, temporary piping back to the tank to be made).

### **Commissioning and Testing**

- Pressurize the fire hydrant system by running the jockey pump and after it attains the shut-off pressure of the pump. Then, open bypass valve and allow the pressure to drop in the system. Check that the jockey pump cuts-in and cuts-out at the preset pressure. If necessary, adjust the pressure switch for the jockey pump. Close by-pass valve.
- Open hydrant valve and allow the water to flow into the fire water tank in order to avoid wastage of water. The main fire pump shall cut-in at the preset pressure and shall not cut out automatically on reaching the normal line pressure. The main fire pump shall stop only by manual push button. However, the jockey pump shall cut-out as soon as the main pump starts.
- Switch off the main fire pump and test check the Diesel engine driven pump in the same manner as the electrically driven pump.
- When the fire pumps have been checked for satisfactory working on automatic controls, open fire hydrant valves simultaneously and allow the hose pipes to discharge water into the fire tank to avoid wastage.
- 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. Each landing valve shall also be checked by opening and closing under pressure.
- Check all annunciators by simulating the alarm conditions at site.

## **STATUTORY AUTHORITIES' TESTS AND INSPECTIONS**

- As and when notified in writing or instructed by the Engineer-in-charge, the Contractor shall submit shop drawing and attend all tests and inspections carried out by Local Fire Authorities and other Statutory Authorities, and shall forth execute free of charge any rectification work ordered by the Engineer-in-charge as a result of such tests and inspections where these indicate non-compliance Statutory Regulations. Some of these tests may take place after the issue of Practical Completion of the Main Contract and the Contractor shall make allowances in this respect.
- The Contractor shall be responsible for the submission of all necessary forms and shop drawings to the Statutory Authorities which shall conform in layout to the latest architectural plans submitted to and kept by these Authorities.
- The submission shall comply the requirements set forth in the current Codes of Practice and circular letters of the Statutory Authorities. The shop drawings to be submitted shall be forwarded to the Architect for checking before submission.
- The Contractor shall allow for at least two submissions of complete sets of shop drawings to the Authorities. The Engineer-in-charge may at his discretion instruct the Contractor for additional submissions to the Local Authorities whenever necessary.
- The Contractor shall notify the Engineer-in-charge at least seven days in advance of his application for local Authority tests and inspections. On receipt of a confirmed date for test and inspection the Contractor shall inform the Engineer-in-charge out delay.

## **FINAL ACCEPTANCE TESTS**

Following commissioning and inspection of the entire installation, and prior to issue of the Completion Certificate, the Contractor shall carry out final acceptance tests in accordance to a programme to be agreed with the Engineer-in-charge.

If the results of the acceptance tests show that plant, systems and/or equipment fail to perform to the efficiencies or other performance figures as given in this Specification, the Contractor shall adjust, modify and if necessary, replace the equipment without further payment in order that the required performance is obtained.

Where acceptance tests are required by the relevant Authorities having jurisdiction, these tests shall be carried out by the Contractor prior to the issue of Completion Certificate to the acceptance of the Authorities.

## **REJECTION OF INSTALLATION / PLANT**

Any item of plant or system or component which fails to comply the requirements of this specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site may be rejected either in whole or in part as considered necessary/appropriate. Adjustment and/or modification work as required by the Engineer-in-charge so as to comply the Authority's requirements and the intent of the Specification shall be carried out by the Contractor at his own expense and to the satisfaction of the Authority/Engineer-in-charge.

After works have been accepted, the Contractor may be required to carry out assist in carrying out additional performance tests as reasonably required by the Engineer-in-charge /Employer.

## **HANDING OVER OF DOCUMENTS**

All testing and commissioning shall be done by the Contractor to the entire satisfaction of the Engineer-

in-Charge and all testing and commissioning documents shall be handed over to him. The Contractor shall also hand over all maintenance and operation manuals, all certificates and all other documentation as per the terms of the contract to the Engineer-in-Charge.

**STAIRWAYS AND LIFT WELL PRESSURIZATION SYSTEM:**

- All the staircases shall be pressurized.
- All the lift well for the buildings higher than 15 m in height shall be pressurized at 50 pa +ve pressure.
- Dedicated pressurization system to be installed for Individual Lift as per the Fire safety norms and should be integrated with Fire Alarm system installed in the building.
- Dedicated pressurization system to be installed for each Emergency Stairs inside the building as per the Fire safety norms and should be integrated with Fire Alarm system installed in the building.

**WATER PUMPING SYSTEMS:**

The water pumping system shall be supplied and installed by the contractor as per the below mentioned scheme and specifications:

Sl. No.	Name of the Building	No. of Floors	No. of Blocks/ Buildings	Domestic Water Pump System	Flush Water Pump System
1	Construction of Faculty Housing – Tower FT1A (Type – C) at IITH	G + 12	1	1 W + 1 S	1 W + 1 S
2	Construction of Faculty Housing – Tower FT1B (Type – C) at IITH	G + 12	1	1 W + 1 S	1 W + 1 S
3	Construction of Staff Housing – Tower ST2A (Type – D) at IITH	G + 12	1	1 W + 1 S	1 W + 1 S
4	Construction of Staff Housing – Tower ST2B (Type – D) at IITH	G + 12	1	1 W + 1 S	1 W + 1 S
5	Construction of Staff Housing – Tower ST1A (Type – E) Floors at IITH	G + 12	1	1 W + 1 S	1 W + 1 S
6	336 Boarders Pre-cast Hostel-1	G+6	1	1 W + 1 S	1 W + 1 S
7	336 Boarders Pre-cast Hostel-2	G+6	1	1 W + 1 S	1 W + 1 S
8	336 Boarders Pre-cast Hostel-3	G+6	1	1 W + 1 S	1 W + 1 S



The scope of work includes Planning, designing, preparation of drawings, obtaining approvals from statutory bodies (if applicable), third party vetting, obtaining approval of the Department, supply, installation, testing and commissioning of water supply pumping system consisting of domestic water supply pump sets and flushing water supply pump sets (combination of one working and one stand by separately for each type of water supply i.e., domestic water supply and flushing water supply). Domestic water supply pump sets and flushing water supply pump sets are of open well submersible type (centrifugal) of pump sets. Execution of work as per the approved design and drawings and directions of Engineer-In-Charge.

The selection of capacity and discharge of Domestic water supply pump sets should be such that the minimum discharge of each pump at desired height shall be designed so as to fill the terrace tanks on the building within 3 hours' time through one working pump.

Similarly, the flushing water pump sets capacity and minimum discharge shall be designed considering to transfer the treated water received from STP Plant (specifically treated water tank) to terrace overhead tank meant for flushing/ gardening purpose and to fill the same within 1 hour time, combination of one working and one stand by separately for each building. This includes Electrical control- panels with incoming and outgoing MCBs, starters with dry run protection, Automatic cut off for Pump and auto start as per water level controllers for automatic operation of pumps between OH tank and UG Sump/STP treated water tank , incoming and outgoing XLPE insulated and PVC sheathed aluminium/ copper conductor armoured cables (Up to 16 sqmm size cable shall be with copper conductor) of appropriate rating including laying and connections/terminations at both pumps and panels ends, earthing and loop earthing etc. as per CPWD specifications as amended up to date and additional conditions/ specifications of this Sub head.

The scope of work includes Supplying, Installation, Testing, Commissioning, handover and training of water pumping system for the campus as per the actual requirement at site.

The water pumping system shall be designed as per scheme described as below:

(i) The UG sump near each building for domestic water requirements shall be constructed of appropriate capacity. That UG sump shall be provided with 2 Nos. (1W+1S) pump-sets responsible for feeding the OH domestic water tank of individual bldg. From OH Tank, water shall be feed to individual flats/apartments through gravity. Pumps shall be designed to fill the OH tank in 3 hrs duration. Accordingly, each pump shall fill the OH tank in three hrs.

(ii) Similarly the STP treated water tank shall be provided with 2 Nos (1W+1S) of pump-sets responsible for feeding the water to flush tank of individual buildings. From OH Tank, water shall be feed to individual flats/apartments through gravity. Capacity of pumps shall be sufficient to feed all the flush tanks of individual bldgs. in 1.0 Hrs duration. Accordingly, each pump shall fill the OH Flush tank in 01 hrs.

(iii) Pumping of STP treated water required for horticulture shall also be done by using 2 nos (1W+1S) pump sets.

(iv) The pump room shall be equipped with 2 Nos (1W+1S) of dewatering pump sets to be installed at the point having lowest level of the pump room. The capacity shall be designed to expel out the water in minimum time with level sensors for automatic operation.

(v) All pumps, comprising of multistage/single stage centrifugal pumps (suitable to work in hydro pneumatic system), submersible type or floor mounted type (as per the direction of Engineer- In-

charge), booster pumps, valves, piping, cabling, motor control panels with water level indicator with sensor based automatic operation, to fulfil different requirement/utilities of the buildings like drinking, utilities, firefighting system, Wash basin etc. One additional pump of each type and of same capacity shall be provided as stand by.

(vi) The operation of all the pumping system of this Project shall be automatic only and level sensor based/pressure sensor based depending upon the approved final design/scheme by the Engineer-in-charge.

(vii) The water requirement of the Project shall be calculated based on the discharge rate of each outlet of the building and shall be as per the NBC requirements subject to GRIHA norms as applicable. The water requirement of the building shall be derived separately based on the requirement of domestic water and STP treated water.

- **LEVEL SENSOR & LEVEL CONTROLLER:**

- **SCOPE**

This scope includes providing and fixing water level indicators cum controllers, for pump operations, working on hydrostatic pressure measurement principle made of Stainless Steel for installation in storage tanks, and capable of providing 4 to 20 mA analogue signals compatible with PLC signal inputs, including all wiring and piping as required complete as per working requirements for details of equipment below.

These level sensors and panels are for operating the submersible pumps in the Underground Tanks, for filling of the Terrace Tanks, and the Motorised valves installed at the inlet of the tanks, as the case may be.

The pumps would be provided with their respective starter panels, which have to be integrated with the level sensor panels, and Potential free contacts to monitor On /Off & Trip status.

The scope includes integration of the pump starter panels, electrically actuated butterfly valves and level sensors.

The level sensors would be located in the Terrace tanks and Underground Tanks, and the cabling from the terrace tanks to the submersible pump panel near the Underground tanks and underground tanks to the valves in the site, are included in this scope.

All cabling, wiring, conduiting, etc required for this job are included in the scope.

This scope also includes providing and fixing local level controllers near / on each overhead tank, comprising of control module and level sensor SS guide and float type, to close the Motorised valve (installed at the inlet line of the tank) when the level in the tank is high and open the valve when the level in the tank is low. (The power to this controller shall be provided to the vendor at the installation point).

The scope shall also include one number of bypass assembly including fittings, specials and flanges etc. as required. (The complete set up shall be required to be installed just before the inlet of overhead tank which can be 12 - 15 feet above the roof top terrace level. The contractor should take this into account while quoting. It should be compatible with BMS System.

- **MATERIAL**

The water level indicator shall be designed to operate on hydrostatic pressure measurement principle. The MOC shall be principally of Stainless-steel.

Remote Position Indicator:

- a) A 4-20 mA remote position analog signal transmitter shall be provided in the level sensor.
- b) The remote position indicator shall continuously indicate the status of the level indicator. Internal wiring for power and control circuits shall be appropriately sized for MOV actuator rating.

- c) Each wire shall be identified at both ends using PVC ferrules.
- d) The terminal compartment shall be separated from the inner electrical components of the level sensor by means of a watertight seal so that the sensor's electrical components are protected from the ingress of moisture and foreign materials when the terminal cover is removed during installation and maintenance.
- e) Contractor shall be solely responsible for the compatibility of the for the selection and sizing of various electrical devices and components in the sensor.
- f) The sensor shall be provided with minimum three adequately sized cable entries viz., one for power cable and two for control cables.

All control outputs to MCC panel shall be included as per requirements.

All MCC panels should be provided with pedestals / wall mount facility, and shall be installed

All MCC Panels shall have weatherproof cabinets with IP - 65 for housing the level controller and electronic unit of level indicator, potential free contact for compatibility with BMS. complete as approved and specified.

- **TESTING**

The sensor shall be tested as per the relevant standard & duly stamped. Test certificate shall be submitted for material & hydraulic testing.

Should the Engineer-In-Charge require, he may ask for a Factory Acceptance Test, and for this the contractor is bound to make the adequate arrangements for the factory visit at no extra charge.

After fixing in the tanks, the system shall be hydraulically tested for 2 working days for any variations in the readings / operation of the solenoid valves. In case of fall-outs the contractor shall rectify/replace sensors / valves at his own cost.

- **OPENWELL SUBMERSIBLE PUMPS**

- **SCOPE**

The scope includes supply, installation, testing and commissioning of open well horizontal submersible pump set. The scope also includes the starter panels, cables/wires to the pumps, the pump controller shall be mounted in a control cabinet with an IP 67 enclosure of suitable rating having potential free contacts to monitor On /Off & Trip status with necessary sensors/switches, complete for single / three phase submersible motor having (Soft Water transfer from UGT to OHT). The scope also includes motor, delivery piping up to Discharge Header with necessary pipe, fittings, cabling up to electric panel, pressure gauges, etc. Each pump shall have isolation gate/ ball valve, Y Strainer & NRV at delivery side & on header.

- **CODES AND STANDARDS**

The design and manufacture of the pump shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed.

- **DESIGN FEATURES:**

The pump shall be capable of developing required total head at rated capacity.

Impeller shall be enclosed type and shall be dynamically balanced.

The pump shall have non-overloading characteristics.

The pump shall be submerged in tank/ reservoir.

- **CONSTRUCTIONAL FEATURES**

The casing shall be of rigid construction and shall have central delivery pipe.

The casing shall be of Cast Iron.

The pump shall have very small length suction and delivery pipe connections which will result in minimum friction loss in case of moonset pumps.

Impeller shall be of one piece and shall be of SS CF 8 M.

The shaft shall be of S.S. and its surface shall be properly finished.

Shaft sleeves shall be provided to protect shaft from any damage.

Bearing shall be ball or roller type.

Mechanical seal shall be provided to avoid any leakage.

Each pump shall be driven by directly coupled squirrel cage induction motor having 1500/2900 RPM, TEFC enclosure & IP 55 protection.

- **INSPECTION AND TESTING**

The pump shall be offered for visual inspection before dispatch.

Material test certificates for the various pump components shall be furnished for Engineer-In-Charge approval.

Hydrostatic test shall be carried out at 1.5 times the maximum discharge pressure.

For electrical accessories, necessary tests shall be performed, or factory test certificate shall be furnished.

- **DRAWINGS:**

Following drawings shall be furnished by the vendor.

Overall dimensional drawing.

Cross-sectional drawings with Bill of Material and Material of Construction. Pump performance curve.

- **SUMP PUMP:**

- **SCOPE**

The scope includes providing and fixing compact Monoblock dry motor submersible pumps of suitable rating, with non-clog free flow open impeller, solid handling capacity of up to at least 28mm suitable for operation on 415 volts +12%, 3 Phase, 50Hz, A.C supply, speed 2900 RPM including oil chamber, guide wire for lifting & lowering of pump, M.S. galvanized lifting chain, duck foot bend complete.

- **DESIGN & CONSTRUCTION FEATURES**

These shall be fully submersible with a fully submersible motor.

The pumps shall be provided with an automatic level controller and all interconnecting power and control cabling which shall cause the pumps to operate when the water level in the sump rises to a pre-set level and stop when the pre-set low level is reached.

Pumps for drainage shall be single stage, single entry.

Pump shall be C.I. casing and C.I. two vane open type with a dynamically balanced impeller connected to a common shaft of the motor.

The vane for Sewage sump pump will be open type, while for storm drainage pump, etc. it will be of semi open type.

The MOC of the sump shall be in accordance to schedule of quantity.

Stuffing box shall be provided with mechanical seals.

Each pump shall be provided with a suitably rated induction motor, suitable for 230 / 415 volts, single / three phase, 50 Hz A.C. power supply.

Each pump shall be provided with in built liquid level controller for operating the pump between predetermined levels.

The pumping set shall be for stationary application and shall be provided with pump connector unit.

The delivery pipe shall be joined to the pump through a rubber diaphragm, and bend and guide pipe for easy installation.

Pump shall be provided with all accessories and devices necessary and required for the pump to make it a complete working system.

Sump pump shall be complete, with level controllers, power and control switchgear, Auto/off/Manual switches, pumps priority selections and control and power cabling up to motor and controller/probes

etc. (Including earthing).

Level control shall be such that one pump starts on required level, 2nd pump cuts in at high level and alarms is given at extra high level. All level controllers shall be provided with remote level indications.

The pump sets shall be supplied with required accessories & as per specification with the following:

- (a) Necessary cables from pump set to control panel (position of panel marked on enclosed drawings).
- (b) Electrical control panel having all necessary accessories & safety devices of standard specifications and suitable for receiving incomer cable to connect complete. (Panels with sump pumps near each sump as per site conditions).

Should the Engineer-In-Charge require, he may ask for a Factory Acceptance Test, and for this the contractor is bound to make the adequate arrangements for the factory visit at no extra charge.

- **MOTOR DESIGN**

The pump motor shall be a squirrel cage induction, housed in air filled watertight enclosure. Oil filled motors are not acceptable. The stator windings shall be Class "F" insulation (155 C° or 311 F°) for general usage and class 'H' insulation (180 C° or 317-8 grade 2) for submersible type.

The stator shall be heat shrunk fitted into the enclosure and shall not use bolts, pins or other fasteners that penetrate through the stator enclosure. The starter shall be equipped with a thermal switch embedded in series in the coils of the starter windings to protect the stator from wheel.

The motors shall be designed for continuous running duty type at 230/ 415 volts, 1/3phase, 50 Hz power supply and capable of sustaining a minimum of 20starts/stops per hour.

**Scope of work and Technical specification for LAN, Wi-Fi and Networking system, Telephone wiring:**

The following sub heads mentioned in the payment schedule.

- 1 . Sub-head A10 (Annexure A10)
- 2 . Sub-head B10 (Annexure B10)
- 3 . Sub-head C10 (Annexure C10)
- 4 . Sub-head D11 (Annexure D11)
- 5 . Sub-head E11 (Annexure E11)
- 6 . Sub-head F11 (Annexure F11)
- 7 . Sub-head G11 (Annexure G11)
- 8 . Sub-head H11 (Annexure H11)

## **CONDITIONS AND SPECIFICATIONS FOR NETWORKING (LAN, WI-FI) SYSTEM**

### **GENERAL - SCOPE OF WORKS**

The general character and the Scope of work to be carried out under this contract is illustrated in Drawings, Specifications and Schedule of Quantities. The Contractor shall carry out and complete the said work under this contract in every respect in conformity with the contract documents and with the direction of and to the satisfaction of the Engineer-In-Charge. The Contractor shall furnish all labour, materials and devices and specified otherwise, transportation and incidental necessary for Supply, Installation, Testing, Commissioning, final testing, putting into operation and handing over of the complete Extra Low Voltage (ELV) system as described in the Specifications and as shown in the drawings. This also includes any material, devices, appliances and incidental work not specifically mentioned herein or noted on the Drawings / Documents as being furnished or installed, but which are necessary and customary to be performed under this contract.

All the specifications for the Conduits, Cable trays and Raceway items to be considered as specified in other subheads of the tender documents.

The ELV system works shall comprise of but not limited to the following:

1. Information & Communication Technology (ICT) Infrastructure – (Data/LAN & Telecom) – Passive Components
2. Fire Detection, Alarm and Control System (FAS) – Complete System Works
3. IP Television & Audio-Visual (AV) System – Only Enabling works with Conduit Provision.

### **1. INFORMATION & COMMUNICATION TECHNOLOGY (ICT) INFRASTRUCTURE –(DATA/LAN & TELECOM) - PASSIVE COMPONENTS**

#### **SCOPE OF WORK**

- Complete Design, Supply, Installation, Testing and Commissioning (SITC) shall be done in accordance with installation practices for a well-structured cabling system, using components from a single OEM (Original Equipment Manufacturer) to ensure consistent and assured performance. The structured cabling distribution network shall serve as a vehicle for transport of data, video and voice telephony signals over a common network throughout the network.
- The scope consists of both Active and Passive system, the system should be designed for suitable no of LAN, WIFI & Telephone points for each floor with UTP cable for horizontal distribution from Manageable switch/Distribution Switch/POE Switch per floor and vertical connectivity with UTP/OFC as per the approved design in individual buildings listed below.
  - Faculty Housing-02Nos.
  - Staff Housing-03Nos.
  - Hostels-03Nos.
- Supplying, Installation, Testing & commissioning of suitable Active Components (Manageable switches/ Distribution Switches/ POE Switches/ WI-FI Access points) are included in scope of work.
- Supply, laying of Main OFC cable(input) from existing nearest building to individual Faculty/Staff Housing and Hostels with required civil works(excavation for burying cable/laying through existing RCC Hume pipe /laying new RCC Hume pipe/DWC HDPE pipe for OFC routing) is included in the scope as per the approved design and directions of Engineer-In-Charge.

- Devices and services that shall run on the passive network shall include, but not limited to, the following:
  - a) Wired LAN access
  - b) Wireless LAN access
  - c) Voice communications servers and IP/SIP end-points
  - d) IP-based CCTV/Surveillance Cameras
  - e) Various devices and controllers for AV system
  - f) Fire Detection System
  - g) Public Address System
- Cabling installation for data and voice communications shall originate at networking racks and terminate at IOs terminated at wall or furniture.
- Installation, termination and identification of wiring between station outlets and networking distribution rack(s) and networking distribution rack(s) and main rack (s), shall be considered part of the ELV Sub-Contractor's work.
- All cables and terminations shall be tested @500 MHz identified, labelled and documented at all locations.
- The ELV Sub-Contractor carrying out the SITC shall make the system entirely operational for its intended use, by addition of components specific to its make/model even if not specifically mentioned in the BoQ at no additional Cost.

**Supported Applications, but not limited to:**

- Ethernet Applications – wired Ethernet and wireless as per IEEE 802.11a/b/g/n/ac
- IEEE 802.3af Data Terminal Equipment (DTE) Power via Media Dependent Interface (MDI)
- Telecom – BRI, PRI and Digital Subscriber Loop (DSL) Applications
- Voice, Video and ISDN Applications

It shall be the responsibility of the ELV Sub-Contractor and OEM manufacturer to ensure that:

The Passive Components of structured cabling distribution network will be free from manufacturing defects in material and workmanship under normal and proper use.

All Passive Components in the structured cabling distribution network shall meet or exceed the relevant component specification of the EIA/TIA 568-B and EIA/TIA 568-C.2 series, EIA/TIA 569-A, EIA/TIA 606, EIA/TIA 607 and ISO/IEC 11801-1: 2017 standards or latest version, amended to date.

As per TIA/EIA standards requirement, the horizontal cabling system shall run from each workstation outlet to the patch panel installed at networking rack. The maximum horizontal distance from the workstation outlet to the patch panel shall not exceed 90 meters. An additional length shall be permissible for patching cables between patch panels and networking switch at one end and between workstation outlet and workstation and the combined length shall not exceed 12 meters. The patching cables shall be from cabling system OEM in various lengths, i.e., 1mtr, 2mtrs or 3 mtrs as per requirement. The complete cabling system shall be from a single OEM.

As per TIA/EIA standards requirement, the backbone cabling that shall run between the floors of the



building (risers) or across a campus for providing the interconnection for equipment installed inside racks/enclosures shall be either UTP/STP/FUTP CATx based or Single mode or Multi mode fiber optic cables. The permissible distances of this cabling shall depend on the type of cable and shall be as follows:

- UTP/STP/FUTP: up to 90 meters
- Multimode fiber optic cable: 2000 meters
- Single mode fiber optic cable: 3000 meters

As per TIA/EIA standard for grounding guideline, the shield of FUTP cables shall be bonded through a conducting path to the telecommunications grounding busbar (TGB) in the network room(s) or server room(s). Grounding at the work area is usually accomplished through the equipment power connection. Shield connections at the work area are accomplished through an FUTP patch cord. At the work area end of the horizontal cabling, the voltage measured between the shield and the ground wire of the electrical outlet used to supply power to the work station shall not exceed 1.0 V rms. The cause of any higher voltage shall be removed before using the cable.

The structured cabling distribution network compliant channels will meet or exceed the Guaranteed Channel Performance as per relevant standards in the structured cabling distribution network Performance Specifications in effect at the time of installation.

The site will be duly certified by OEM for a period of 20 years from the date of issuance of the registration certificate or installation, whichever is earlier, for which they shall submit detailed performance test reports for every IO installed.

The specifications for items in this section, applies to the following:

- a) F/UTP CAT6A cable and associated components such as Patch Panels, IOs/RJ45 Jacks, Patch Cords
- b) UTP CAT6 cable and associated components such as Patch Panels, IOs/RJ45 Jacks, Patch Cords
- c) Single-Mode fibre optic cable and associated components such as distribution shelves, LIUs, pigtails and patch cords
- d) Networking Racks – for termination of networking cables

**Installation:**

The final branch connections with single pair cables in conduits and the maximum number of cables in each conduit shall be as follows:

Conduit Diameter	mm.	Max. No. of cables
1"	25	2 Nos. of F/UTPCAT6A cables
1 ½"	40	4 Nos. of F/UTPCAT6A cables

**Codes& Standards, but not limited to the following:**

All the following codes & standards shall follow and conform to the latest editions, amended to date.

- TIA/EIA568-C.1–Commercial Building Telecommunications Cabling Standard – General requirements

- TIA/EIA 568-C.2 – Commercial Building Telecommunications Cabling Standard - Balanced Twisted
- Pair Cabling Components
- TIA /EIA 568-C.3 – Optical Fiber Cabling Components Standard
- TIA /EIA 569-A – Commercial Building Standard for Telecommunications Pathways and Spaces
- TIA /EIA 606 – Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
- TIA/EIA 607 – Commercial Building Grounding and Bonding Requirements for Telecommunications
- TIA/EIA-862 - Building Automation Systems Cabling Standard For Commercial Buildings
- ISO/IEC 11801-1: Information technology - Generic cabling for customer premises – Part-1 General Requirements
- EN
- ETL
- ITU for Voice
- ISO/OSI models
- International Electro technical Commission (IEC)
- European Committee for Electro technical Standardization (CENELEC)
- American National Standards Institute (ANSI)
- Institution of Electrical and Electronics Engineers (IEEE)

Wherever there is reference to multiple standards and/codes, the ones most recent as amended to date and most stringent shall apply.

#### F/UTP CAT6A CABLING SYSTEM

No.	Description	Specification
	<p>Following common specifications shall apply to all F/UTP CAT6A standards based structured cabling components, i.e., Cable, Patch Panel, IOs&amp; Patch Cords.</p> <p>All components of the structured cabling system shall be from the same OEM manufacturer. As per structure cabling, ELV Sub-Contractor should have to consider maximum 90 meter CAT 6A cable length from rack side patch panel to LAN I/O.</p>	
i.	Standards Compliance	<p>F/UTP cabling system, conforming to ANSI/TIA/EIA 568-C.2 CAT6A Cabling system, ISO/IEC 11801-13rd edition, EN-50173-1 as amended to date.</p> <p>The cabling system components must be UL listed</p>
ii.	OEM Performance Certification	<p>Performance characteristics shall be provided after installation at site and actual tests conducted at site after installation and commissioning for the following parameters:</p> <p>Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT, Return Loss, ACR and PS ACR for 4-connector channel.</p> <p>The site will be duly certified by OEM for a period of 20 years from the date of issuance of the registration certificate or installation, whichever is earlier, for which they shall submit</p>

		detailed performance test reports for every IO installed.  The cable shall be tested for minimum guaranteed performance as per standards at 500MHz operation minimum.
iii.	OEM Requirement	All passive cabling must be from same OEM (UTP, F/UTP and Fibre)
	<b>F/UTPCAT6A</b>	
	Standards Compliance	As per i) above under F/UTP CAT6A Cabling System
	Conductors	23 AWG solid bare copper
	Construction and mechanical details	Polyethylene insulation, LSZH jacket, each pair to be individually foiled.
	Operating temperature	-20 Deg. C to +60 Deg. C
	Delay Skew	Not exceeding 45 ns / 120m
	Performance Characteristics	Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT, Return Loss, ACR and PS ACR for 4-connector channel, to be submitted with bid
	<b>F/UTPCAT6A I/O Jack</b>	
	Standards Compliance	As per 1.i) above, UL Listed
	Performance Characteristics	ETL Verified 4-Connector Channel to ISO/IEC 11801 AMD 1 Class EA, along with channel illustration, and parts numbers to be submitted along with the bid, options in different colours
	<b>F/UTPCAT6A PATCH PANEL</b>	
	Standards Compliance	As per 1.i) above
	Ports	12/24/48 Ports Angular/Straight (as per BOQ) pre-loaded with shutter for keystone Jacks
	Port arrangement	Individually replaceable jacks or keystone
	Height	1 U (1.75 inches)
	Panel	Fully powder coated
	Approvals	UL listed
	Termination Pattern	TIA / EIA 568 A, B and C;
	Performance Characteristics	ETL Verified 4-Connector Channel to ISO/IEC 11801 AMD 1 Class EA, along with channel illustration, and parts numbers to be submitted along with the bid
	<b>F/UTPCAT6A PATCH CORDS</b>	
	Standards Compliance	As per 1.i) above
	Conductor	24-26 AWG, multi-stranded copper, UL Listed
	Length	1 Meter, 2 Meter, 3 Meter options in different colours
	<b>FACEPLATES</b>	
	Type	1-port, 2 -port or 4-port, White Face plate
	Material	ABS / UL 94 V-0
	No. of ports	One/ Two / Four

## FIBER OPTIC CABLE AND COMPONENTS

SPECIFICATIONS OF SINGLE MODE FIBER OPTIC CABLING SYSTEM:		
Type		Single mode OS2 fiber cabling system and all its components; must be from a single OEM (Cables + Components)
Networks Speeds Supported		1Gbps, 12Gbps and 40Gbps
Standard Compliance		ITU-T G.652A, B, C & D, IEC - 60793-2-50, TIA/EIA 568-C.3
Performance Testing OEM Performance Certification		Fiber channel compliance to ANSI/TIA568 -C.0 for OS2 The site will be duly certified by OEM for a period of 20 years from the date of issuance of the registration certificate or installation, whichever is earlier, for which they shall submit detailed performance test reports for every IO installed and OTDR test report

SPECIFICATIONS FOR SINGLE MODE OPTICAL FIBER CABLE:		
Cable Type		12 core/ 6 core as applicable as per BoQ, Single Mode, OS2 Type, Armored, Loose- unitube for 6 and 12 core
Fiber Type		Single Mode, 9 / 125
Fiber core must be		As per Telecordia GR20, ITU-T G652D, IEC-60793-2-50, TIA/EIA 492-CAAB
No of cores		12 core / 6 core as applicable as per BoQ-ISO 11801 -OS2
Armor		Corrugated steel tape armour
Cable Construction Type		Loose tube corrugated steel tape armored cable, provided with FRP non-metallic central strength member
Outer Jacket Construction		High density polyethylene, anti - termite, anti - rodent suitable for direct burial application. Jacket must be UV stabilized
Losses @ 1312nm Frequency		< = 0.4 dB/Km
Losses @1550nm Frequency		< = 0.3 dB/Km
Operating Temperature		-20 deg C to + 60 deg C
Cable / Component		All fiber cables and components must be from a single OEM (Including F/UTP CAT6A Cabling System)
Testing Parameters		Must pass the following: -IEC794-1-E1, IEC794-1-E2, IEC794-1-E3, IEC794-1-E4, EIA-455-124, IEC794-1-E7, IEC794-1-E12, IEC794-1-E11, IEC794-1-F5
Multi-channel capability		The fiber cable must have been designed to provide optimum performance from 1265nm to 1625nm making it suitable for 16 -channel Course Wavelength Division Multiplexing (CWDM) Applications.

SPECIFICATIONS FOR CONNECTORS:		
Connector Type		LC-Style, Duplex
Operating temperature		-20 deg C to + 50 deg C
Durability		(500 Matting's): < 0.2 dB Max

Ferrules	Pre-radius Ceramic Zirconia Ferrule. Bayonet Coupling: 2.5 mm Zirconia Ferrule
Attenuation	Not more than 0.75 dB per mated pair
Parameters / standard	Meets or exceeds ITU specifications

**SPECIFICATIONS FOR PIGTAILS:**

Type	LC style, SM OS2as required. Simplex, lengths of 1,2 & 3meters, compliant to ITU-G657.B - Bend Insensitive Fiber
Operating temperature	-20 deg C to + 50 deg C
Durability	(500 Matting's): < 0.2 dB Max
Ferrules	Pre-radius ceramic Zirconia ferrule. Bayonet coupling: 2.5 mm Zirconia ferrule
Attenuation	Not more than 0.75 dB per mated pair
Parameters / standard	Meets or exceeds ITU specifications UL Listed

**SPECIFICATIONS FOR FIBER OPTIC CABLE PATCHCORDS:**

Cable type	LC-LC style, SM OS2 as required. -Simplex or duplex patch cord with lengths of 1, 2 & 3 meters. Compliance to ITU-G657.B - Bend Insensitive Fiber
Fiber type	Single mode 9/125-micron primary coated buffers
No of cores	2 cable construction type PVC outer jacket
Outside Diameter	1.6mm x 3.0mm (Simplex) or 1.6mm x 3.3mm(Duplex)
Operating Temperature	-20 deg C to + 60 deg C

**SPECIFICATIONS FOR 19" RACK MOUNTED FIBER OPTIC PATCH PANELS**

Fiber optic patch panel	19-inch, rack mounted fiber optic patch panel
Height	1U
Number of fiber cores	12 core configurations
Number of OSP (outdoor) cables for Termination	Minimum 2
Grounding	2 Nos. of earthing lugs
Cable Management rings	Front and rear cable management rings
Adapter plates	12 Port adapter plates with each plate loaded with single-mode couplers, as applicable
Construction	Complete Aluminum alloy housing, fully powder coated
Splice tray	Shall be included in LIU

**SPECIFICATIONS FOR ADAPTOR PLATES & ADAPTORS:**

Fiber Optic adapter plate	12 port/6-port, SC or LC style
Attenuation	Max of 0.75 dB per mated pair
Adaptors	Available in Simplex and Duplex types
Durability	< 0.2 dB max (Min 500 and upto 1200 Matting cycles)
Standard	Compliant as per EIA/TIA 568-B and ISO/IES 11280

<b>SPECIFICATIONS FOR EXTERNAL FIBER OPTIC ENCLOSURE:</b>		
	No of fiber core terminations	12 ports/6-port
	Features	Easy and fast-to-fix for fiber cable termination, IP-68 Rated
		Easy to re-enter, it should not require re-entry kits
		Fiber optic splice tray must be designed in snap in lock & easily fixable way.
		Must meets fire codes and industry standards
		Should prevent cable sheath movement with temperature changes

#### **Fiber Joint Enclosure (IP 68 Rated)**

Enclosure	It Shall be a butt type enclosure with a dome and base (IP 68 Rated)
Cable Entry	The Cable entries shall be through the cable ports located in the base.
Dome & Base	The dome and base shall be sealed using a clamp with O-ring system. The cable entry ports should be sealed mechanically and no need of added tools for cable Installation.
General Specifications	<ul style="list-style-type: none"> <li>a) IP68 Rated</li> <li>b) No. of Splice trays: 6 nos.</li> <li>c) Splice Tray Capacity: 24 Fibers</li> <li>d) No. of cable entry ports: 4 round ports and 1 oval port.</li> </ul>
Closure	<ul style="list-style-type: none"> <li>a) The closure should have the capability to accommodate loop cables (un cut loose tube cables)</li> <li>b) The cables should be secured to the closure using hose clamps and a cable attachment device.</li> <li>c) The closure should have a basket for storing loose tubes.</li> </ul>

#### **48/24/12 Sliding Fiber Shelf**

<b>Specifications &amp; Standard Compliance</b>	
Type of Fiber Shelf	Shall accommodate 4 coupler plates or 4 pigtail cassettes for a total of 48 fiber terminations.
Width	The width shall be 19 inches and height of 1U (1.75 inches), with a maximum of 18 inch depth.
Sliding type	The shelf/LIU shall be sliding.
Intelligent Upgradable	The Fiber shelf must be intelligent ready and must support field upgrade to intelligent fiber panels without removal of existing patch cords and without disruption of network services.
Splice trays	Shall have splice trays to splice minimum 32 fibers.

#### **12 Fiber Single mode Fiber Pigtail Cassettes**

<b>Specifications &amp; Standard Compliance</b>	
Type	Shall be Single mode OS2, zero water peak fiber.
Standards Compliance	G.652.D, G.657.A1 and OS2
Regulatory Compliance	RoHS 2011/65/EU

Safety Standard	UL
Number of Fibers	12
Interface, Front	LC
Adapter Color:	Blue
Optical Performance	a) Insertion Loss Change, mating: 0.30 dB b) Insertion Loss Change, temperature: 0.30 dB c) Insertion Loss, Typical: 0.30 dB d) Return Loss, Min: 55.0 dB
Pigtail Environmental Specifications	Environmental Space: Plenum Operating Temperature: -12 degree Celsius to +60 degree Celsius Cable Retention Strength, Max: 1.00 lb @ 0 degree, 1.00 lb @ 90 degree Ferrule Geometry: Pre-radiused Ferrule Material: Zirconia
Optical Components Standard:	ANSI/TIA-568-C.3

#### LC – LC Single mode LSZH Patch Cords

Specifications & Standard Compliance	
Type	Shall be Singlemode (OS2), zero water peak, LC to LC, Fiber patch cords.
Standards Compliance	G.652.D, G.657.A1 and OS2
Regulatory Compliance	RoHS 2011/65/EU
Jacket	Low Smoke Zero Halogen (LSZH) compliant to IEC 60332-3, IEC 60754-2, IEC 61234-2, IEEE 383, UL 1666, UL 1685
Flame Test Listing	NEC OFNR-LS (ETL) and c(ETL)
Cable Qualification Standards	ANSI/ICEA S-83-596 and Telcordia GR-409
Optical Components Standard	ANSI/TIA-568-C.3
General Specifications	Connector Color: Blue Connector Interface: LC Operating Temperature: -12 degree Celsius to +60 degree Celsius
Connector Optical Performance	Insertion Loss, Typical: 0.20 dB Return Loss, minimum: 55.0 dB Insertion Loss Change, mating: 0.30 dB Insertion Loss Change, temperature: 0.30 dB

#### 19"WALL MOUNTED NETWORKING ENCLOSURES (9U TO 15U USABLE HEIGHTS)

- Construction shall be single section welded robust with ventilation holes on the sides and top & bottom covers with provision to mount 2 fans
- Top/ Bottom covers and side panels shall be of sheet steel, powder coated
- Vertical 19" metric panel mounts and door trims shall be of sheet steel and powder coated

- The top and bottom covers shall be provided with four cut outs on top and bottom cover for cable entry and round cuts shall be edge protected with rubber grommets
- Two pairs of 19" equipment mounting angles with mounting holes conforming to IEC 297-3
- Toughened glass front lockable door
- Wall mounted 19" Networking rack shall be available in various heights
- Cooling shall be achieved with the help of two fans, 90 CFM capacity each, mounted on top
- Power shall be provided in form 19" rack mountable power strip which shall consist of minimum four 5/15A power sockets. Power strip shall be provided with 20A MCB
- Cantilever shelf – at least one front mounting 1U cantilever shelf shall be provided with depth of 250 mm or more
- 1U vertical cable managers on as required for dressing of cables for 12/24/48 ports patch panel and switch Hardware Pack / Rack mounting accessories and hardware – as required
- Horizontal managers on as required basis for ensuring neat and aesthetically clean installation
- Cabinet material – cabinet shall be made of 16 Gauge (1.5mm) thick cold rolled steel sheets or thicker
- Finish – cabinet shall be black or grey epoxy powder-coated of durable quality
- Load carrying capacity – min. 25 kg load of equipment should be mountable
- Product must be UL listed and certified for use in Information Technology or Communication Equipment
- EIA standard pattern design with 12-24 tapped holes (EIA-312-E compliant)

#### **19" FLOOR STANDING NETWORKING ENCLOSURES (22U TO 42U USABLE HEIGHTS)**

- Frame of sturdy frame section construction, consisting of 9 x folded rolled hollow frame section punched in 25mm DIN pitch pattern. All profile edges are radiused. The corners are stiffened with welded zinc die-cast corner connectors, Front and rear perforated door. Top cover with cable entry and Bottom open. 42 U 19" L type angle Front & Rear on 6 x punched section. Cabinet color should be Black and light grey
- The Thickness of the CRCA sheets used for Doors is 1.5mm and for Side Panels is 1.5mm
- Fully adjustable 19" equipment mounting angles
- The cabinet design conforming to DIN 41494 or EIA 312D standards
- Top and Bottom Covers and Side panels shall be of sheet steel and Primary Dip Coat = 20-30 Microns Power Coat = 80-120 Microns



- Vertical 19" metric panel mounts and door trims shall be of sheet steel and powder coated
- The Top cover with min. 4 cut out of diameter 120mm or more for cable entry. Bottom cover with 4 cut out of diameter 120mm or more for cable entry. All cut outs blanked with plastic caps
- Perforation - for full / split perforated doors the style should be" Honeycomb" type of perforation for maximum air circulation and stiffness. Doors should have min. 75% perforation for better air Circulation
- Cabinet shall be capable of dismantling and reassemble at the site
- Locks options – options shall be available such as slam lock - common key or unique key, Swing handle lock, Digital Keypad operated locks, Biometric locks
- Side panels – must contain slam latches for locking purpose and option of providing slam locks, or screw fitted for removal, if required
- Two pairs of 19" Equipment mounting angles with mounting holes conforming to IEC 2973
- Front glass door made of toughened glass, tinted with easily detachable hinges, lockable type.
- Two pairs of slotted vertical cable channel shall be provided at front and back for managing cables
- Lockable industrial grade castors with foot brakes
- Rack shall be supplied with 4 x 90 CFM fans at top
- Rack shall be supplied with equipment mounting hardware in pack of 20s such as mounting nuts and screws either 12-24 or M6 type as applicable
- Minimum 2 nos. of 8 x 5/15 Amps power supply sockets, 2 nos. of vertical cable managers and 2 no. of 19" 1U size horizontal cable managers
- Finish – cabinet shall be black or grey epoxy powder-coated of durable quality. The Powder coating of the racks is as per Nano coated, electro-dip coat primed to 20 microns, and power coated with texture polyester with 80 to 120 microns for long lasting paint against corrosion
- Product must be UL listed and certified for use in Information Technology or Communication Equipment
- EIA standard pattern design with 12-24 tapped holes (EIA-312-E compliant) or EIA standard pattern design with 3/8" (9.5mm) square punches for Cage Nuts for mounting.

#### **SPECIFIC REQUIREMENT TO THE SOLUTION**

- a. Supply, installation, testing and commissioning of networking components for providing LAN in new Upcoming Precast buildings of IIT Hyderabad.
- b. The solution includes
  - i. Supply, installation, including necessary cabling, testing, commissioning, and documentation.

- ii. Integration with the existing environment
- c. Network operational centre (NOC) is in Academic block A. OFC connectivity from NOC to these building should be in star topology.
- d. Solution should include a distribution switch
- e. Connectivity between distribution switch to access switches should be in star topology for all buildings.
- f. All access switches Non-PoE should support stacking.
- g. Building to Building connectivity should be with single mode (SM) OFC
- h. Switch to switch connectivity within the building should be with Multimode (MM) OFC

## **SCOPE OF WORK**

Supply, installation, testing and commissioning of Active and passive components for establishing Network Infrastructure in IIT Hyderabad campus.

- The contractor should submit the cabling routing plan, labeling of the cabling infrastructure and the documentation of the cabling infrastructure for maintenance & handing over to the IIT Hyderabad.
- The contractor should submit a separate HLD / LLD document which is validated by the OEM.
- Performance testing of laid Fiber Optic cable by OTDR for continuity, length & db loss.
- The LAN IP addressing, creation of in building VLAN for segregation between users, configuration for all the LAN security issues will be carried out by the contractor. (wherever required).
- All the switch & IP addressing scheme need to be documented for maintenance purposes.
- The scope of work also includes supply and services that are necessary to lay & terminate OFC cable.
- Preparation of cable route survey drawings.
- Labeling of Cables, I/Os, Patch Panel, Switches
- Repair/Refurnishing work owing to damage caused due to cabling or any other work related to this Project. There should not be any hanging or uncovered wire.
- Patch cords should be branded, and factory crimped.
- Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment's and/or needed for erection, completion and safe operation of the equipment's as required by applicable codes though they may not have been specifically detailed in the tender document, unless included in the list of exclusions. All similar standard components/parts of similar standard equipment's provided, shall be interchangeable with one another.
- The Contractor shall be responsible for providing all materials, equipment's, necessary software, licenses, drivers and services, specified or otherwise, which are required to fulfill the intent of ensuring operability, maintainability, and reliability of the complete equipment covered under this specification within the quoted price. This work shall be in compliance with all applicable standards, statutory regulations and safety requirements in force on the date of award of this contract. All the safety measures should be taken for the protection of cables and devices from LI and other such sources.
- The scope covers design/development of a suitable architecture/layout of the proposed networking system, preparation of bill of materials, pre-dispatch/ inspection / testing, packing and forwarding, transportation, insurance and carrying out further activities at viz. unloading, storage, (space to be provided by IITH) further handling, erection, testing and commissioning including successful completion of acceptance tests and any other services specified.

- Testing of LAN Cables and Fiber Optic after laying, terminations and ferruling at both the ends. All testing tools and instruments shall be brought by the contractor and taken back after the testing.
- Integration with existing setup.
- Entire networking infrastructure must be IPV6 & IPV4 Compliant
- The installation of equipment's shall be accepted only after successful commissioning and testing are over and certified by the designated team of IITH
- The contractor should ensure that during installation of LAN, day-to-day functioning of official work should not get disrupted.
- The contractor proposal shall include the list of tools (such as crimping tool, Krone punch tool, standard fiber optic installer tools etc.) and other accessories, which are required for installation of the Project. No separate charges for fixing/crimping/terminating/other connection charges would be paid by IITH.
- The Contractor shall be responsible for obtaining necessary clearances for excavation work from the respective buildings and provide requisite copies of information, maps, survey report etc to the authorities. The IITH shall assist the Contractor in obtaining such clearances.
- The contractor is required to submit the make and model of proposed equipment with detail data sheets for approval of the Engineer –In – Charge.
- All equipment should be latest models with no End of Life for at least five years from date of commissioning.
- The contractor is required to submit the drawing of installed network.
- Distribution Switches on each site should have redundant power supply.
- Acceptance Parameters
- Site acceptance tests to establish satisfactory performance of the equipment's as per specifications.
- The contractor must implement the solution at the site and complete the necessary integration of the solution with the core network infrastructure deployed at IIT Hyderabad and demonstrate the performance of the deployed infrastructure to the technical committee.
- The warranty services will start only after installation and commissioning of the complete solution.

## **TECHNICAL SPECIFICATIONS**

Notes:

- All proposed distribution switches, Access switches, must be manageable and of enterprise class.
- Cisco/HPE(Aruba) or equivalent makes are preferred.
- Cisco SMB switches and HP office connects are not admissible.
- The equipment supplied must support the below specifications.

Distribution Switch:

<b>Specifications</b>
<b>Architecture</b>
Should have min 16 autosensing 1200/12000 SFP+ ports.
Shall be 19" Rack Mountable
Switch should have support for 25/40/50 G uplink for future upgrade without changing hardware.
The switch should have one Rj-45/USB-micro-B console port and RJ45 management port
<b>8GB SDRAM, 16 GB of Flash Memory and 8 MB Packet buffer size</b>
Shall have switching capacity up to 480 Gbps
Shall have up to 360 million pps switching throughput or higher
The Switch should support min 32000 MAC address

	Should support stacking or equivalent Virtual chassis technology to group min 2 switches. Stacking modules and cables to be provided from day 1"
	<b>Features</b>
	The switch should support HTTP redirect function
	Should Support Network Visibility and Analytical Capability
	<b>Quality of Service (QoS)</b>
	The switch should support Traffic prioritization (IEEE 802.1p) to allows real-time traffic classification into eight priority levels mapped to eight queues
	The switch should support Layer 4 prioritization to enable prioritization based on TCP/UDP port numbers
	The switch should support Class of Service (CoS) to sets the IEEE 802.1p priority tag based on IP address, IP Type of Service (ToS), Layer 3 protocol, TCP/UDP port number, source port, and DiffServ
	The switch should support Rate limiting to sets per-port ingress enforced maximums and per-port, per-queue minimums
	The switch should have Modular operating system
	<b>IPv6 Feature</b>
	The switch should support IPV6 host to enable switches to be managed in an IPv6 network
	The switch should support Dual stack (IPV4 and IPV6) to transition from IPv4 to IPv6, supporting connectivity for both protocols
	The switch should support MLD snooping to forward IPv6 multicast traffic to the appropriate interface
	The switch should support ACL with min 1200 access control entries (Ingress) and QoS for IPv6 network traffic.
	<b>Security</b>
	The switch should support RA guard, DHCPv6 protection, dynamic IPv6 lockdown, and ND snooping
	The switch should have Energy-efficient design
	The switch should support Energy-efficient Ethernet (EEE) to reduce power consumption in accordance with IEEE 802.3az
	The switch should support very low latency, increased packet buffering, and Optimum power consumption
	Selectable queue configurations
	The switch should have facility to allow for increased performance by selecting the number of queues and associated memory buffering that best meet the requirements of the network applications
	<b>Convergence</b>
	The switch should support IP multicast routing and PIM Sparse and Dense modes to route IP multicast traffic
	The switch should support IP multicast snooping and data-driven IGMP
	The switch should support LLDP-MED (Media Endpoint Discovery)
	The switch should support IEEE 802.1AB Link Layer Discovery Protocol (LLDP)
	The switch should support Local MAC Authentication
	<b>Resiliency and high availability</b>
	Switch should have Hot Swappable redundant Power Supply from day 1 Include Power supply units and Power cords Indian Standard

	The Switch should create one virtual resilient switch from two or more switches and attached the network devices using standard LACP for automatic load balancing and high availability to simplify network operation by reduce the need for complex protocols like Spanning Tree Protocol (STP), Equal-Cost Multipath (ECMP), and VRRP
	The switch should support IEEE 802.1s Multiple Spanning Tree
	The switch should support IEEE 802.3ad link-aggregation-control protocol (LACP) and port trunking
	The switch should provide easy-to-configure link redundancy of active and standby links
	<b>Management</b>
	Should support Configuration validation and config check capability as part of a solution.
	The switch should support SNMPv1, v2, and v3
	<b>Layer 2 switching</b>
	The switch should support IEEE 802.1Q (4094 VLAN IDs) and 1200 VLANs simultaneously
	The switch should support Jumbo packet support
	The switch should support IEEE 802.1v/802.1Q protocol VLANs
	The switch should support Rapid Per-VLAN Spanning Tree (RPVST+)
	The switch should support GVRP and MVRP
	The switch should support encapsulation (tunneling) protocol for overlay network that enables a more scalable virtual network deployment
	<b>Layer 3 services</b>
	The switch should support DHCP server
	The switch should support DHCP relay agent
	<b>Layer 3 routing</b>
	The switch should support minimum 16000 unicast routes
	The Switch should support VXLAN
	The switch should support OSPFv2, OSPFv3 and BGP4 protocols for routing between access and the next layer on the LAN.
	Switch should have Hot Swappable redundant Power Supply from day 1 and should have hot swappable fan tray
	The switch should support Policy-based routing
	<b>Security</b>
	The switch should support IEEE 802.1X
	The switch should support Web-based authentication
	The switch should support MAC-based authentication
	The switch should support Multiple IEEE 802.1X users per port
	The switch should support Concurrent IEEE 802.1X, Web, and MAC authentication schemes per port and accept up to 32 sessions of IEEE 802.1X, Web, and MAC authentications. The switch also should support Sflow/Jflow/ Net flow or equivalent.
	The switch should provide IP Layer 3 filtering based on source/destination IP address/subnet and source/destination TCP/UDP port number
	The switch should support Source-port filtering
	The switch should support RADIUS/TACACS+
	The switch should support Secure shell
	The switch should support Secure Sockets Layer (SSL)
	The switch should support Port security
	The switch should support MAC address lockout

The switch should support Secure FTP
The switch should support Switch management logon security
The switch should support STP BPDU port protection
The switch should support DHCP protection
The switch should support Dynamic ARP protection
The switch should support STP root guard
The switch should support Identity-driven ACL
The switch should support Per-port broadcast throttling
The switch should support Private VLAN or equivalent
<b>Environmental Features</b>
Operating temperature of 0°C to 40°C
Safety and Emission standards including EN 60950; IEC 60950; VCCI Class A; FCC Class A
<b>Warranty and Support</b>
The below Warranty shall be offered directly from the switch OEM.
Vendor should provide 3 years warranty which will provide NBD advance hardware replacement and 24x7x365 days a year online TAC support. A proof of this offering to be submitted
Software upgrades/updates shall be included as part of the warranty
All above mentioned features should be available from day 1. Any license required to be factored from day 1
The Proposed Switches, transceivers, wireless, equipment's and NMS shall be from the same OEM.
<b>OEM Criteria</b>
The OEM shall be consistently present in Leaders or Challengers quadrant in Gartner's Magic Quadrant for Wired and Wireless LAN Access Infrastructure for last three years
Switch / Switch's Operating System should be tested for EAL2/NDPP or above under Common Criteria Certification.

#### 48 Port Access Switch

<b>Specifications</b>
<b>Architecture</b>
48 x ports 12/120/1200 Base T ports and minimum 4 SFP+1/12GbE or more
Shall be 19" Rack Mountable
The switch should have RJ45 management port / USB-micro-B console port
Min of 2 GB SDRAM, 4GB of Flash Memory and min 6 MB Packet buffer size or more or sufficient DRAM, Flash & Buffer to be provided from Day1
Shall have switching capacity of minimum 176 Gbps or more
Shall have up to 130 million pps switching throughput or More
The Switch should support min 16000 MAC address
Quoted 24 port POE / 24 port non-POE / 48 port non-POE switches should support stacking with one other from day 1 with minimum of 4 Switches in a stack and stacking modules and cables to be provided from day one for POE switches only.
The Switch should support VXLAN
<b>Features</b>

	The switch should support HTTP redirect function
	Solution should Support Network Visibility and Analytical Capability
	<b>Quality of Service (QoS)</b>
	The switch should support Traffic prioritization (IEEE 802.1p) to allows real-time traffic classification into eight priority levels mapped to eight queues
	The switch should support Layer 4 prioritization to enable prioritization based on TCP/UDP port numbers
	The switch should support Class of Service (CoS) to sets the IEEE 802.1p priority tag based on IP address, IP Type of Service (ToS), Layer 3 protocol, TCP/UDP port number, source port, and DiffServ
	The switch should support Rate limiting to sets per-port ingress enforced maximums and per-port, per-queue minimums
	<b>IPv6 Feature</b>
	The switch should support IPV6 host to enable switches to be managed in an IPV6 network
	The switch should support Dual stack (IPV4 and IPV6) to transition from IPv4 to IPv6, supporting connectivity for both protocols
	The switch should support MLD snooping to forward IPv6 multicast traffic to the appropriate interface
	The switch should support ACL with 1200 access control entries (Ingress) and QoS for IPv6 network traffic
	<b>Security</b>
	The switch should support RA guard, DHCPv6 protection, dynamic IPv6 lockdown, and ND snooping
	The switch should have Energy-efficient design
	The switch should support Energy-efficient Ethernet (EEE) to reduce power consumption in accordance with IEEE 802.3az
	The switch should support very low latency, increased packet buffering, and Optimum power consumption
	Selectable queue configurations
	The switch should have facility to allow for increased performance by selecting the number of queues and associated memory buffering that best meet the requirements of the network applications
	<b>Convergence</b>
	The switch should support IP multicast routing and PIM sparse and dense modes to route IP multicast traffic
	The switch should support IP multicast snooping and data-driven IGMP
	The switch should support LLDP-MED (Media Endpoint Discovery)
	The switch should support IEEE 802.1AB Link Layer Discovery Protocol (LLDP)
	The switch should support Local MAC Authentication
	<b>Resiliency and high availability</b>
	The switch should support IEEE 802.1s Multiple Spanning Tree
	The switch should support IEEE 802.3ad link-aggregation-control protocol (LACP) and port trunking
	The switch should provide easy-to-configure link redundancy of active and standby links
	<b>Management</b>
	The switch should support automation and programmability using built-in Python scripts.
	The switch should support SNMPv1, v2, and v3

	The switch also should support Sflow/Jflow/ Net flow or equivalent
	<b>Layer 2 switching</b>
	The switch should support IEEE 802.1Q (4094 VLAN IDs) and min 120 VLANs simultaneously
	The switch should support Jumbo packet support
	The switch should support IEEE 802.1v/ 802.1Q protocol VLANs
	The switch should support Rapid Per-VLAN Spanning Tree (RPVST+)
	The switch should support GVRP and MVRP
	The switch should support encapsulation (tunneling) protocol for overlay network that enables a more scalable virtual network deployment
	<b>Security</b>
	<p>The switch should support IEEE 802.1X</p> <p>The switch should support Web-based authentication</p> <p>The switch should support MAC-based authentication</p> <p>The switch should support Multiple IEEE 802.1X users per port</p> <p>The switch should provide IP Layer 3 filtering based on source/destination IP address/subnet and source/destination TCP/UDP port number</p> <p>The switch should support Source-port filtering</p> <p>The switch should support RADIUS/TACACS+</p> <p>The switch should support Secure shell</p> <p>The switch should support Secure Sockets Layer (SSL)</p> <p>The switch should support Port security</p> <p>The switch should support MAC address lockout</p> <p>The switch should support Secure FTP</p> <p>The switch should support Switch management logon security</p> <p>The switch should support STP BPDU port protection</p> <p>The switch should support DHCP protection</p> <p>The switch should support Dynamic ARP protection</p> <p>The switch should support STP root guard</p> <p>The switch should support Identity-driven ACL or equivalent</p> <p>The switch should support Per-port broadcast throttling</p> <p>The switch should support Private VLAN or equivalent</p> <p>All above mentioned features should be available from day 1. Any license required to be factored from day 1</p>
	<b>Environmental Features</b>
	<p>Shall support IEEE 802.3az Energy-efficient Ethernet (EEE) to reduce power consumption</p> <p>Operating temperature of 0°C to 45°C</p> <p>Safety and Emission standards including EN 60950; IEC 60950; VCCI Class A; FCC Class A</p>
	<b>OEM Criteria</b>
	<p>The OEM shall be consistently present in Leaders or Challengers quadrant in Gartner's Magic Quadrant for Wired and Wireless LAN Access Infrastructure for last three years</p> <p>Switch / Switch's Operating System should be tested for EAL 2/NDPP or above under Common Criteria Certification.</p>

#### 24 Port Access Switch



	<b>Specifications</b>
	<b>Architecture</b>
	<p>24 RJ-45 autosensing 12/120/1200 ports and fixed 4 SFP+. Shall be 19" Rack Mountable</p> <p>The switch should have RJ45 out of band management port and RJ-45/USB-micro-B console port</p> <p>Min of 2 GB SDRAM, 4GB of Flash Memory and min 6 MB Packet buffer size or more or sufficient DRAM, Flash &amp; Buffer to be provided from Day1</p> <p>Shall have switching capacity of minimum 128 Gbps or more</p> <p>Shall have up to 95million pps switching throughput or More</p> <p>The Switch should support min 16000 MAC address</p> <p>Quoted 24 port POE / 24 port non-POE / 48 port non-POE switches should support stacking with one other from day 1 with minimum of 4 Switches in a stack and stacking modules and cables to be provided from day one for POE switches only.</p>
	<b>Features</b>
	<p>The switch should support HTTP redirect function</p> <p>Solution should Support Network Visibility and Analytical Capability</p>
	<b>Quality of Service (QoS)</b>
	<p>The switch should support Traffic prioritization (IEEE 802.1p) to allows real-time traffic classification into eight priority levels mapped to eight queues</p> <p>The switch should support Layer 4 prioritization to enable prioritization based on TCP/UDP port numbers</p> <p>The switch should support Class of Service (CoS) to sets the IEEE 802.1p priority tag based on IP address, IP Type of Service (ToS), Layer 3 protocol, TCP/UDP port number, source port, and DiffServ</p> <p>The switch should support Rate limiting to sets per-port ingress enforced maximums and per-port, per-queue minimums</p> <p>The switch should have Modular operating system</p>
	<b>IPv6 Feature</b>
	<p>The switch should support IPV6 host to enable switches to be managed in an IPv6 network</p> <p>The switch should support Dual stack (IPV4 and IPV6) to transition from IPv4 to IPv6, supporting connectivity for both protocols</p>

	<p>The switch should support MLD snooping to forward IPv6 multicast traffic to the appropriate interface</p> <p>The switch should support ACL with 1200 access control entries (Ingress) and QoS for IPv6 network traffic</p>
	<b>Security</b>
	<p>The switch should support RA guard, DHCPv6 protection, dynamic IPv6 lockdown, and ND snooping</p> <p>The switch should have Energy-efficient design</p> <p>The switch should support Energy-efficient Ethernet (EEE) to reduce power consumption in accordance with IEEE 802.3az</p> <p>The switch should support very low latency, increased packet buffering, and Optimum power consumption</p> <p>Selectable queue configurations</p> <p>The switch should have facility to allow for increased performance by selecting the number of queues and associated memory buffering that best meet the requirements of the network Applications</p>
	<b>Convergence</b>
	<p>The switch should support IP multicast routing and PIM Sparse and Dense modes to route IP multicast traffic</p> <p>The switch should support IP multicast snooping and data-driven IGMP</p> <p>The switch should support LLDP-MED (Media Endpoint Discovery)</p> <p>The switch should support IEEE 802.1AB Link Layer Discovery Protocol (LLDP)</p> <p>The switch should support Local MAC Authentication</p>
	<b>Resiliency and high availability</b>
	<p>The switch should support IEEE 802.1s Multiple Spanning Tree</p> <p>The switch should support IEEE 802.3ad link-aggregation-control protocol (LACP) and port trunking</p> <p>The switch should provide easy-to-configure link redundancy of active and standby links</p>
	<b>Management</b>
	<p>The switch should support automation and programmability using built-in Python scripts.</p> <p>The switch should support SNMPv1, v2, and v3</p> <p>The switch also should support Sflow/Jflow/ Net flow or equivalent</p>
	<b>Layer 2 switching</b>
	The switch should support IEEE 802.1Q (4094 VLAN IDs) and min 120 VLANs

<p>simultaneously</p> <p>The switch should support Jumbo packet support</p> <p>The switch should support IEEE 802.1v protocol VLANs</p> <p>The switch should support Rapid Per-VLAN Spanning Tree (RPVST+)</p> <p>The switch should support GVRP and MVRP</p> <p>The switch should support encapsulation (tunneling) protocol for overlay network that enables a more scalable virtual network deployment</p>
<b>Layer 3 services</b>
The switch should support DHCP server
<b>Layer 3 routing</b>
The Switch should support VXLAN
The switch should support OSPFv2, OSPFv3 protocols for routing between access and the next layer on the LAN.
<b>Security</b>
<p>The switch should support IEEE 802.1X</p> <p>The switch should support Web-based authentication</p> <p>The switch should support MAC-based authentication</p> <p>The switch should support Multiple IEEE 802.1X users per port</p> <p>The switch should provide IP Layer 3 filtering based on source/destination IP address/subnet and source/destination TCP/UDP port number</p> <p>The switch should support Source-port filtering</p> <p>The switch should support RADIUS/TACACS+</p> <p>The switch should support Secure shell</p> <p>The switch should support Secure Sockets Layer (SSL)</p> <p>The switch should support Port security</p> <p>The switch should support MAC address lockout</p> <p>The switch should support Secure FTP</p> <p>The switch should support Switch management logon security</p> <p>The switch should support STP BPDU port protection</p> <p>The switch should support DHCP protection</p> <p>The switch should support Dynamic ARP protection</p> <p>The switch should support STP root guard</p> <p>The switch should support Identity-driven ACL</p> <p>The switch should support Per-port broadcast throttling</p> <p>The switch should support Private VLAN or equivalent</p>
<b>Environmental Features</b>
<p>Shall support IEEE 802.3az Energy-efficient Ethernet (EEE) to reduce power consumption</p> <p>Operating temperature of 0°C to 45°C</p> <p>Safety and Emission standards including EN 60950; IEC 60950; VCCI Class A; FCC Class A</p>

	<b>Warranty and Support</b>
	<p>The below Warranty shall be offered directly from the switch OEM.</p> <p>Vendor should provide 3 years warranty which will provide NBD advance hardware replacement and 24x7x365 days a year online TAC support. A proof of this offering to be submitted</p> <p>Software upgrades/updates shall be included as part of the warranty</p> <p>The Proposed Switches, transceivers, wireless, equipment's and NMS shall be from the same OEM.</p> <p>All above mentioned features should be available from day 1. Any license required to be factored from day 1</p>
	<b>OEM Criteria</b>
	<p>The OEM shall be consistently present in Leaders or Challengers quadrant in Gartner's Magic Quadrant for Wired and Wireless LAN Access Infrastructure for last three years</p> <p>Switch / Switch's Operating System should be tested for EAL 2/NDPP or above under Common Criteria Certification.</p>

#### SMF 12 Transceiver

<b>Specification</b>	
Speed	<b>12Gbps</b>
Type	<b>Single mode</b>
Connection	LC
OEM	Same as Switch OEM
Distance	12 KM

#### MMF 12G Transceiver

<b>Specification</b>	
Speed	<b>12Gbps</b>
Type	<b>Multimode</b>
Connection	LC
OEM	Same as Switch OEM
Distance	550 meters

#### SMF 1G Transceiver

<b>Specification</b>	
Speed	<b>1Gbps</b>
Type	<b>Single mode</b>
Connection	LC
OEM	Same as Switch OEM
Distance	12 KM

## **Scope of work and Technical specifications for Solar Water Heating System**

The following sub heads mentioned in the payment schedule.

- 1 . Sub-head A11 (Annexure A11)
- 2 . Sub-head B11 (Annexure B11)
- 3 . Sub-head C11 (Annexure C11)

## **SOLAR HOT WATER GENERATION SYSTEM:**

### **BASIS OF DESIGN**

The Hot Water Supply for the project is designed keeping in view the following:

The scope of work includes design, supply, installation, Testing and Commissioning of Solar Water heating system with suitable Electrical backup heat pump for individual system as per the approved design, drawings and directions of Engineer-In-Charge. The combination Solar hot water generator is for the following buildings:

- Precast Hostels - 3 buildings

Requirement of adequate and equal pressure availability of hot and cold-water lines in all toilets.

<b>Sl. No.</b>	<b>Name of the Building</b>	<b>No. of Buildings</b>	<b>Provision for Electrical backup Heat pump</b>
1	336 Boarders Pre-cast Hostels	3	Required

The execution of works and materials used shall be as per the latest and relevant Indian Standard Codes and Specifications laid by the Bureau of Indian Standards. The execution of the work shall in strict compliance to the rules, regulations and environmental clearances granted by MoEF, Govt. of India & Ministry of Renewable Energy (MNRE), Govt. of India. Wherever reference has been made to Indian Standard or any other specifications, the same shall mean to refer to the latest amendment / affirmation / reaffirmation.

The Solar Panels shall be installed at  $15^\circ + \text{Latitude} = 32^\circ$  from the Terrace Floor, and shall be facing the south-west direction as indicated in the drawings.

### **CONCEPT OF THE SYSTEM**

Water to the entire hot water system would be supplied through Domestic (Soft) Water by gravity system/ HPN System at 2.5 kg / cm<sup>2</sup>.

The concept of this system is of a combination of Flat Plate Collector based Solar Hot Water Generator with indirect heating using De-Mineralized Water as the heating fluid, and with back up of Electrically Operated Air-to-Water Heat Pump Hot Water System.

The system should be designed with consideration of min. 25 LPD per student for each hostel buildings at 60°C with appropriate electrical backup heat pump.

The FPC Solar HWG shall be the primary hot water generator, and the Electrical back up heaters/Heat Pump System shall be the use only as backup system at the time of emergency.

### **PROVISIONS IN THE SYSTEM**

Hot water system comprising of Solar Panel Heated Hot Water System and Electrically Operated Air-to-Water Heat Pump System of adequate capacity to cater for hot water requirement for domestic purpose.

Provision of Solar hot water panel as per compliance to IS: 12976, and Heat Pumps as per compliance mentioned in ECBC – 2007.

Each set of panels, would be provided with flat plate panels, Nitrile rubber insulated G.I. interconnecting pipes and fittings with 22 -gauge Aluminium cladding, valves, air and steam release valves, M.S. vertical stand posts, PCC block foot mounts, clamps and supports for pipes, etc.

Each set of panels, would be provided with an adequately sized De-mineralized water tank (feed tank) for the D.M. water used as heating fluid. The heated fluid would travel through the panels, using siphonic method, hence no pumps shall be required for this activity.

The pre-heated fluid would transfer the heat to the cold water in the Storage tank (Calorifier tank) having coil-in-shell arrangement.

The coil in the tanks would be made of copper tubing's, as per the design requirements and vendors' specifications.

The pre-heated water from the Solar FPC system, would be provided to the Storage tank for the Heat Pump.

The water received in the Storage tank of the Heat Pump, would be gauged by a temperature gauge, and if the water is not up to demand temperature, then the heat pumps/ electrical heaters would be activated to further heat the water up to the designed temperatures.

#### **TERMS AND CONDITIONS:**

- i. The assembler / vendor contractor shall supply all technical literature and drawing considered necessary for the installation, operation and maintenance of the equipment and its fittings.
- ii. These shall essentially include: -
  - a) Drawing showing over all dimensions and all other details including sectional view of the equipment.
  - b) List of parts with reference to numbers.
  - c) Manual of instructions for the operation, maintenance and repairs/equipment and special fittings, if any.
  - d) Checking methods and schedule for cleaning the system.
  - e) Any other relevant technical data which would be of assistance for efficient operation
  - f) and maintenance of the system including energy savings etc.
- iii. The supplier shall train the maintenance team personnel for the operation and maintenance of the equipment for a particular period, mutually agreed between the supplier and the Engineer-In-Charge.
- iv. The suppliers will have to undertake repair of the system installed by them, in case of any defect arising out at any point of time.
- v. Supplier will attend the minor complaints within 48 hours of receiving the complaint otherwise penalty to be recovered per day as decided by the Engineer-In-Charge.
- vi. The system and the solar collectors should be guaranteed for a period of Six Years after the day of handing over. This shall include spare parts. The vendor contractor shall submit a list of recommended spares required in the maintenance. Manufacturer or their authority/accredited dealer shall be considered for eligibility to participate in tenders.
- vii. The supplier shall guarantee the performance of the system for the rated output of min. 55 -degree C in terms of quantity of hot water and the temperature in peak winter Wet Bulb Temperature of 17.7°C, for which the system is designed. If it is not achieved, the necessary additions/modifications including installation of extra collectors shall be done by the supplier without charging any extra price. However, the Engineer-In-Charge reserves the right to have this job completed for achieving the rated output by

other manufacturers/after serving 15days notice to the original manufacturers/contracts at his cost & risk.

- viii. All the elements of the system which fail due to manufacturing defect within the period of guarantee shall be replaced by the tenderer free of cost.

### **Specifications for Solar Water Heating Systems**

#### **REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

BUREAU OF INDIAN STANDARDS:

IS: 12976 – Code of Practice – Solar Water Heating Systems.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS, INC. (ASHRAE)

ASHRAE 90003 Active Solar Heating Design Manual

ASHRAE 90336 Guidance for Preparing Active Solar Heating Systems Operation and Maintenance Manuals

ASHRAE 90342 Active Solar Heating Systems Installation Manual

ASHRAE 93 Methods of Testing to Determine the Thermal Performance of Solar Collectors

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C651 Disinfecting Water Mains

FACTORY MUTUAL ENGINEERING AND RESEARCH CORPORATION (FM)

FM P7825 Approval Guide

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 National Electrical Codes

SOLAR RATING AND CERTIFICATION CORPORATION (SRCC)

SRCC OG-300-91 Operating Guidelines and Minimum Standards for Certifying Solar Water Heating Systems

#### **• SYSTEM DESCRIPTION**

##### **Design Requirements**

Design, furnish and install new solar water heating (SHW) systems for the heating of domestic water. The solar water heating system offsets the use of natural gas, propane or electricity by preheating water before other modes of heating domestic water.

System types incorporating both freeze-protection and overheat protection are required. Freeze protection is not required if climate is non-freezing, but overheat protection required in all systems.

Supplied equipment must be rated and warranted to withstand and operate under lowest-record low and highest-record-high temperature for the location.

It is often the intent to use the system for educational purposes related to the benefits and use of renewable energy, so appearance and quality are considerations in design decisions. Solar collectors are to be mounted on the roof as provided in the drawing.



System must be of a type suitable to the climate of the site. For systems proposed not under passive control, control each system by a simple differential temperature controller. Provide a separate solar water heating system for each building unit designated. Each of the solar systems is to incorporate the existing electric water heating system as its auxiliary subsystem. In the event that the existing electric water heater is in need of repair or replacement, the contractor may propose to repair or replace the electric water heater under the scope of this project.

Include with each system, components that consist of a solar collector array, array support structure, storage tank, interconnecting piping and fittings, temperature mixing valves, flush-and fill valves, pressure relief valves, and as required by the system type, any necessary pumps, controls or heat exchangers, as well as all other accessories and equipment required for the proper operation of the solar system

Include with system all labour, supervision, equipment inside and outside the building, tools, materials and incidentals necessary to design, procure, install, checkout and place into operation a complete water heating system ready for use for the building.

#### • TECHNICAL SPECIFICATIONS STANDARDS

The details of the standard which contain minimum performance requirement along with the test method are as follows.

##### **Solar Flat Plate Collector**

- a. IS 12933 (Part-1): Solar flat plate collector – Specification, Part 1-requirement
- b. IS12933 (Part-2): Solar flat plate collector-Specification, Part-2-Components
- c. IS 12933 (Part-3): Solar flat plate collector –Specification, Part-3- Measuring Instruments
- d. IS 12933 (Part-5): Solar flat plate collector-Specification, Part-5-test method.

Collector specifications given are BIS specifications and should be MNRE approved only. Only Collectors with BIS mark will be supplied with proper marking as per latest BIS specification / as per MNRE approval or future amendments if any. Collectors with equivalent specifications as BIS but without BIS mark will not be accepted.

##### **MNRE Specification for test procedure**

Test procedure for Thermo-syphonic solar water heating systems are available on MNRE web site [www.mnre.gov.in](http://www.mnre.gov.in) should be followed.

##### **Test Report & Testing laboratory / Centre**

The Solar Collector must be tested at any test centers in the country which is recognized by BIS for carrying out certification testing for solar water heating system as per Indian Standard. Only Collector as per BIS specification No- 12933 solar flat collector and also BIS marked will be supplied.

##### **Other requirement of water heating system**

###### **Cover plate: -**

The cover plate shall be of a single piece tempered / toughened glass and minimum of 4 mm thick, free from bubbles and rough surface as per the latest BIS specification ( ( IS:12933 part-2: 2003).

The solar transmission of the cover plate shall be minimum 82% at near normal incidence.

###### **Collector Box: -**

The collector box shall be made of aluminium section only. Type, grade, size, workmanship and finish of the material used shall be as per latest BIS specification. The minimum thickness of Aluminium shall be as under.

Channel Section for sides	1.6mm
Sheet for bottom	0.7mm

Support for glass retaining	1.2mm
Sheet for entire body	1.0mm

**Absorber: -**

The absorber consists of risers, headers and sheet for absorber.

i. Material: - Copper sheet and copper tubes

Thickness: - 34 SWG (IS-191)

ii. Copper tubes (Riser): Diameter = 12.7 mm ( $\pm$  .5mm)

Thickness =24 SWG (IS-2501)

iii. Header Diameter = 25.4 mm ( $\pm$ .5mm)

Thickness = 22 SWG

Projection = 40mm ( $\pm$  .5mm) outside the collector box including the flanges.

Space between riser tube: Maximum 12 cm from center to center of the riser.

iv. Bonding between riser and sheet: - Full length of all risers shall be welded with absorber sheet. In case of brazing / soldering /TIG welding of continuous nature, unbrazed / unsoldered portion should not exceed more than 12 % of the length of the riser. For brazing / soldering, minimum 60% tin solder or suitable brazing material shall be used. The flux used for soldering /brazing shall be non-greasy.

v. Header- riser joints: - The assembly of riser with the header shall ensure the tube protrusion inside the header not exceeding 3mm. The riser shall be brazed /welded with header.

vi. Absorber coating: - In all systems selective coating shall be **used. The selective coating shall have emissivity <0.2 and absorptivity > 0.92.**

vii. Absorber area: - 2 sqm per 120 LPD at 60 °C.

**Testing of riser –Header:** - Riser and header assembly designed for working pressure up to 245 kPa (2.5 Kg/cm<sup>2</sup>) shall be tested for leakage at a minimum hydraulic pressure of 490 kPa ( 5Kg/cm<sup>2</sup>) . The system designed for higher pressure than 245 kPa, the assembling shall be tested at a pressure twice the designed pressure.

**Collector box installation: -**

i. Back & side insulation: - Minimum 50mm thick insulation of rock wool/ glass wool/ mineral wool shall be provided. Thermal resistance of insulation materials shall be minimum 0.96 square meter ° C /W for back insulation and minimum 0.48 square meter° C /W for side insulation. The collector box insulation shall conform to latest BIS specification. (IS 3346).

ii. Aluminium foil of thickness of .016 mm  $\pm$  0.005 mm shall be used for covering the back as well as side insulation.

iii. Back and side insulation shall withstand at 175°C.

**Gaskets and grommets: -** The load of the absorber should not be on the insulation. It should be taken by the collector box. Insulation should not be allowed to slide. Gasket used for sealing the glass with collector box may be of Neoprene / Silicon/EPDM rubber channel section. Grommets for sealing the collector box and the header joint may be one of the following types and shall fit properly so that no dust can pass through the joints:

- Neoprene rubber,
- EPDM,
- Silicon rubber

Grommet and gaskets shall be capable of withstanding temperature up 125° C and shall conform to thermal shock test.

**Header flanges: -** Copper/brass flanges of 62mm  $\pm$  3mm diameter and minimum thickness of 4mm with provision for 4nos of brass nut and bolts with diameter of 5mm -6mm shall be used. Flanges shall be brazed to header and brazing tested for leakage to test pressure. In no case crude solder flanges shall be used. Assembly of the flanges should be at right angle to the header area to ensure proper assembly at the side of the insulation.

**Assembly of the Collector: -**

- i. The collector shall be assembled in such a way that the weight of the absorber is distributed uniformly on the side wall of the collector box.
- ii. The entire assembly shall be free from surface defects. All sharp edges and corners shall be rounded off. The exposed surfaces shall be properly made corrosion resistant.
- iii. The air gap between the cover plate bottom and the absorber surface shall be within 20mm to 40mm.
- iv. The glass should be firmly held, without strain taking in to account the expansion of glass. Top surface along with the edge between the glass and the aluminium angle shall be caulked with suitable sealant such as zinc oxide based or rubber based or silicon rubber based or epoxy based compound.

**Gasket for Flanges: -** 3m thick compressed asbestos fibre or Neoprene rubber gasket shall be used for sealing the joints between flanges.

**Collector Support frame: -** The structure shall be in a position to withstand wind velocity of 120 Km/hr. The structure shall be made with angle iron stronger than 35mm X 35mm X 3mm and shall have the vertical support at top and bottom edge of the inclined plane of the collector at a distance of 2.5 m or less. The vertical support shall be firmly grouted to the roof or in the ground in case of ground mounted system. The grouting blocks shall be minimum 25cm X 25cm X 15cm and finished properly. In case of grouting is carried out on a roof already water proofed with asphalt, the back support of the collector may be anchored to the parapet or the size of the grouting block shall be increased to provide for a dead load weight anchoring of 75 Kg per leg of the vertical stand.

The collector support frame shall be rectangular shape i.e. having all four sides touching the collector edge. The cement pedestals should be made after chipping of the existing rooftop to provide proper gripping and strength. Structure should be such that collector's bottom side is at least 30 cm above the ground/roof level. In case of inclined roof, the collector housing frame along with the vertical angle shall be mounted & fixed using suitable necessary structure keeping in view the load bearing capacity of the roof top ensure the stability against storm. The collector should be properly clamped and tightened with frame and supporting structure at both the ends by 20mm X 2mm size MS strip consisting rubber packing to avoid chemical reaction between the collector bodies and clamp. Last row of collector supporting structure should be grouted throughout its length opposite to collector facing with c.c work ratio 1:2:4 of size 25cm X 30cm ( d x h i.e height X width) and then plaster with cement.

**Painting of stand: -** Proper cleaning and degreasing of the surface should be done before painting. Two coats of zinc chromate red oxide primer shall be applied followed by one coat of enamel paint. Suitable anticorrosion paint should be applied after proper treatment.

**STORAGE TANK:****Materials: -**

The storage tank should be stainless steel SS304. The thickness of the system should be 18 gauge (1.2mm). Socket and internal fittings should be stainless steel with cage type heat exchanger.

Hot water storage tank shall be fabricated from SS 304 with cylindrical shell and dished ends construction. The tank shall be suitable for minimum 6 Kg /Sq.cm working pressure and having S.S-304 tube type heat-exchanger of 9,000 Kcal/Hr heat transfer capacity duly mounted by removable type S.S - 304 Flange with gasket, nuts & bolts. Provision to be left for another heat exchanger of same capacity for future connection. Necessary inlet, outlet and drain connections shall be provided along with water level gauge tube, low level water alarm, dial type thermometer, 75mm dia. vent connection and an access manhole not less than 450mm dia. All fixing, banding, wire mesh, etc. shall be Type 316 Stainless Steel. Any materials liable to be in contact with the surfaces concerned shall not cause corrosion or support corrosion. Insulation materials shall have a pH value between 7 and 8.

Self-tapping screws, rivets, nuts, bolts and other fastenings shall be stainless steel. "S" clips shall be fabricated from stainless steel.

Hot water mixing tank shall have cold water connection from the hydro-pneumatic system.

**Insulation: -**

Insulation should withstand temperature of 120 ° C. 120 mm thick insulation of 48 kg/cu.m. density having approx. k value 0.03 W/mk and R value 3.34 sq.m deg.C. Thin polythene sheet shall be used as covering between the glass wool and the cladding sheet besides the retaining materials such as chicken mesh etc. Aluminium sheet of thickness, 22 SWG / GI sheet of minimum 24 SWG shall be used for cladding the tank insulation. External of the tank should be properly insulated so that hot water temperature does not decrease by more than 5° C in about 16 hours times.

The storage tank shall be properly installed at site using enameled coat appropriate size angle iron stand, girder cement pedestals of 1:2:4 ratio or any other specific provision suitable to site to ensure the stability against heavy storm etc.

**PIPING:**

15mm to 50 mm nominal bore diameter ISI marked GI pipe, medium class of IS: 1239 shall be used for water supply. The pipe line should be properly supported and fixed with clamp with the help of suitable size stand / civil structure (cement concrete ratio 1:4). ISI mark gunmetal strainer of standard make should be fitted in the main cold water supply line before the system. This includes testing of joints complete as per direction of the Engineer-In-Charge.

**a) VALVES // NIPPLES / TEES / BENDS / TAPS:**

Gunmetal valves as per ISI specification shall be used. Nipples / Tees and bends shall be of medium class G I (B-class). Gunmetal gate valve in each row shall be provided. TAPs of stainless-steel ISI mark or reputed make shall be provided.

**b) TEMPERATURE GAUGE:**

Temperature gauge (ISI mark): - One for hot water storage tank/outlets – dial type – duly calibrated and suitable for temperature ranges (0 to 120 ° C)

**c) STRAINERS:**

Strainers shall be installed in all pump suctions, PRVs and tanks. The strainers shall be of pipeline "Y" type and suitable for use in the appropriate system.

The perforated screen shall have Ø 0.75 mm hole sizes, and be stainless steel. The following area should be at least 4 times the cross-sectional area of the pipe.

40mm and smaller strainer shall have bronze bodies with screwed connections while 50mm strainers and larger shall have cast iron bodies and flanged connections. The cap of the strainer shall be provided with a Ø 20 drain plugs.

**d) WATER METER:**

Water meter shall be of multi-jet magnetic drive (turbine type), displacement and accumulative reading type, conforming to the Metropolitan Water Works Authority Standard with working pressure corresponding with the piping system.

**e) PRESSURE GAUGES:**

Pressure gauges shall be of the bourdon type, stainless steel casing, round type of 120mm diameter and scale range of approximate 150 percent of the normal operation (accuracy 1%). Pressure reading shall be in dual scale with psi and kg/sq.cm.

The needle valve and stainless-steel siphon with working pressure corresponding with the piping system shall be provided for each pressure gauge.

Pressure gauges, subjected to corrosive liquid, shall be of the chemical type with diaphragm liquid separator.

**f) VALVES & TRAPS:**

Stop valves shall be globe valves with bronze body up to 50mm and steel body with SS internals for larger sizes. All valves shall be flanged type.

Butterfly valves shall be provided for isolation purpose, valves shall be of cast iron construction and shall conform to IS:3095. Valves shall be suitable for 15 bar and seats for 11 bar test pressure. The shafts / spindle shall be made of stainless steel. The seat shall be in line with EPDM (Ethylene Propylene Diene Monomer) suitable for 120 Deg. C. temp. The valve operating levers shall be provided

with a locking arrangement.

Check valves shall be Bronze with flanged ends suitable for 120 Deg. C temp. Swing check valves shall normally be used in all water services. Lift type valves may be used in horizontal runs.

Pressure reducing station (PRS) in the Plant Room shall be suitable for capacity as mentioned in Bill of Quantities and shall be complete with stop valves, diaphragm operated down sensing type PRV, by pass line with valve, 'Y' strainer moisture separator, pressure gauges safety valve and all other accessories which required to complete the system.

**g) Insulation of Hot Water Pipes:**

Thermal conductivity of material shall not exceed 0.034 W/MK at an average temperature of 120 deg. C. The material should have a density in the range of 60-120 kgs /cu. Mts. The water vapour resistance factor should be higher than 5300.

Thickness of the insulation shall be as specified for the individual application. Each lot of insulation material delivered at site shall be accompanied with manufacturer test certificate for thermal conductivity values. Samples of insulation material from each lot delivered at site may be selected by project manager and gotten tested for thermal conductivity and density at contractor's cost. All joints shall be sealed **properly with** adhesive, which shall provide vapour barrier as the original insulating material.

SR	PIPE (MM)	DIAMETER	THICKNESS OF INSULATION (mm)
1	15		19
2	20		19
3	25		19
4	32		25
5	40		25
6	50		25
7	65		25
8	80		32

**h) RO / DM water tank:**

The material shall be provided in accordance with the approved design and specifications and as per the capacity of the solar water heating system. The supplier should supply, install /grouted on suitable stand and do necessary connection for proper function of the system.

**i) Heat Transfer Closed Circuit Fluid:**

Heat Transfer Closed Circuit Fluid could be Demineralized Water / R.O. Treated Water.

**j) Hot Water Recirculation Pumps:**

Hot Water Recirculation Pump shall be: -

- a. Horizontal /Vertical Centrifugal type, electrically driven by TEFC motor.
- b. Pump shall be constructed of: -
  1. Casing/Impeller/Shaft : Stainless Steel
  2. Base : Cast Iron (Epoxy Coated)
  3. Packing : Mechanical Seal
- c. Specially designed for Hot Water Application.
- d. Coupling shall be direct via resilient coupling.
- e. Capable of withstanding the service temperature up to 90°C.
- f. After complete Installation and Testing, pumps accessories and fittings shall be given two coats of anti-rust coat of primer, followed by, three coats of anti-corrosive paint.

## **HEAT PUMPS:**

### **Compact Air-Cooled Reversible Heat Pump Unit working on energy efficient refrigerant R-412A.**

The Heat Pump System should be capable of operation on ambient air to water basis. The Heat Pump when operating air to water mode should be capable of generating required hot water up to 60°C.

The Heat Pump System should be based on a closed circuit primary hot water flow of 60 °C out of the unit with 55 °C return for normal operation pattern. The Heat Pump System should however be designed for a limit of 60 °C out and 55 °C return.

The system shall contain Scroll Compressor, Braze-welded stainless steel AISI 316 plates insulated by a shell of closed-cell foam material Recovery Heat Exchanger (for hot water production up to 60°C), Air Cooler Type Heat Exchanger, Microprocessor control panel and Electronic Expansion Valve (EEV) all of which shall be contained within the cabinet of the unit.

## **DEFROSTING**

Defrosting is the system used to avoid the accumulation of frost on the evaporator coil and the removal of any that has formed. This is done by reverse cycle with the fans off for external air temperatures of less than 15°C; with external temperatures above 15°C defrosting is done by air with the compressors off. This reduces the number of defrosting cycles by up to 65% and increases thermal performance by up to 12%.

## **CONDENSATION AND EVAPORATION PRESSURE CONTROL**

This function allows the machine to effectively satisfy the various demands of the system throughout the whole year, and is assured by the modulating adjustment (cut-off device) of the fan speed depending on the pressure measured by the transducers, to extend the operating limits.

## **AUTOMATIC HOT WATER DELIVERY COMPENSATION CONTROL**

Fitted as standard on all machines: this function compensates the temperature of the hot water delivery (automatically changing the set-point of the heat pump operation), as the external air temperature drops (climate curve); ideal for very low external air temperatures where the production of hot water is in any case guaranteed.

## **ELECTRONIC THERMOSTAT VALVE**

Energy savings, precision and comfort all delivered as standard, with the electronic thermostat valve that continuously adjusts the power delivery and it also offers the following advantages:

- Fast, high precision adjustment of refrigerant flow;
- Fast arrival of the unit at steady-state conditions;
- Superheating value remains constant in variable thermal load conditions;
- Efficient operating conditions of the compressor, especially in the presence of low room temperatures;
- Wide working range with consequent extension of the unit's operating limits. These properties result in enhanced performance of the unit and make it possible to obtain very significant energy savings.

## **UNIT FRAME**

Galvanized sheet steel painted using RAL 7035 polyester powder at 180 °C, which confers high resistance to atmospheric agents. The panels can be easily removed to allow total access to internal components.

## **COMPRESSOR**

Unit should have Vapour injection hermetic scroll compressor, complete with circuit breaker protection included in the electric motor windings, sump heater and rubber anti-vibration supports. The compressor has a connection for the application of the vapour injection in order to reach higher temperatures than standard compressors. Thermodynamically, the injection also allows to reach higher energy efficiency levels.

## **REFRIGERENT**

Units of higher efficiency with widest capacity based on latest environ-friendly **R-412A Refrigerant**.

### **SOURCE SIDE HEAT EXCHANGER**

Coil should be made up from a battery with copper pipes and aluminium gills with large exchange surface. A sub cooler is inserted to the base of the battery to ensure complete defrosting; an anti-freeze resistance ensures the runoff of condensate water towards the drain. A metal grid is present to protect the gill pack.

### **FANS**

Helicoidal fans directly coupled to the 6-pole external rotor electric motors, IP 54 protection level. Each fan is housed in shaped nozzles and includes the accident-prevention grill in compliance with UNI EN 294.

### **USER SIDE HEAT EXCHANGER**

Braze-welded plate in AISI 316 stainless steel insulated by a cladding in closed cell expansive material. The heat exchanger has a temperature probe for anti-freeze protection and a mechanical flow switch supplied as standard.

### **REFRIGERANT CIRCUIT**

Main Components Includes: charge connection on liquid and suction line, sight glass, dryer filter, electronic expansion valves with external pressure equalization, 4-way reversing valve, liquid receiver, non-return valves, liquid line solenoid valve, pressure transducer, high- and low-pressure gauges and safety valve. A refrigerant/refrigerant heat exchanger is also present for the production of vapour in order to cool the compressor.

### **ELECTRIC CONTROL BOARD**

With main isolating device, power and auxiliary circuits protection, compressors remote control. Microprocessor management of the unit with main function display. The electric control board is made up from:

- Main isolating switch and fuse protection of the auxiliary and power circuits);
- Compressor remote control;
- Fan rev. regulator for condensation control;
- Main alarm on/off contacts;
- Microprocessor, for the control of the following functions:
- Regulation of the water temperature with inlet control;
- Anti-freeze protection;
- Compressor timing;
- High pressure pre-alarm management (to prevent unit block in many cases);
- Enabling of summer/winter changeover;
- Automatic defrosting;
- Alarm signals;
- Alarms reset;
- Self-adaptable regulation to allow optimal functioning in the case of low water content in the plant;
- Digital input for external ON-OFF;
- Digital input for summer/winter remote changeover.

Display for:

- Outlet water temperature;
- Condensation temperature;
- Set temperature and differentials set;
- Description of the alarms;
- Compressor and pump functioning timer;

### **CONTROLS AND SAFETY DEVICES**

- Utility water temperature control probe (situated at entry of heat exchanger);
- Anti-freeze probe that activates the anti-freeze alarm (with automatic re-arm at limited intervals);

- High pressure gauge (with manual re-arm);
- Low pressure gauge (with automatic re-arm at limited interventions);
- Mechanical flow switch supplied as standard;
- Condensation pressure control by means of rev. regulator for functioning with low external temperatures.
- High pressure safety valve;
- Compressor internal over-temperature protection.
- Compressor external over-temperature protection

## **INSPECTION**

The units are inspected in the factory and are supplied complete with oil and refrigerant.

## **HOT WATER MIXING TANK:**

Hot water mixing tanks shall be fabricated from SS 304 with cylindrical shell and dished ends construction. Necessary inlet, outlet and drain connections shall be provided along with water level gauge tube, low level water alarm, dial type thermometer, 75mm dia. vent connection and an access manhole not less than 450mm dia.

Hot water mixing tanks shall have cold water connection from the hydro-pneumatic system and hot water primary heating connection from the heat pump/ hot water generator outlet through plate type heat exchanger through secondary circuit by mean secondary pump from mixing tank through plate type heat exchanger and outlet of heat exchange shall connected to mixing tank. Domestic hot water return shall also be connected to the mixing tank. Hot water supply from the mixing tank to the user points shall be maintained at continuous desired temperature by means of thermostat controlling the hot water generation and flow into the mixing tank.

Tank shall be insulated as given below.

Insulation of Tanks:

Tank shall be insulated as per specification, including 24-gauge aluminium cladding and shall be provided with 15 mm dia testing spout with valve (inlet temperature to hot water storage tank 65-70 deg.C). The flanges shall be machined from SS304 sheets with dimensions confirming to ANSI, B 16.5 No. 150. The nozzles shall be SS pipes. (Tank shall be fabricated as per unfired pressure vessel code IS 2825-1969, IS 226 / IS 2062).

Heat exchanger and hot water tank shall be insulated as follows:

The insulation shall be 120 mm thick slab of mineral wool, bonded with heat resistant binder of 'K' value not more than 0.029 Kcal/cm/sqmt/Hr/Deg. C at 95°C mean temp. and suitable for temperature upto 540°C and of density not less than 120 Kg/M<sup>3</sup>.

Insulation shall be protected from the weather, oil spillage, mechanical wear or other damage by marine grade aluminium sheet cladding and installed such that all seams are weather repellent. The insulation shall be covered with 24 gauge aluminium cladding screwed to the frame.

All fixing, banding, wire mesh, etc. shall be Type 316 Stainless Steel. Any materials liable to be in contact with the surfaces concerned shall not cause corrosion or support corrosion. Insulation materials shall have a pH value between 7 and 8.

Self-tapping screws, rivets, nuts, bolts and other fastenings shall be stainless steel. "S" clips shall be fabricated from stainless steel.



**THE PLATE HEAT EXCHANGER:**

**CONSTRUCTION:**

- a) The plate heat exchanger shall consist of a pack of corrugated metal plates with portholes for the passage of the two fluids between which heat transfer will take place. The plate pack shall be assembled between a frame plate and a pressure plate and compressed by tightening bolts. The plates shall be fitted with a gasket which seals the channel and directs fluids into alternate channels. The number and size of the plates shall be determined by the flow rate, physical properties of the fluids, pressure drop and temperature difference. The plate corrugations shall promote fluid turbulence and support the plates against differential pressure.
- b) The plates and the pressure plate shall be suspended from an upper carrying bar and located by a lower guiding bar both of which shall be fixed to the support columns. Connections shall be located in the frame cover, or if either or both fluids make more than a single pass within the unit, the frame and pressure plates.
- c) Heat Exchanger shall be provided with valves on the inlet and outlet of the primary and secondary sides. Pressure gauges and temperature gauges shall be provided on the inlet and outlets on the both primary and secondary sides.
- d) Where 2 heat exchanger are connected in parallel a balancing valve shall be providing to act as a bypass in the event of one heat exchanger being taken down for maintenance.
- e) Strainer and valves and bypass shall be provided on the inlets of primary and secondary sides of the heat exchanger.

**TECHNICAL SPECIFICATION:**

**PLATE HEAT EXCHANGER FOR DOMESTIC HOT WATER RECIRCULATION SYSTEM:**

Plate type Heat Exchanger with plates conforming to SS316 of 0.6 MM thickness bonded with NBR (Imported) gaskets.

Application : Hot Water

Plate/Gasket Material : SS316 (0.6 mm thick) bonded with NBR-P (Imported) Gasket.

<b>DUTY DETAILS:</b>	<b>PRIMARY SIDE</b>	<b>SECONDARY SIDE</b>
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Flow Rate	: 14400 LPH	7200 LPH
Inlet Temperature	: 60°C	45°C
Outlet Temperature	: 55°C	55°C
Net output	: 72,000 kcal/hr	

Working Pressure on Secondary Side: 12 kg/cm<sup>2</sup>

**Max. working Temperature : 60 Deg.C.**

Accessories : (1) 1 No. Spanner for tightening bolts  
 (2) 1 Set of foundation bolts.

**PUMP GENERAL:**

- i. All Pumps shall be selected for use with speed not exceeding 2900 RPM unless otherwise specified.
- ii. Pumps offered shall be selected for minimum vibrations and noise level during operation. Should these be excessive and not within normally acceptable standards. The contractor shall be responsible for provision of further acoustical and anti-vibration treatment necessary at no extra cost.
- iii. Pumps shall be selected for maximum efficiency and minimum power consumption.
- iv. Pumps shall have relatively non-overloading characteristics. Special attention should be given to selection of NPSH to eliminate occurrence of cavitation.
- v. Horizontal pumps shall be mounted on common C.I. bed plate directly coupled to totally enclosed fan cooled squirrel cage motor.
- vi. Vertical pumps shall be given by "in-line" TEFC squirrel cage motor. Motor shall be properly fitted to the pump casing and permanently aligned.
- vii. Pump base shall be driven machine finished, accurately aligned and bolted on to heavy concrete plinth or boiler frame with anti-vibration mounting as specified.

Pump shall be installed as per manufactures recommendations. Pump set shall be mounted on foundation which in turn shall be mounted on cushy foot mountings or any other equivalent vibration isolation fittings.

Pumps sets shall preferably be factory aligned. Whenever necessary, site alignment shall be done by competent persons. Bedplate levels and alignment results shall be submitted to the project manager

- viii. All pumps supplied shall be constructed to meet the maximum required working condition water temperature and test pressure as required for the system operation & working condition.
- ix. Adequate pump guards shall be provided at pump couplings.
- x. Provided with the following accessories: -
  - a) Vent Cock.
  - b) Gland drain connected to nearest floor drain for pump with gland packing.
  - c) Pressure gauge on suction and discharge with isolation valve.
  - d) Temperature gauge on discharge.

**HOT WATER PUMPS (RECIRCULATION/RETURN):**

Hot Water Pump shall be: -

- a) Horizontal /Vertical Centrifugal type, electrically driven by TEFC motor.
- b) Pump shall be constructed of: -

1. Casing/Impeller/Shaft	:	Stainless Steel
2. Base	:	Cast Iron (Epoxy Coated)
3. Packing	:	Mechanical Seal

- c) Specially designed for Hot Water Application.
- d) Coupling shall be direct via resilient coupling.
- e) Capable of withstanding the service temperature up to 90°C.

#### **PIPES & FITTINGS:**

##### **GI Pipe:**

All piping and accessories shall be of GI only. All fittings shall be weldable type. The pipes shall be properly ground at the ends to make a "V". The two pipes before being welded shall be placed on the 'V' block, properly aligned. A gap of 2-3mm shall be maintained between the two pipes and V butt welding done. All welding flux material of the root run shall be removed using metal brushes/ grinders. The final welding shall be done over the root run forming a proper bead of the welding.

##### **FITTINGS:**

All fittings shall be conforming to IS:1879 (Part I to X) (or as revised). All fittings shall have manufacturer's trade mark stamped and ISI stamped on it. Fittings in G.I. pipe lines shall include elbows, tees, bends, reducers, nipples, union, G.I. Clamps / Steel structural supports of approved design, nuts, bolts, washers, etc. All fittings shall be tested at manufacturer's works. Contractors may be required to produce certificate to this effect from the manufacturers.

##### **CUTTING AND THREADING:**

Where the pipes have to be cut or rethreaded, the ends shall be carefully filed out so that no obstruction to bore is offered. The end of the pipes shall then be carefully threaded conforming to the requirements of IS:554-1964 with pipe dies and taps in such a manner that will not result in slackness of joints when the two pieces are screwed together. The screw threads of pipes and fittings shall be protected from damage until they are fitted.

##### **JOINTING:**

The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over with material suitable to food grade and a few turns of spun yarn wrapped around the screwed end of the pipes. The end shall then be screwed in the socket, tee etc with the pipe wrench. Care shall be taken that all pipes and fittings are properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Burr from the joints shall be removed after screwing. After laying, the ends of the pipes shall be temporarily plugged to prevent access of water, soil or any other foreign matter.

##### **PAINTING:**

The buried pipes shall be cleaned and coated with zinc chromate primer and bitumen paint, then wrapped with bitumen faced hesian.

##### **TESTING OF JOINTS:**

After laying and jointing, the pipes and fittings shall be inspected under working condition of pressure and flow. Any joint found leaking shall be redone and all leaking pipes removed and replaced without extra cost.

##### **ACCESSORIES:**

**STRAINERS:**

Strainers shall be installed in all pump suction, PRVs and tanks. The strainers shall be of pipeline "Y" type and suitable for use in the appropriate system.

The perforated screen shall have  $\varnothing$  0.75 mm hole sizes, and be stainless steel. The following area should be at least 4 times the cross-sectional area of the pipe.

40mm and smaller strainer shall have bronze bodies with screwed connections while 50mm strainers and larger shall have cast iron bodies and flanged connections. The cap of the strainer shall be provided with a  $\varnothing$  20 drain plug.

**WATER METERS:**

Water meters shall be of multi-jet magnetic drive (turbine type), displacement and accumulative reading type, conforming to the Metropolitan Water Works Authority Standard with working pressure corresponding with the piping system.

**PRESSURE GAUGES:**

Pressure gauges shall be of the bourdon type, stainless steel casing, round type of 120mm dia and scale range of approximate 150 percent of the normal operation (accuracy 1%). Pressure reading shall be in dual scale with psi and kg/sq.cm.

The needle valve and stainless-steel siphon with working pressure corresponding with the piping system shall be provided for each pressure gauge.

Pressure gauges, subjected to corrosive liquid, shall be of the chemical type with diaphragm liquid separator.

**VALVES & TRAPS:**

Stop valves shall be globe valves with bronze body up to 50mm and steel body with SS internals for larger sizes. All valves shall be flanged type.

Butterfly valves shall be provided for isolation purpose, valves shall be of cast iron construction and shall conform to IS:3095. Valves shall be suitable for 15 bar and seats for 11 bar test pressure. The shafts/spindle shall be made of stainless steel. The seat shall be in line with EPDM (Ethylene Propylene Diene Monomer) suitable for 120 Deg. C. temp. The valve operating levers shall be provided with a locking arrangement.

Check valves shall be Bronze with flanged ends suitable for 120 Deg. C temp. Swing check valves shall normally be used in all water services. Lift type valves may be used in horizontal runs.

Pressure reducing station (PRS) in the Plant Room shall be suitable for capacity as mentioned in Bill of Quantities and shall be complete with stop valves, diaphragm operated down sensing type PRV, by pass line with valve, 'Y' strainer moisture separator, pressure gauges safety valve and all other accessories which required to complete the system.

**INSULATION OF HOT WATER PIPES:**

Specification for Thermal insulation for Hot water pipes in Shaft/Plant Room above False Ceiling.

**MATERIAL**

Thermal conductivity of material shall not exceed 0.034 W/MoK at an average temperature of 120C. The material should have a density in the range of 60-120 kgs/cu. Mts. The water vapour resistance

factor should be higher than 5300

Thickness of the insulation shall be as specified for the individual application. Each lot of insulation material delivered at site shall be accompanied with manufacturer test certificate for thermal conductivity values. Samples of insulation material from each lot delivered at site may be selected by project manager and gotten tested for thermal conductivity and density at contractor's cost. All joints shall be sealed **properly with** adhesive, which shall provide vapour barrier as the original insulating material

#### **PIPING INSULATION:**

All hot water piping shall be insulated in the manner specified herein. Before applying insulation, all pipe shall be brushed and cleaned. Thermal Insulation shall be applied as follows or as specified in drawings or schedule of quantity.

Insulating material in tube form shall be sleeved on the pipes. On existing piping – opened tube from insulating material shall be placed over the pipe and adhesive (as recommended by the manufacturer) shall be applied as suggested by the manufacturer. Adhesive must be allowed to tack dry and then press surface firmly together starting from butt end and working towards centre

Wherever flat sheets shall be used it shall be cut out in correct dimension. All longitudinal and transverse joints shall be sealed as per manufacturer recommendations. The insulation shall be continuous over the entire run of piping, fittings and valve. All valves, fittings, joints, strainers etc. in hot water piping shall be insulated to the same thickness as specified for the main run of piping and application shall be same as above. Valves bonnet, yokes and spindles shall be insulated in such a manner as not to cause damage to insulation when the valve is used or serviced

#### **APPLICATION:**

1. Clean the surface of the pipe to be insulated free from dust, grease and other matter.
2. Select the correct ID of the pipe suitable for the pipe to be insulated and slit the pipe along its length using a sharp knife. Ensure that the cut is straight.
3. Apply a thin coat of adhesive on both the cut surfaces of the tubing and leave it for 2-3 minutes for drying.
4. Once the adhesive is dry but tacky to touch bring both the ends of tubing where is adhesive is applied in contact and stick them well. Ensure that both the surfaces are matched properly.
5. Apply Self Adhesive Black Cotton tape on both the longitudinal and the circumferential joints. Before fixing the tapes, it must be ensured that all the joints are sealed properly and free of dust, loose particles etc. to provide good adhesion.
6. In case of pipes exposed to the atmosphere one layer of **Polysield** Protective Coating has to be applied over the insulation.
7. Generally, sheets are recommended for insulating the pipes of 4" NB above. In this case the adhesive has to be applied on the pipe surface as well as the inside surface of the sheet. Once the adhesive is tacky to touch bring them together to stick. Care must be taken that the joints are sealed properly before fixing the self-adhesive tape.
8. Supplying and fixing Thermal Insulation in the form of tubing/sheeting depending on the size of the pipe and as per the thickness recommendation given in the tender. The application procedure mentioned in the tender should be strictly adhered to and the ancillary material to be used should also be as mentioned in the application procedure.

## **POLYSHIELD PROTECTIVE COAT:**

### **APPLICATION:**

Since material i.e. Nitrile foam is a soft resilient product, coating cannot be directly carried out on the surface of the insulation material. A reinforcement layer has to be provided to sustain the coating system and to attain a tough finish. One layer of poly glass tape has to helically wound on the insulated surface with an over lap of 5 mm to 8 mm. The tape winding has to be firm and not exceedingly tight as the insulation material will get compressed which is not desirable, as insulation values will get affected.

After winding of polyglass tape, the first coat of polyshield is applied with the help of a brush & care should be taken to ensure that the first coating is spread evenly thoroughly wetting the tape. The material spreads itself and therefore, only a thin layer should be applied by dipping the brush in the mixed liquid only upto 12 mm. The first coat will cure/dry in 2 hrs in dry & hot conditions, excessively high humidity inhibits the curing process. Therefore, this coating should not be applied during monsoons. The second coat should be applied over the first coat evenly & allowed to dry. The coating achieves hard cure in 8 hrs to 12 hrs. on total drying the coating will attain a semi glossy to glossy finish.

### **PREPARATION METHOD:**

'Polyshield' coating consists of resin & hardener (part 'A' & part 'B'). take a clean plastic container (Mugs, small bucket), mix the part 'A' & part 'B' thoroughly before pouring into the container as the solids tend to settle down to the bottom of the can. Pour only one Kg at a time (since the pot life is limited) of part 'A' and add only 0.6 Kgs of part 'B' to part 'A' and thoroughly mix both the parts. Care should be taken while mixing the liquid as improper mixing will result in improper cure and colour dispersion. The measurement of part 'A' & part 'B' should be accurate with proper measurement devices as less or excess of hardener will change the property of the cured system. Care should be taken to avoid inhalation of vapours as the system is solvent based.

### **TOOL & STORAGE:**

Store the material in a cool dry place and away from direct sunlight as per-gelation may occur. Brushes can be cleaned with NC thinner or acetone, and reused (mixed coating material should not be stored as the fluid will gel).

### **MS/GI PIPE:**

MS/GI Pipes above ground shall be measured per linear metre (to the nearest cm) along the center line of the pipe and shall be inclusive of all fittings e.g. couplings, tees, bends, elbows, unions, flanges, etc. Deduction for valves shall be made. Rates quoted shall be inclusive of all fittings, clamps, cutting holes chases and making good the same and all other items mentioned in the specifications and Schedule of Quantities.

### **VALVES, STRAINERS, MOISTURE SEPARATORS:**

Valves shall be measured by numbers. However, wherein these items are included as integral part of an assembly and described as such in the B.O.Q., these will not be prescribed and paid for separately.

### **FLANGES FOR NOZZLES:**

Flanges for nozzles shall be measured by numbers and the quoted rate shall include welding of the flanges to the pipe nozzles.

## **PIPING / PIPE PROTECTION / INSULATION:**

Unless otherwise specified painting / Pipe protection / Insulation for pipes shall be measured and paid for separately. These shall be measured per linear metre along the centre line of the pipe over the finished surface and shall include all valves and fittings for which no special rates shall be applicable.

## **INSTALLATION, TESTING, COMMISSIONING, & HANDOVER:**

### **Installation:**

The complete installation of the Solar Hot Water Generator System including all items mentioned above, shall be in the scope of the Contractor / Vendor.

The contractor shall ensure that the vendor has complied to all the terms and conditions of supply and installation.

All installations must be approved by the Engineer-In-Charge.

All installations must be undertaken after getting the required approvals from local authority / architects.

### **Testing:**

The entire system must be tested by the contractor and approved prior to submitting the request for inspection by the Engineer-In-Charge.

Should the Engineer-In-Charge require, he may ask for a Factory Acceptance Test, and for this the contractor is bound to make the adequate arrangements for the factory visit at no extra charge.

### **Commissioning:**

Prior to submitting the system for final commissioning, the contractor must have an approval from the Engineer-In-Charge to commission the system.

A complete commissioning certificate including the approval of the local authority or governing body must be submitted in triplicate to the Engineer-In-Charge.

### **Handover:**

The manufacturer shall supply all technical literature and drawing considered necessary for the installation, operation and maintenance of the equipment and its fittings.

These shall essentially include: -

- a) Drawing showing over all dimensions and all other details including sectional view of the equipment.
- b) List of parts with reference to nos.
- c) Manual of instructions for the operation, maintenance and repairs/equipment and special fittings, if any.
- d) Checking methods and schedule for cleaning the system.
- e) Any other relevant technical data which would be of assistance for efficient operation and maintenance of the system including energy savings etc.

The supplier shall train the Employer personnel for the operation and maintenance of the equipment for a period, mutually agreed between the supplier and the Employer.

The supplier will have to undertake repair of the system installed by them, in case of any defect arising out of any point of time. Supplier will attend the minor complaints within 24 hours of receiving the complaint otherwise penalty to be recovered per day as decided by the Engineer-In-Charge.

The system and the solar collectors should be guaranteed for six years after the day of handing over. This includes first three years with spare parts and next three years without spare parts. They shall submit list for recommended spares required in maintenance along with the price list as part of their offer. Manufacturer or their authority/accredited dealer shall be considered for eligibility to participate in tenders.

The supplier shall guarantee the performance of the system for the rated output of 55 ° C in terms of quantity of hot water and the temperature in peak winter for which the system is designed. If it is not achieved, the necessary additions/modifications including installation of extra collectors shall be done by the supplier without charging any extra price. However, the purchaser reserves the right to have this job completed for achieving the rated output by other manufacturers/after serving 15days notice to the original manufacturers/contracts at his cost & risk.

All the elements of the system which fail due to manufacturing defect within the period of guarantee shall be replaced by the tenderer free of cost.

#### **DOCUMENTS TO BE SUBMITTED ON COMPLETION OF INSTALLATION**

The following documents must be presented to the Engineer on completion of the installation:

1. Detailed List of all items installed with actual quantities.
2. Make List of all items installed with actual vendor contacts and details.
3. MNRE certificates for Solar FPC panels.
4. Data Sheets with Performance Curves for all pumps installed with actual flow and head considerations.
5. Testing Certificates for all items installed at site, from CPWD/NABL approved test laboratories.
6. Design parameters versus actual parameters of all items installed.
7. Bureau of Indian Standards approval certificates for all items installed.

#### **MINIMUM INSPECTIONS OF MATERIALS**

##### **MINIMUM INSPECTION REQUIREMENTS FOR VALVES:**

- I. Type of valve;
- II. Make of valve;
- III. Factory performance of valves;
- IV. Actual performance of valve in hot water system;
- V. B.i.s. certification of valve manufacturer;
- VI. B.i.s. certification of valves installed;
- VII. Laboratory certificates from cpwd assigned laboratories for thickness of body, seal, seat, lining, etc of valves;
- VIII. Dimension of valves from manufacturers;
- IX. Actual dimensions of valves;
- X. Deviation from standard dimensions as per applicable indian codes and standards;
- XI. Final inspection: Inspection shall be done by Engineer

##### **MINIMUM INSPECTION REQUIREMENTS FOR PIPES:**

- I. Thickness as per Indian standards & codes;
- II. Actual thickness of pipes;
- III. Deviation from standards;
- IV. Surface finish
- V. Threaded finish
- VI. Dimensions
- VII. Visual examinations
- VIII. Jointing and sealing;
- IX. Method of insulation;



- X. Type of insulation;
- XI. Quality of insulation;
- XII. Type of polysield coating;
- XIII. Thickness of polysield coating;
- XIV. Type of cladding;
- XV. Thickness of cladding;
- XVI. Method of cladding;
- XVII. Finishes;
- XVIII. Inspection shall be done by Engineer.

## **Scope of work and Technical specifications for Radiant Cooling System & High side HVAC System with Chillers**

The following sub heads mentioned in the payment schedule.

- 1 . Sub-head A13.1 (Annexure A13.1)
2. Sub-head B13.1 (Annexure B13.1)
3. Sub-head C13.1 (Annexure C13.1)
- 4 . Sub-head A13.2 (Annexure A13.2)
- 5 . Sub-head A13.3 (Annexure A13.3)

**A. GENERAL:**

These Specifications shall be read in conjunction with the General Conditions of Contract, special condition of contracts, schedule of work, drawings and other documents connected with the work.

**Reference Codes and Standards and their latest versions/ amendments**

- National Building Code
- Energy Conservation Building Code
- Bureau of Energy Efficiency
- ANSI/ ASHRAE/ IESNA standard 90.1 Energy standard for buildings except low rise residential buildings.
- AMCA: Air Movement and Control Association
- AHRI 412- with Addenda 1, 2 and 3: Forced-Circulation Air-Cooling and Air-Heating Coils
- ANSI/AHRI 430: Central Station Air Handling Units
- ANSI/AHRI 440: Performance Rating of Room Fan-Coils
- AHRI 575: Standard for method of measuring machinery sound within equipment room.
- ANSI B31.5: Code for Refrigeration piping
- ASME B31.1: Code for Process piping
- Air Filters as per ASHRAE 52.1
- Indoor Air Quality as per ASHRAE 62-1
- Duct Fabrication as per IS 655
- GI Sheets, IS: 277
- Aluminium Sheets, IS: 737
- Three-phase induction motors, IS: 325
- Safety code for air conditioning, IS: 659
- Safety code for mechanical refrigeration, IS: 660
- Expanded polystyrene for thermal insulation purposes, IS: 4671
- Centrifugal Fans, IS: 4894
- Pipe & Pipe Fitting IS: 1239 & IS 3589
- Fire Damper UL555
- SMACNA- HVAC Duct Construction and leakage test Standards - Metal & Flexible
- NFPA 121 Life Safety Code.
  - AMCA 212 Laboratory Method of Testing Fans for rating
  - Cooling Technology Institute, CTI

- ATC-125-00: Acceptance Test Code for Water-cooling Towers (CTI Std- 03 Code Tower Standard Specifications).
- ATC-201-96: Standard for Certification of Water-Cooling Tower Performance (CTI Code Tower Standard Specifications).

The proposed Radiant Cooling System in IIT Hyderabad campus is for the following buildings:

- **Pre-cast Hostel buildings -03 Nos.**

### **SCOPE OF WORK AND BASIS OF DESIGN**

The scope consists of design, supply, installation, testing and commissioning of radiant cooling system for individual student room in precast hostel buildings-03Nos. with all required equipment accessories at low side along with design, supply, installation, testing and commissioning of suitable capacity chiller at high side(in AC Plant-2) including Chiller Plant Manager(CPM), Standby Chiller(if required), Automated tube cleaning system, Cooling Tower, Chilled water pumps, condenser pumps, required pipeline works inside plant, suitable makeup water system with all required equipment and chilled water pipeline works from AC Plant-2 to new Precast hostels-03Nos. The scope includes all civil works for Chillers/Pumps/Cooling towers foundation and buried pipeline from AC Plant-2 to New Precast Hostels-3Nos. buildings. Work execution as per the approved design, drawings and directions of Engineer-In-Charge.

All the HVAC works to be executed as per the CPWD General Specifications for Heating, Ventilation & Air-Conditioning (HVAC)-2017 amended up to date.

Minimum 6KL makeup water to be considered at high side system (in AC Plant-2) with all required tanks/equipment/accessories. Water source may be considered from tap off point shown in the AC Plant-2, as per the approved design, drawings and directions of Engineer-In-Charge.

Epoxy painting to be used for the condenser pipeline (In & Out) painting from chiller till cooling tower and any amendments as directed by Engineer-In-Charge.

Suitable room with aluminium partition and air-conditioning split AC units(with standby provision) for Chiller Plant Manager in the AC Plant-2 shall be provided by the contractor to maintain the ambient temperature in this room as 25+/-2 deg.C as approved by E-I-C.

The general character and the scope of work to be carried out under this contract is illustrated in Drawings, Specifications and Schedule of Quantities. The Contractor shall carry out and complete the said work under this contract in every respect in conformity with the contract documents and with the direction of and to the satisfaction of the Engineer-In-Charge. The contractor shall furnish all labor, materials and equipment and specified otherwise, transportation and incidental necessary for Supply, Installation, Testing, Commissioning, final testing, putting into operation, equipment capacity computation and handing over of the complete air conditioning system as described in the Specifications and as shown in the drawings. This also includes any material, equipment, appliances and incidental work not specifically mentioned herein or noted on the Drawings / Documents as being furnished or installed, but which are necessary and customary to be performed under this contract. All the specification for the electrical items to be considered from the electrical part of the tender documents The HVAC system shall comprise but not limited to the following.

a. Radiant Cooling System comprising of:

- i. Mixing Tank
- ii. Pumps
- iii. Valves

- iv. Motor Control Centre,
- v. Insulated Chilled water piping inclusive of all valves, fittings, pressure gauges, thermo wells.

### For Radiant Cooling System

Following indoor design conditions for Hostel rooms with radiant system are proposed:

Space	Indoor Conditions Temp °C (°F)	Relative Humidity %	Noise Criteria NC	Outdoor Air Ventilation Rate Based on ASHRAE 62.1- Latest
Hostel Rooms	30 ±1°C (86±2°F)	No Control over RH	30	Natural Ventilation

### PIPING WORKS:

- **Scope**

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

- **Pipe Sizes**

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

Water velocity in pipes shall not exceed 2.5 m/sec.

- **Chilled Water/Condenser Water & Drain Piping**

Following material shall be used for pipes and fittings.

**Pipes Nominal size (mm)**

≤150

**Material Specification**

IS 1239 Part-1(Mild steel medium class (Black steel) tube)

200 and above

IS 3589 Gr. FE 48 (6.35mm thick ≤350 NB, 7mm thick for 400 NB, 8mm thick >400NB & ≤600NB, 12mm thick above 600 NB) (Welded black steel pipe, class 2)

**Fittings Nominal size (mm)**

≤40

**Material Specification**

Socket welded

50-150

Butt welded, ASTM A234 Gr. WPB as per ANSI

≥200

B16.9

Site fabricated from IS 3589 Gr. FE 48 (6mm)

**Flanges Nominal size (mm)**

≤ 150

**Material Specification**

ASTM A85 as per ANSI B16.5 (#150 class)

≥200

IS 2062 Gr.A, as per ANSI B16.5 (#150 class)

Out of three weld one butt weld of each welder shall be fully radiographed for testing purposes. Upon approval of welding joints the concerned welder shall be allowed to carry further welding of pipes. Rest of the welds shall have 80% visual inspection.

**All welded joints (except pipe welded end-to-end) shall be made by use of one-piece welding flanges, caps, nozzles, elbows, branch outlets and tees of approved make. If not available in approved make then pipe shall be cut and welded to make these attachments. Cut samples shall be submitted for approval, if directed. All such fittings etc., shall be of a type which maintain full wall-thickness at all points, simple radius and fillets, and proper bevels or shoulders at ends. All job welding shall be done by the electric arc welding process in accordance with the following:**

- All joints shall have 45-degree bevel type, pipe mill-beveled or machine beveled by the contractor.
- All scale and oxide shall be removed with hammer, chisel or file and bevel left smooth and clean.
- Pipe lengths shall line up straight with abutting pipe ends concentric.
- Both conductors from the welding machine shall be extended to locations at which welding work is being done. The leads from welding machine to location of welding work shall be held together with tape or other approved means so as to prevent induced current in structural steel, in piping or in other metals within the building. The ground lead shall be connected to length of pipe through joints in pipe, structural steel of building or steel pipe supports.

**All pipes and their steel supports shall be thoroughly cleaned and given one primary coat of red oxide paint before being installed. For vibration isolators remoulded polyurethane pipe sections of 160 Kg/m<sup>3</sup> density with adhesive shall be fixed between pipe and MS support. 8 mm thick MS 'U' clamp shall be fixed on the pipe so that the pipe is kept in position. All welded piping shall be subject to the approval at site.**

**Fittings shall be malleable casting of pressure rating suitable for the piping system. Fittings used on welded piping shall be of the weldable type. These shall form part of piping and are not separately identified in Schedule of Quantities.**

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

**Ball and butterfly valves conforming to the following specifications shall be provided as shown on Drawings:**

Size	Construction	Ends	Type
15 to 40 mm	Brass ASTM B62	Screwed	Ball
50 mm and over	Body Cast iron	Wafer	Butterfly

Valves shall have non-rising spindles unless specified otherwise and shall be suitable for PN16 rating as indicated in the schedule of quantities.

- **Butterfly valves**

Butterfly valves shall be suitable for a working pressure of minimum PN 16 rated. Pipe dia 50 mm & above should be used with butterfly valves.

The butterfly valve shall be supplied along with flow control lever with spring loaded position lock arrangement for small size up to 200mm valves and flow control wheel for above 200 mm sizes valves and extended shaft for easiness of insulation. The valves shall be compact in size and shall conform

to BS 5155.

The valves shall be light in weight and easy to install. The body shall be of close grain cast iron conforming to IS: 212 and the seating shall be of resilient black, Nitrile rubber / EPDM molded on to the body. The disk shall be of SS with nylon coating, whereas the shaft shall be of stainless steel A ISI 431 treated permanently for lubrication. The shaft seals shall be of Nitrile 'O' rings and rubber seals.

Care should be taken during installation to see that the disk is not damaged during installation due to the flanges being incorrectly spaced.

Provide gear operated valves for sizes having 200 mm and above and lever operated for 150mm and below. For smaller sizes such as 40 mm and below ball valves are acceptable.

Necessary mating flange (with gaskets if required), GI nut bolts with GI washers shall be provided along with valve.

Necessary insulation shall be applied & care should be taken that no air gap left between valve body & insulation material.

If two valves of different pipelines are coming adjacent to each other, care should be taken that the valve lever/handle/wheel shall be easily accessible & operate with full functionality.

Butterfly/Ball valves shall be provided at

- i. Suction and delivery sides of pumps.
- ii. All drain connections from equipment.

• **Motorized Butterfly valves**

These valves shall be made of cast iron body, seat of black Nitrile rubber (tight shut-off), nylon coated SS disc, PTFE coated SS (AISI 412) shaft, complete with companion flanges, nuts, bolts, gaskets etc. as required. These valves shall conform to BS: 5155, IS13095, and shall be designed to fit without gaskets between mating flanges. The valves shall be suitable for flow in either direction and seal in both directions. The valves shall be of integral moulded design. Actuator shall have potential free contacts for status monitoring. The valves shall be complete with (Push Button for ON/OFF arrangement & ON /OFF valve indications) companion flanges, nuts, bolts, gaskets etc. The actuator shall be IP67 rating capable of accepting upto 12V DC, and upto 20mA electric signal and providing similar transduced feedback output to control system as required. These valves shall have wheel for manual operation also.

• **Pressure Independent Balancing cum Control Valves**

Each Air Handling Unit / Fan Coil Unit shall be provided with 2Way Pressure Independent Balancing Cum Control Valve with Integrated in a single Body with Globe Type in Construction as indicated in BOQ.

Control – Valve should be equipped with electronic modulating actuator which can accept either 4(0)-20 mA / 2(0)-12V DC signals. Operating voltage for actuator shall be 24V AC. Delta p controller should ensure 120% valve authority at all loads (part load Actuator shall be able to work against maximum closing pressure of 6 Bar at full load) with feedback signal to Control system. 230/24V transformer shall be included.

Balancing – Each Valve should have steeples adjustable maximum flow limitation as per the designed flow rate of coils. Balancing should be done only in Valve not in actuator so that at any given condition of failure balancing is not lost and easily accessible.

All Valve actuator shall be microprocessor based with self calibrating feature. The actuator shall be BMS compatible for command and feedback Valve should be of linear control characteristics with stepless characteristics.

**Valve specifications**

Description	For 15 to 32mm	For 40 to 150mm
Diff Pressure (P1-P3)	16 To 400 kPa	35 To 600 kPa
Media Temperature	+1 to 112 <sup>o</sup> C	-12 <sup>o</sup> to 120 <sup>o</sup> C
Body Material	Brass	Grey iron / Ductile iron

Test Ports	Needle measuring nipple	Needle measuring nipple
Shutoff Leakage	Max. 0.05% of Kvs	Max. 0.05% of Kvs
Stem Seals	EPDM	EPDM
Maximum Close Off Pr	Minimum Should be 400kPaD	600kPaD
Pressure rating	PN16 or above	PN 16 or above

#### Actuator specifications for all sizes

Supply Voltage	: 230 V AC for on/ off type actuator
Max. Power Consumption	: 8W
Frequency	: 50HZ
Control Input	: 2 12V DC, 4 20mA, 3 point Selection
Position Output	: 2-12V DC 4-20mA
Body Housing Insulation	: Non Corrosive - IP 42 for valves dia. up to 32mm and IP 54/55 for valves dia. above 32mm.

#### Valve Body and Characteristics

- i. Pressure Controller Device should maintain the Pressure, irrespective of fluctuations in the system with the help of a self-adjusting diaphragm.
- ii. Control valve shall accurately control the flow, with help of Modulating Actuator
- iii. All Valve Sizes should have Testing Ports for verifying the flow with respect to the Differential Pressure.

#### Valve Actuator and Housing:-

- i. Control/Dip Switch Setting should be easy to access for doing the balancing at site.
- ii. The valve should be mounted with the actuator above the valve to prevent condensation water leaking into the actuator.

#### Valve Flow Balancing :

- i. Balancing & Control: Balancing should be accomplished by the Diaphragm and Control should be taken care by Actuator receiving signals from Room Thermostats or BMS.
- ii. Manual Override facility shall be provided to either open or close the valve.
- iii. Flow Setting Balancing (Commissioning) for the Valves should be simple and not require measuring devices.
- iv. Proper operation of the valve should not be dependent on additional operations like de-airing of the valve or flushing procedures.

#### • MANUAL BALANCING VALVES

These valves shall be provided at various tap-offs line as indicated in design drawings. These valves shall have built-in pressure-drop measuring facility to compute flow rate across the valve. The test cocks shall be long enough to protrude out of pipe insulation. The pressure rating shall be PN 16. To enable accurate and practical operation, measurement of flow and differential pressure shall be noted down and stored in employer's database for future reference. Balancing valve shall be of cast iron flanged construction with EPDM/SG iron with epoxy coated disc.

#### • FLANGES

These flanges shall be of approved make. The supply of flanges shall form part of piping (not separately identified in Schedule of Quantities) and shall also include supply of bolts, washers, nuts and suitable asbestos fibre / rubber insertion gaskets (minimum 3 mm thick).



• **ALL BALL VALVES AND BALL VALVES WITH Y STRAINER:**

- i. For room side:
  - a) Ball valve shall be of minimum PN 16.
  - b) Ball Valves below 40mm dia shall be lever operated bronze forged body, chrome plated bronze ball. The shaft shall be of stainless steel. The seat shall be of PTFE. The valve shall be complete with FTA ends for connection.
  - c) Necessary insulation shall be provided to avoid condensation
- ii. For Air vent & drain
  - a) Where ever necessary & required to complete the function, air vent shall be installed at the highest position in the piping. The location where anticipated to form air lock in the piping routine, necessary auto air vent shall be provided.
  - b) If position of air vent is within false ceiling, Auto Air Vent should be installed. The information about the AAV should be marked by CONTRACTOR on AS BUILT layout.
  - c) CONTRACTOR should carefully make Engineer-In-Charge aware while conducting onsite testing & commission so that the special care should be taken to avoid water spillage & damage of other property.
  - d) Air vents shall be of brass construction and of automatic type. Similarly drain valves shall be provided at all dirty legs. The size of the valves shall be 25 mm size for pipes upto 150 mm. Drain shall be closed with dummy caps to prevent accidental opening.

• **CHECK VALVES:**

These valves shall be dual plate check valve provided as shown on the Drawings, and identified in Schedule of Quantities conforming to relevant Codes and in accordance with the following Specifications:

Size Ends	Construction
50 to 150 mm flanged	Body Cast Iron, gun metal plate
200 mm to 450 mm	Body cast iron, plate carbon steel Flanged with 11% chrome overlay

While screwed or flanged ends may be provided up to 65 mm, flanged ends shall be provided for larger sizes.

The spring and hinge/stop pin shall be SS304 and bearing PTFE material.

Valves shall be PN 16 rating as indicated in the schedule of quantities.

• **STRAINERS:**

These strainers shall be 'Y' type or pot type as specified suitable for PN 16 rating as shown on drawings and included in BOQ. 'Y' Strainer shall be fabricated out of MS 'C' class pipe two sizes higher than that of Strainer pipe size. Flanges as per B.S. 8 shall be provided at inlet and outlet connectors. The strainer shall be of ductile CI body with flanged end connections. Permanent magnet shall be provided in the body of the Strainer to arrest MS particles. Filter element shall be of non-magnetic 20 SWG SS sheet with 3 mm perforation. Strainers shall be provided at in let of each Air Handling Unit and Pump as shown in drawings and included in BOQ.

'Y' strainers shall be provided on the inlet side of each air-handling unit and pump in chilled water and condenser water circuit. Pot strainers, where specified, shall be provided in return water headers for chilled water and condenser water if enough floor area is available in the refrigeration plant room, as an alternate to individual Y type strainers with pumps. The strainers shall be designed to the test pressure specified for the gate valves.

They shall be provided with equal size isolating gate valves on either side so that the strainers may be cleaned without draining the system.

Pot strainer shall be fabricated out of MS sheet and the sizes shall be as under:

Pipe sizes (mm)	Pot dia (mm)	Pot Height (mm)	Basket dia (mm)	Basket Height (mm)
50	300	400	200	240
80	350	450	250	250
120	450	500	300	280
125	500	600	330	340
150	540	700	360	390
200	612	815	400	470
250	800	955	550	512
300	1200	1125	750	580
350	1190	1300	895	678
400	1350	1500	1220	785
450	1518	1700	1260	890
500	1690	1800	1120	900

Strainers shall have a removable bronze/stainless steel minimum 1mm thick screen with 3 mm perforations and permanent magnet. Strainers shall be provided with flanges or threaded sockets as required. They shall be designed so as to enable blowing out accumulated dirt and facilitate removal and replacement of screen without disconnection of the main pipe.

• **MANIFOLDS WITH FLOW METER AND BALANCING VALVES (for radiant cooling):**

Sandwich type double skinned insulated 25 mm thick Manifold Box with front cabinet openable for operation & Maintenance. and shall be made of 1.2 mm thick Precoated GI sheet outside and 1.2 mm plain GI sheet inside with 25 mm thick puff insulation in it. manifold box shall be installed in cavity/ niche.

Manifold Box will consist of Supply and return modular brass manifold ,connector for PEX pipe , Air Vent , Ball valve for isolation , flow meter -mechanical type , drain cock The body of manifold should be made of Brass. It should comprise of a Flow meter Nut, Flow meter insert & Union for compression fitting all made of Brass. The Manifolds should withstand the Test Pressure not less than 2 bar and Maximum Working Pressure of 6 bar (PN6). The fittings should be able to operate at a Maximum Working Temperature of 95 °C. The manifolds shall be modular type with push fit which will give versatile solution and allow to have multiple number of connections and high water capacity as per the site requirement. The manifold shall be with flow meters and balancing valves with mechanical memory stop.

The Intermediate manifold connection piece shall be 1" self sealing connection for distribution manifolds. They shall be complete with automatic air vent, drain cock and temperature gauge with self sealing connection.

The manifold cabinet shall be box type. It shall be powder coated and manufactured from thick sheet which should be able to withstand the load of manifold & other accessories.

The manifold box shall have manifold with 8nos / 12 Nos for pipes 16 mm dia and 20 mm dia connections for supply and return. The box shall be fixed in the location as shown in drawing.

• **THREE WAY MIXING VALVES/ ZONE VALVES WITH ACTUATOR.**

The valves should be suitable for water applications. It should be made of Bronze body with threaded connections or cast iron body with flanged-end connections, Stainless steel stem and replaceable seats. The maximum operating pressure should be 145 psi (PN12).

The valve shall be capable of mixing or diverting applications and controlled via thermostatic operator or actuated via 24V electronic actuator. The modulating actuator must be suitable to operate at 230 V AC, 50 Hz, of suitable torque to operate the valves in any condition; it should be suitable to operate at a temperature range of 0 °C to 50 °C The valve shall be available with female pipe threads or copper compression fittings. The Control characteristics should be logarithmic or based on Equal percentage.

• **EXPANSION BELLOWS:**

- i. The Expansion Bellows shall be flanged type expansion joint. Flanges shall be non-compressible and mechanically strong type and the Neoprene rubber shall be provided in between the flange ends. The Bellow shall work for a temperature range of minus 12°C to 70°C.
- ii. The length and working pressure of bellows shall be as follows:

iii. Bellows shall be	Nominal Bore (mm)	Length (mm)	Pressure (Bars)
	Up to 200	150	16
	above 200	200	16

provided with control roads to control the excessive elongation or compression of piping systems.

- iv. It shall have torsional movement up to 3o without damage.
- v. Bellows shall be single arch.

• **RADIANT COOLING PIPING:**

Polyethylene cross link pipe:

- i. The PE-X pipe shall be of high density - 0.939 g/cm<sup>3</sup> with anti-oxygen vapour barrier suitable for pressurized distribution of cold water in cooling radiant panel systems. The degree of reticulation should be more than 70% and breaking load 31MPa. The elongation at 23 °C breaking should be 520% and elasticity module at 23 °C 540Mpa. The coefficient of linear expansion  $1.9 \times 10^{-4}/K$  and thermal conductivity of tube 0.38 W/mK. The PE-X shall conform to the EN Standard 15875. The Maximum operating temperature should not be less than 95 °C.
- ii. The PE-X pipe supplied and installed for each circuit shall be single length without any joints. The length of the Pex pipe for each circuit shall not be more than 120 meters. The pipe shall be installed on the plastic tracks at pitch of 150mm for 20 mm dia pipe and 120 mm for 16 mm dia pipe.
- iii. The PE-X pipes shall be installed on the floor which shall have EPS insulation 25 mm thick / 32 kg cum density installed as over deck insulation.
- iv. The PE-X pipes are to be tested before it is covered by screed. Each circuit of PEX Piping & Manifolds shall be tested to pressure 1.5 times the maximum working pressure for minimum 12 hours.
- v. Locating & Rectification of Punctures / Damage to PEX Piping & other Leaks, including minor civil work, by Circulating Chilled Water or Hot Water & Thermal Imaging, shall be done prior to Commissioning.

**Compression Fittings:**

These are special fittings required for installation of PE-X Pipes. The fittings should withstand the Test Pressure of 6 bar and Maximum Working Pressure of 2 bar. The fittings should be able to operate at a Maximum Working Temperature of 95 °C. Proper adapters shall be used while installing the manifolds and piping.

### **Basic Rail & Rail Clips for installing PE-X pipes:**

Basic Rails are required for guiding the installation of the pipes. To install tubing pipe clamping track system shall be used. This will align the pipes and keep them in straight line. The length to be 1m with pitch 150 mm for 20 mm dia and 120 mm for 16 mm dia pipe. The track shall be fixed on EPS with the screws so that track remains in place.

### **Basic Pipe Sleeves:**

The Pipe Sleeve is designed to be clicked over the pipe and placed in the middle of the Movement Gap. Should be used in each place where pipe is crossing expansion joint.

### **Polythene sheet.**

Polythene sheet of 80 GSM to be placed above EPS, before fixing Basic Rail / Clip & PEX Pipe

### **Insulation Strip**

Wall insulation tape to be fixed on wall so that the wall cooling load is not transferred to the slab. The size should be minimum 15 mm x 0.8 mm thick.

### **Thermal Diffuser for Wall installation**

Diffuser with Zinc plated steel with size 997 x 120 mm with 0.4 mm thickness- Metal to use for transfer energy from PEX pipe to diffuser. Diffuser should be able to cover minimum 80 % of periphery area of PEX Pipe. Diffuser fixing should be such that it transfer energy of PEX pipe to Finish surface

### **Installation of Radiant piping on floor**

- EPS insulation to be laid on the finished slab. On top of EPS insulation, Polythene sheet to stapler to EPS. On Perimeter of Wall Insulation strip to be fixed, so that energy from screed is not being transferred to Wall.
- On top of Polythene sheet Plastic track to laid at 1.5 Mtr distance between track to support PEX Pipe
- PEX Pipe to laid with pitch of 150 mm for 20 mm dia pipe and 120 mm for 16 mm dia pipe. Both end of PEX pipe to connect with Supply & return manifold.
- Each PEX Circuit should not exceed 120 mtr total in length.
- Manifold box to installed at suitable position.
- Manifold with all connected circuit should be purged for air & pressurised up to 6 bar for minimum 12 hours.

### **Installation of Radiant piping on Wall**

- C channel of GI sheet 0.5 mm thick 120 GSM of size 50 x 27 mm to be fixed on the wall. This channel to installed in such way that we get level surface on wall.
- Fixing of Panel grooved EPS with thermal diffuser by screwing to C channel.
- PEX Pipe to be laid on Metal Diffuser.
- PEX Pipe to laid with pitch of min 150 mm for 20 mm dia pipe and 120 mm for 16 mm dia pipe with metal diffuser. Both end of PEX pipe to connect with Supply & return manifold.
- Each PEX Circuit should not exceed 120 mtr total in length.
- On bottom of Metal diffuser, Gypsum board of Min – 9 mm to be fixed. All surface should be smooth & ready for final painting.
- Manifold box to installed at suitable position. Manifold Box will consist of Supply modular brass manifold, connector for PEX pipe, Air Vent, Ball valve for isolation, drain cock.
- Manifold with all connected circuit should be purged for air & pressurised up to 6 bar for minimum 12 hours.
- 

### **• MIXING TANK (FOR RADIANT COOLING)**

The tank shall be of suitable capacity with a partition at centre up to 80% height. Tank shall be insulated with 19mm thick Nitrile rubber. The tank shall be fabricated from 5mm thick MS sheet with 12 bar design pressure and corrosion allowance considering maximum corrosion rate of 0.3 mm/yr. The tank shall have

partition at centre up to height of 80%. The tank shall have connection to receive supply and return to the AHU main header. The tank shall have isolating valves and flow regulating valve at the outlet connecting chilled water piping from AHU. The tank shall have connection to supply and return from the manifold. The mixing valve is installed at the outlet of tank supplying water to the manifold. The tank shall be able to withstand operating pressure of 5 bar.

• **PIPING INSTALLATION:**

- i. Design Drawings indicate schematically the size and location of pipes. The Contractor, on award of the work, shall prepare detailed shop drawings, showing the cross-section, longitudinal sections, details of fittings, locations of isolating and control valves, drain and air valves, and all pipe supports. He must keep in view the specific openings in the building through which pipes are designed to pass.
- ii. Piping shall be properly supported on, or suspended from, stands, clamps, hangers as specified and as required. The Contractor shall adequately consider all the brackets, saddles, anchors, clamps and hangers and be responsible for their structural sufficiency.
- iii. All pipes shall be supported with pipes and channels with necessary PUF pipe supports.
- iv. Pipe supports shall be of steel, adjustable for height and primer coated with rust preventive paint and finish coated black. Where pipe and clamps are of dissimilar materials, a gasket shall be provided in between. Pipe supporting details to refer from tender drawings. Spacing of pipe supports shall not exceed the following :

Pipe Size	Spacing between supports
Upto 12mm	1.5 Meter
15 to 25mm	2.0 Meter
32 to 150mm	2.0 Meter
Over 150mm	2.5 Meter

- v. Vertical pipes passing through floors shall be plumb and parallel to wall. Pipes shall be supported at each floor. MS cleats shall be welded on pipes and rest on MS channel placed on the floor with 15 mm thick pads between the cleat and channel. U clamps with sheet shall be provided to keep the pipe in position.
- vi. Bull heading in water/refrigerant piping shall be avoided.
- vii. Pipe sleeves at least 3 mm thick, 50 mm / 80 mm larger in diameter than condenser / chilled water pipes respectively shall be provided wherever pipes pass through retaining wall and slab. Annular space shall be filled with fiberglass and finished with retainer rings welded on the ends of the sleeve.
- viii. Wherever pipes pass through the brick or masonry / slab openings, the gaps shall be sealed with fire sealant such as fire barrier caulks.
- ix. Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation. 20 SWG metal sheet shall be provided between the insulation and the clamp, saddle or roller, extending atleast 15 cm on both sides of the clamp, saddles or roller.
- x. All piping work shall be carried out in a workmen like manner, causing minimum disturbance to the existing services, buildings and structure. The entire piping work shall be organized, in consultation with other agencies work, so that laying of pipes, supports, and pressure testing for each area shall be carried out in one stretch.
- xi. Cut-outs in the floor slabs for installing the various pipes are indicated in the Drawings. Contractor shall carefully examine the cut-outs provided and clearly point out where the cut-outs shown in the Drawings do not meet with the requirements.
- xii. The Contractor shall make sure that the clamps, brackets, clamp saddles and hangers provided for pipe supports are adequate. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.
- xiii. All pipes shall be accurately cut to the required size in accordance with relevant BIS Codes, edges bevelled and burrs removed before laying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter. Where reducers are to be made in horizontal runs,

eccentric reducers shall be used for the piping to drain freely. In other locations, concentric reducers may be used.

- xiv. Flanged inspection pieces 1.5 meters long, with bolted flanges on both ends, shall be provided no more than 30 meters centres, or where-ever shown in Approved-for-Construction shop drawings, to facilitate future cleaning of all welded pipes.
- xv. All buried pipes shall be cleaned and coated with zinc chromate primer and bitumen paint, and placed on concrete blocks with PUF saddles dipped in bitumen at every 2 meters and wrapped with three layers of fibre glass tissue, each layer laid in bitumen.
- xvi. Insulated buried pipes shall be cleaned, de-rusted, then coated with rust-resistant primer and placed on concrete blocks with PUF saddles dipped in bitumen at every 2 meters. Insulation shall be applied as per the section "Insulation"
- xvii. Expansion loops or joints shall be provided to take care of expansion or contraction of pipes due to temperature changes.
- xviii. Tee-off connections shall be through equal or reducing tees, otherwise ferrules welded to the main pipe shall be used. Drilling and tapping of the walls of the main pipe shall not be resorted to.
- xix. Wherever reducers are to be made in horizontal runs, eccentric reducers shall be used if the piping is to drain freely, in other locations, concentric reducers may be used.
- xx. Open ends of piping shall be blocked as soon as the pipe is installed to avoid entrance of foreign matter.
- xxi. All pipes using screwed fittings shall be accurately cut to the required size and threaded in accordance with IS: 554 and burs removed before laying.
- xxii. Piping installation shall be supported on or suspended from structure adequately. The contractor shall design all brackets, saddles, clamps, hangers etc. and shall be responsible for their structure integrity.
- xxiii. Where pipes are to be buried under ground, the top of the pipes shall be not less than 75 cms from the ground level. Where this is not practicable, permission of the Engineer-In-Charge shall be obtained for burying the pipes at lesser depth. The pipes shall be surrounded on all sides by sand cushion of not less than 15 cms. After the pipes have been laid and top sand cushion provided, the trench shall be refilled with the excavated soil and any extra soil shall be removed from the site of work by the contractors.
- xxiv. Flanges and unions shall be provided in each line preceding the connection to each equipment which require maintenance. Flanges / unions will be treated as part of piping.
- xxv. Extra supports shall be provided at the bends and at heavy fittings like valves to avoid undue stress on the pipes. Pipe hangers shall be fixed on walls and ceiling by means of metallic or raw plugs or approved shear fasteners.
- xxvi. Riser shall have suitable supports at the lowest point.
- xxvii. All pipes and their steel supports shall be thoroughly cleaned and given one primer coat of Zinc chromate before being installed.
- xxviii. 3mm gasket shall be used for flanged joints.

- **AIR VENTING**

Air valve shall be provided at the summit of piping system for air venting. Needle valve for 12mm air vent and ball valve for 15mm air vent of same size as air valves shall be incorporated. All such valves will be measured & paid.

- **PRESSURE GAUGES**

Socket for Pressure gauges shall be provided at the following locations.

- Suction and discharge sides of Chilled water pumps.
- Suction and discharge sides of AHUs.

- Pressure gauges shall be of bourdon type with stainless steel construction of 150mm dia. and of range (0-12 bar) / (0-150 psi) as required and be complete with brass valves(3/8" Dia.) and SS tubing duly calibrated before installations
  - It shall be weather proof with an IP 55 enclosure
  - Pressure gauges shall have shut off valves and shall be provided with U tube near each mixing tanks for Radiant Cooling.
  - Pressure gauges shall have snubbers to suppress the effect of pressure pulses and pressure peaks for high fluctuating applications like pump discharge applications etc.
- **THERMOMETER:**  
Direct reading 255 mm long industrial mercury filled thermometers shall be provided at the inlet and outlet of all heat ex-changers to read water entering and leaving temperature.  
Thermometers shall be of stainless steel construction with dial of 150mm dia and range up to 50°C, with 0.5°C least count and shall be calibrated before installation.  
The thermometers shall be installed in separate brass oil wells of 1/2" size with a stem of minimum 3/4th of pipe. Thermometers for insulated piping shall be installed in extended neck to avoid damage or deformation of the insulation.
- **Insulation**  
Chilled water piping, condensate drain piping etc., shall be insulated as per the specification enumerated under the specification "Insulation".
- **Testing**  
Piping shall be flushed with water 2 times thoroughly before commencement of test.  
Piping shall be tested by hydro-static test pressure at 1.5 times the maximum working pressure for a period of 24 hours. However, during the takeover, minimum test pressure shall be 12 Kg/sq. cm. The defects in joints and leaks observes shall be rectified to the entire satisfaction of the Engineer-In-Charge and piping shall again be subjected to pressure test. The testing of piping system shall be conducted in presence of Engineer-In-Charge. No insulation shall be carried out till the satisfactory completion of pressure testing. The contractor shall furnish all the necessary equipment, tools, instruments and labour to perform the test, to re-water and clean space.  
  
System may be tested in sections and such sections shall be securely capped. It shall be made sure that proper noiseless circulation is achieved through all the coils and other heat exchange equipment in the system. If proper circulation is not achieved due to air-bound connections the contractor shall rectify the defective connections. He shall bear all the expenses for carrying out the above rectification including the tearing up and refinishing of floors, walls etc. as required. Insulation shall be applied to piping only after the completion of the pressure testing to the satisfaction of the Engineer-In-Charge.  
  
Pressure gauges may be capped off during pressure testing of the installation.  
The contractor shall provide all materials, tools, equipment, Instruments, services and labour required to perform the tests and to remove water resulting from cleaning after testing.
- **Balancing**  
After the completion of installation and testing of piping, all the piping system shall be adjusted and balanced to deliver the water quantities as specified / as required /as directed. The instruments /equipment required to adjusting the balancing of water system shall be accurately calibrated before taking any measurement. Calibrated orifices and portable flow meters may be used to adjust and balance the water flow. The contractor shall furnish certificate/ balancing report to the Engineer-In-Charge for evaluation and approval. These shall be permanently marked after the balancing is completed so that they can be restored to their correct positions, if disturbed.

- **Painting**

- i. After successful completion of installation, testing and insulation all exposed piping shall be given two coats of approved synthetic enamel paint as per the colour coding requirements.
- ii. All the underground piping shall be given one coat of Zinc chromate and two coats of black anti-corrosive paint or bituminous paint of minimum 120 DFT each coat.

- **Chilled water piping Insulation using closed cell nitrile rubber (inside the building)**

- i. The outer surface of the pipes on which the insulation is to be provided shall be thoroughly cleaned and rendered free from all dust and grease. All MS pipes shall be provided with a coat of zinc chromate/bituminous primer.
- ii. Good quality adhesive as per manufacturer recommendation should be used for pasting 120% surface area of insulation to the pipe surface without leaving any air bubble or sag between two surfaces. The joints shall be paste along the thickness of the insulating material.
- iii. The insulation material shall be closed cell nitrile rubber shall be in sleeve form for pipe size up to 80mm. These sleeves shall be factory cut and self adhesive type. For bigger sizes, factory pre-cut sheet shall be used made for particular pipe sizes. The thickness of insulation shall be as identified in the schedule of quantity. The insulation joints shall be butted tightly.
- iv. Insulation for union and expansion joints shall be built up type with a slabs and the insulation shall extend 12 mm beyond the adjoining insulation for identifications. The ends of piping insulation shall be sealed with glass cloth.
- v. All insulated pipes shall be labeled (S, R or RR) and provided with 300 mm wide band of paint along the circumference at every 1200 mm distance for color coding. Direction of fluid shall also be marked.
- vi. All valves, fittings, strainers etc. shall be insulated to the same thickness and in the same manner as for the respective piping, taking care to allow operation of valves without damaging the insulation.

- **Chilled water piping Insulation using expanded polystyrene finished with sand cement plaster (outside the building)**

- i. The outer surface of the pipes on which the insulation is to be provided shall be thoroughly cleaned and rendered free from all dust and grease. All MS pipes shall be provided with a coat of zinc chromate/bituminous primer.
- ii. Good quality adhesive as per manufacturer recommendation should be used for pasting 120% surface area of insulation to the pipe surface without leaving any air bubble or sag between two surfaces. The joints shall be paste along the thickness of the insulating material.
- iii. The insulation material shall be Expanded polystyrene shall be in pre form pipe section in 2 halves for pipe size up to 400mm. For bigger sizes, sheet shall be used. The thickness of insulation shall be as identified in the schedule of quantity. The insulation joints shall be butted tightly.
- iv. The insulation shall be covered with 500 SWG polythene faced hessian, (the polythene facing outwards), with 50 mm overlap. All joints shall be sealed with bitumen.
- v. Cover the surface with 0.63 mm x 19 mm GI chicken wire netting, butting all the joints and tie down with 1.00 mm GI wires.
- vi. Cover the surface with 12 mm thick sand cement plaster in two layers. Plaster shall be finished smooth.
- vii. Plastered surface shall be covered with two layers of Tar felt of approved make and water proofed by applying hot bitumen .



- viii. All valves, fittings, strainers etc. shall be insulated to the same thickness and in the same manner as for the respective piping, taking care to allow operation of valves without damaging the insulation.

● **APPLICATION OF INSULATION ON CHILLED WATER PUMPS**

75mm thick Expanded polystyrene (TF quality) shall be sandwiched between two aluminium sheets of 0.63mm thickness and properly clamped to pump in two semi-circular sections.

● **Insulation covered by false ceiling but not covered by cement plaster**

- i. Clean the pipes to be insulated thoroughly brushed and cleaned to ensure removal of all dirt, rust and grease preferably by using a suitable chemical solution.
- ii. Apply Bituminous primer.
- iii. Apply suitable cold adhesive on piping surface and internal surface of pipe sections at the rate of 1.5 kg/m<sup>2</sup> for each coat.
- iv. Fix specified thickness of expanded Polystyrene factory laminated with aluminum foil backed with Kraft paper and seal all the joints carefully with adhesive compound.
- v. All joints shall be sealed with 75 mm wide aluminum faced adhesive tape

Insulation of piping shall be carried out only after the piping has been satisfactorily tested for leaks at the desired working pressure or at specified test pressure. The insulation of piping shall be carried out by skilled workmen specially trained for the purposes. The method of insulation required to be adopted for each type of piping shall be as per bill of quantities.

● **Over deck Insulation (for Radiant Cooling Spaces)**

Over deck insulation shall be done with 50mm thick expanded polystyrene with a minimum density of 32 kg/m<sup>3</sup> (TF quality).

● **Method of Application**

- i. Lay 25.4 mm thick extruded polystyrene boards over prepared surface fixing with adhesive. Adhesive shall be strictly as per recommendations from manufacturer.
- ii. Lay 80 gsm geotextile fabric/polythene sheet over insulation board.

For radiant cooling system, the insulation shall be installed on clean slab in rooms only.

● **Thermal Expanded Polystyrene Slab Insulation (for radiant cooling):**

The insulation should be expandable polystyrene foam according to IS standard The thickness shall be 25 mm thick with density not less than 32 Kg/m<sup>3</sup>.

The insulation shall be installed on clean slab in rooms only. There shall not be uneven surface which will creating air gaps. The insulation shall be covered by polythene sheet 80gsm.

● **Basic Rail & Rail Clips:**

Basic Rails are required for guiding the installation of the pipes. To install tubing pipe clamping track system shall be used. This will align the pipes and keep them in straight line. The length to be 1m with pitch 150 mm for 20mm dia & 120mm for 16mm dia pipes. The track shall be fixed on EPS with the screws so that track remains in place.

● **Equipment:**

All equipment such as pumps & mixing tank shall be suitably insulated as required and as per manufacturer's requirements. The cost of such insulation is deemed to be included in the cost of equipment. The insulation shall be applied after applying of necessary primer.

- **APPLICATION OF ZINC CHROMATE COATING ON EXPOSED DUCT:**

External Surface of duct on which the Zinc chromate coating is to be provided shall be thoroughly cleaned with wire brush and rendered free from all dust and grease.

Apply three coat of zinc chromate coating evenly by brush with minimum total thickness of 1 mm.

- **Control Philosophy for Radiant System**

Central Network Controller with Primary bus and Display Unit:

It should be suitable to operate at 230 V + 2%. The load on relay output should be 4 (2) A / 240 V A.C. It should be suitable to operate at a ambient temperature range of 0°C to 50 °C. The product should have CE certification and in accordance with the EU standard. It should be equipped to display for overview and control of process.

The network controller shall be used on bus systems for regulation of radiant underfloor thermostats and display units and should be Bacnet/IP. The two main functions of controller shall be to manage and coordinate operations of bus devices connected to the installation and extend their performance compared to standalone function. Also it should act as interface for local supervision and remote control. It should be suitable for 230 V 50 Hz power supply, enables to manage upto 32 bus devices connected on primary bus, 2 analogue inlets for connection with active sensors, 2 analogue inlets for connection with passive sensors and it consent to connection with display unit.

Electronic Remote Control with sensor for controlling temperature & RH:

It should suitable to operate at a temperature range of 0 °C to 40 °C to register ambient temperature and humidity with LCD display, suitable for summer / winter switch, suitable to operate on bus signal network (secondary bus) and primary bus network controller. It should have integrated relay to drive actuators.

**Dew point sensors:**

Dew point sensors shall have measuring range of 70-85% RH and accuracy of +/-1 %

It shall be weather proof with an IP 55 enclosure. It should withstand the maximum pressure of 12 bar.

Manifolds are integrated with Pressure gauges which shall be of bourdon type with stainless steel construction of 150mm dia. and of range (0-12 bar) / (0-150 psi) as required and be complete with brass valves (3/8" Dia.) and SS tubing duly calibrated before installations. It shall be weather proof with an IP 55 enclosure

The thermostats with digital display and dew point sensors are located in the room on ground floor where the mixing tank and pumps are located. The Network controller shall also be located in this room. The Thermostat shall sense the temperature and Relative humidity inside the room where it is installed. These inputs are given to the Network controller. Network controller based on this inputs will control the temperature of water flowing to the radiant system. The dew point temperature sensor is also connected to the network controller and in-case of increase in humidity the network controller shall override the thermostat and increase the water temperature of the water flowing to radiant system above the dew point temperature. There shall be safety of 1.5 deg C above the dew point temperature for the water temperature flowing to the radiant system.

- **Electronic sensors and controllers**

- i. Electronic equipment shall be of the unit type with all elements readily removable for testing and replacement. Equipment shall be enclosed in a suitable housing.
- ii. Electronic sensor/controller shall be used to detect analogue signal (temperature humidity, etc.)

- iii. Thermostats shall be of the proportional type unless two-position instruments are required in these Specifications or diagrams.
- iv. In general, duct thermostat shall be of a remote sensor type. Sensing elements shall be located where they will respond to a representative temperature within the duct. Operating and adjusting mechanisms or controller shall be enclosed in metal or phenolic resin cases and shall be located on the outside of the ducts with covering. If the distance between the remote sensor and controller (operating/adjusting) panel exceeds the recommended maximum length, a remote transmitter, mounted on the outside of the duct, shall be used.
- v. Remote sensor shall be protected against damage. Capillary tubes or wires between sensor and operating mechanisms shall be protected by conduit, moulding or flexible armour. Excess capillary or wire lengths shall be neatly coiled and securely fastened out of the way. Capillaries or wiring shall pierce thermal insulation at the smallest practicable number of points. They shall be properly sealed wherever they pierce an insulation vapour seal.
- vi. Pipe thermostats, generally, shall be of a remote sensor type. Pipe shall be provided with suitable socket or thermo-well for sensor. Where the distance between the sensor and controller (adjusting/operating) panel exceeds the recommended maximum capillary or wire length, a remote transmitter shall be used. Protection of capillary tubing and wires shall be as specified for duct thermostats.
- vii. Room thermostats shall be securely attached to suitable bases mounted on the walls or other building surface. Each thermostat shall be located where shown or, if not shown where it will respond to the average temperature in the room. Thermostats, generally, shall be mounted with center line 1.50 m. above the floor and shall not be mounted on outside walls or light partitions between offices if other locations are more suitable. Thermostats mounted on outside walls shall be provided with insulated bases.
- viii. Room thermostats in which the adjusting mechanism is integral with the sensing element shall have locked or concealed adjustment devices by means of which the operating points can be adjusted through a range of not less than 50C, above and below the operating points specified. External thermometers and knob or lever adjusting devices (lockable type) shall be furnished on room thermostats.
- ix. Every electronic temperature control system shall be provided with one or more transformers to supply power for equipment operating at less than the normal lighting circuit voltage.
- x. Transformer shall be fed from the nearest air-conditioning switchboard.
- xi. Control transformer shall have ample capacity to operate simultaneously all apparatus connected to it and shall be capable of carrying a 25 percent overload. Transformers shall be of the open type with screw type terminals.
- xii. Relay shall be of electronic or electric type and shall be totally enclosed. Capacity shall be suitable for the loads controlled and contacts shall be as specified for thermostats.

● **Electric actuators and motors**

- i. Controlled voltage shall be either 220V or 24V as specified on the Drawings.
- ii. Valve and damper motors shall be of the proportional or on off type in accordance with thermostat or controller and shall be quiet in operation. All motorized valves for air handlers shall be returned to close position when fan motors being turned off.
- iii. Operating speeds of valve and damper motors shall be selected or adjusted so that the motors will remain in step with the controller without hunting, regardless of load variations. Motors operating in sequence with other motors shall have adjustable operating ranges and starting points to permit adjustment of the control sequence as required by the operating characteristics of the system.

- iv. Damper motors may be mounted either inside or outside of the duct or casing. If install outside, they must be mounted on supporting plates that are completely outside the covering. On casings or ducts handling cold air, the supporting plates shall be installed in a manner that will prevent condensation on cold surface.
- v. Valve and damper motors shall be of rugged construction and quiet in operation. When operated at rated voltage, each motor shall be capable of delivering not less than twice the torque required by the valve or damper and shall withstand, without damage, continuous stalling.
- vi. Motors shall function properly with a 12 per cent plus or minus change in line voltage supplying to the equipment.
- vii. Motors shall be of either the hydraulic or geared type. Motor-driven pinions and high speed gears may be made of a suitable non-metallic composition to insure quiet operation, while others may be of steel or bronze. Shaft shall be hardened steel, running through bronze, hardened steel, nylon or other suitable sleeves or ball bearings. Lever arms shall be attached to motor shafts with setscrews or other secure and adjustable means.
- viii. Motors and gear trains shall be totally enclosed in dust proof housing of pressed steel or cast metal with conduit entries. Gear trains shall be oil-immersed.
- ix. Two-position motors shall be of the single direction, spring return (stall) or reversing type. Proportioning motors shall be of the reversing, shaded pole or capacitor induction type, capable of stopping at any point in the cycle and starting in either direction from any points. Reversing and proportioning motors shall have limit switches to limit the lever travelling in either direction. Every valve motor shall be equipped with a spring yield device so that, when in the closed position, it will maintain on the valve disc a pressure equivalent to that of the valve.
- x. Motor actuator shall be selected with sufficient close-off rating according to the actual system.

● **Testing**

The entire system and instrumentation shall be tested for proper operation after commissioning of the plant.

**PROGRAM LOGIC CONTROLER(PLC):**

Supply, installation testing & commissioning of PLC Panel suitable for requirement as mentioned below details provided

"It shall be possible to printout the ladder / logic diagram on the PLC printer. In addition, printer shall also be able to print the following.

- a) Diagnostic messages, as and when they appear.
- b) Diagnostic report when called for.
- c) Processor alarms connected to PLC as and when they appear and alarm report whenever initiated.
- d) Shut down report as and when initiated.
- e) I/o map showing status of all inputs and Corresponding outputs in a user defined format.

The PLC console shall be provided with self-diagnostics feature, which shall display error messages and initiate an audible alarm if the fault is detected.

- " The diagnostic shall include but not limited to the following:
- " Failure of main or I/O processor
- " Memory faults, both PROM and EPROM
- " Microprocessor faults
- " Communication faults
- " I/O interface or address faults
- " Voltage signal discrepancy on input and output
- " Power supply faults
- " Output loop check

## Design Parameters:

### **FOR CENTRAL PLANT: FOR RADIANT COOLING**

#### SCOPE OF WORK AND BASIS OF DESIGN

The scope of work: Section includes design, performance criteria, refrigerants, controls, and installation requirements for VFD based water-cooled Screw chillers.

Location of Chillers Installation is AC Plant-2, in parallel with existing Radiant Cooling Chillers.

The minimum 01Nos.275 TR working chiller to be provided with all associated equipment (i.e., Auto Tube cleaning system, chilled water pumps, condenser pumps, cooling towers etc.). The quantity of the chillers may vary based on the final approved design report and detail Engineering drawings, to be submitted by contractor to the Engineer-In-charge for approval. For any additional/standby chiller if required as per the final approved design, the quantity deviation may be executed with the approval of Competent Authority.

The contractor (Associated Consultant) has to prepare detail heat load calculations of the radiant cooling system to be installed at hostel buildings and also the detailed engineering calculations for the high side equipment which needs to be installed in AC plant-2 should be submitted to the Engineer-In-Charge for final approval.

All Civil foundations works for Chillers, Motor pump sets, associated equipment and structure for cooling tower included in this scope of work.

Supply and install as shown in the enquiry, factory assembled, and factory run tested fully imported water-cooled rotary screw packaged chillers in the quantity specified. Each chiller shall consist of accessible semi-hermetic rotary Mono/Twin screw compressors with discharge service vales, one no shell and tube Flooded type evaporator, water-cooled condenser, microprocessor-based control panel and all components necessary for safe and controlled unit operation. Rubber pad vibration isolators will be provided.

#### **Design Requirements**

General: Provide a complete screw compressor packaged chiller as specified herein and any local codes in effect.

Performance: Refer to the schedule of performance as given in the enquiry. The chiller shall be capable of stable operation to a minimum of 25% of full load. Performance shall be in accordance with ARI Standard 550 / 590 - 2003. The full load power consumption at design condition should be less than 0.58 IKW/TR and NPLV should be Less than 0.33 IKW/TR and COP at ARI condition should be 5.6 and IPLV COP 9.8.

There will be a power loading based on NPLV to be computed using IKW/TR value furnished at 120 % 75 %, 50 %, 25 % with constant condenser water entering temperature.

Acoustics: Sound pressure levels for the units shall not exceed 85 dBA at 1m from the unit. The manufacturer shall provide the necessary sound treatment to meet these levels if required.

#### **Chiller Components**

##### **Compressor:**

The unit shall have Semi hermetic Accessible compressor and **the compressor make should be same as the chiller manufacturer. The compressor must be field serviceable**, semi hermetic Twin/ Mono-screw direct driven type (Hermetic / open type/geared type screw chillers are not acceptable) . Liquid refrigerant shall be used for cooling and sealing the rotor interfaces. The screw compressor should be

suitable for R134A refrigerant

**Electric Motor:**

Electric Motors: Compressor motors shall be high torque, two pole, semi-hermetic, squirrel cage induction type with inherent thermal protection on all three phases and cooled by suction gas. Discharge gas cooled designs are not acceptable.

**Evaporator**

Evaporator shall be of the flooded design, 2-pass (1,3 pass arrangements not acceptable), shell-and-tube type with copper tubes rolled into steel tube sheets. It shall be insulated with 3/4-inch (19 mm) closed cell polyurethane insulation and designed for 150 psi (1234 kPa) water side working pressure and 203 psi (1400 kPa) refrigerant side pressure. It shall be designed and stamped as per ASME and equipped with spring loaded relief valves. And inlet right hand with flange connection with counter flanges. Pressure drop shall not exceed 12 metres water column.

**Condenser**

Condenser shall be of horizontal, 2-pass (1,3 pass arrangements not acceptable), shell and finned tube type with steel shell and integral finned copper tubes rolled into steel tube sheets. The condenser shall be equipped with intermediate tube supports and construct / designed and stamped as per ASME. It shall be designed for 150 psi (1234 kPa) water side working pressure and 203 psi (1400 kPa) refrigerant side pressure. It shall have pressure relief valves. Pressure drop shall not exceed 7 metres water column.

**Refrigerant Circuit:**

The unit shall be provided with single circuit in order to obtain part load benefits.

**Expansion Device:**

Electronic expansion valve modulating main expansion valve type controlled by a pilot float valve to perfectly modulate refrigerant flow to the evaporator, proportionally to the required capacity.

**Starter:**

- Starter: Starter shall be of VFD Starter and capable of starting the compressor under all load conditions. **The starting current of the chiller should be less than RLA.** Compressor motors will be protected internally with thermal sensors and externally with an overload relay. Starters will also be equipped with a phase failure and phase reversal protection device that will safely shut down the compressor.
- Provide enclosed variable frequency drives suitable for operation at the current, voltage, and Power indicated on the schedule. 1.02 RATINGS A. VFD must operate, without fault or failure, when voltage varies plus 12% or minus 15% from rating, and frequency varies plus or minus 5% from rating.
- VFD shall be 415 volts, 50 Hz, 3 Phase, Displacement Power Factor: 0.98 over entire range of operating speed and load, Service factor: 1.0
- Operating Ambient Temperature: NEMA 1 (IP20): -12°C to 40°C (deration up to 50°C with 2% of current per 1°C raise in temperature) , IP00 : up to 60°C with deration ( 2% of current per 1°C raise in temperature)
- Ambient storage temperature: -20°C to 70°C , Humidity: 0% to 95% non-condensing. Altitude: to 3,300 feet (1200m), higher altitudes Achieved by derating.
- Vibration: 9.81m/s<sup>2</sup> (1 G) maximum at 12 to 20 Hz, 2.0 m/s<sup>2</sup> (0.2 G) at 20 Hz to 55 Hz.
- Minimum Efficiency: 96% at half speed; 98% at full speed.
- Starting Torque: 120% starting torque shall be available from 0.5 Hz. to 60 Hz.

- Overload capability: 120% of rated FLA (Full Load Amps) for 60 seconds; 150% of rated FLA peak.
- Controlled speed range of 40:1
- The VFD's shall include EMI/RFI filters. The RFI filter shall allow the entire VFD assembly to be CE Marked and the VFD shall meet product standard EN 61800-3
- Total Harmonic Distortion (THD) compliance: Given the information provided by the customer's electric power single line diagram and distribution transformer data, the VFD manufacturer shall carry out an analysis of the system. The analysis reviews the potential for the proposed equipment, and any existing equipment, to meet IEEE 519,1992 recommendations at the Point of Common Coupling (PCC). The result of the analysis shall determine if additional power quality improvement measures should be included in the proposal to meet the THD recommendations of IEEE 519. The PCC shall be at the primary side of the main distribution transformer.
- VFDs must be suitable for use on a circuit capable of delivering not more than 120,000 RMS symmetrical amperes.

## VFD DESIGN

- VFD shall employ microprocessor-based inverter logic, isolated from all power circuits.
- VFD shall include surface mount technology with protective coating.
- VFD shall employ a PWM (Pulse Width Modulated) power electronic system, consisting of:
- Input Section:
  - a. VFD input power stage shall convert three-phase AC line power into a fixed DC voltage via a solid state full wave diode rectifier, with MOV (Metal Oxide Varistor) surge protection.
  - b. DC bus choke to minimize reflected current.
- Intermediate Section:
  - a. DC bus as a supply to the VFD output Section shall maintain a fixed voltage with filtering and short circuit protection.
  - b. DC bus shall be interfaced with the VFD diagnostic logic circuit, for continuous monitoring and protection of the power components.
- Output Section
  - a. Insulated Gate Bipolar Transistors (IGBTs) shall convert DC bus voltage to variable frequency and voltage.
  - b. The VFD shall employ PWM sine coded output technology to power the motor.
- The VFD must be rated for operation at a carrier frequency of 5 kHz to satisfy the conditions for current, voltage, and Power as indicated on the equipment schedule.
- VFD shall have an adjustable carrier frequency, from 1 kHz to 12.5 kHz (Above 220 Kw from 1 kHz to 5 kHz)
- VFD Must include an adjustable dynamic noise control for quiet motor operation
- VFD shall have all major field bus communication, Modbus/Memo bus, Profibus, Profinet, Ethernet, Can Open, Device net etc

- FD shall include two independent analog inputs. Selectable for either 0-12 VDC or 4-20 mA. Either input shall respond to a programmable bias and gain.
- VFD shall include a minimum of seven multi-function digital input terminals, capable of being programmed to determine the function on a change of state. These terminals shall include, but not limited to:
  1. Remote/Local operation selection
  2. Customer Safeties
  3. BAS / Damper Interlock
  4. Emergency Override
  5. Pre set Speed
  6. PI control enable / disable
- VFD shall include two selectable 0-12 VDC or 4-20 mA analog outputs for monitoring, or "speed tracking" the VFD. The analog output signal will be proportional to output frequency, output current, output power, PI (Proportional & Integral control) feedback or DC bus voltage.
- VFD shall provide terminals for remote input contact closure, to allow starting in the automatic mode.
- VFD shall provide 24 Vdc, 150ma transmitter power supply
- VFD shall include at least one external fault input, which shall be programmable for a normally open or normally closed contact. These terminals can be used for connection of fire stats, freeze stats, high pressure limits or similar safety devices.
- VFD shall include three programmable form "A" contacts and one fixed "Fault" form "C" contact, capable of being programmed to determine conditions that must be met in order for them to change state. These output relay contacts shall be rated for at least 2A at 120 VAC and shall include, but not limited to:
  1. Speed agree detection
  2. Damper control
  3. Hand / Auto Status
  4. No load detection (broken belt alert)
  5. Contactor Control for External Bypass
  6. Drive Faulted
  7. Serial communication status
- VFD shall include a power loss ride through capable of 2 seconds.
- VFD shall have DC injection braking capability, to prevent fan "wind milling" at start or stop, adjustable, current limited.
- VFD shall have a motor preheat function to prevent moisture accumulation in an idle motor.
- VFD shall include diagnostic fault indication, time and date stamped faults storage and heatsink cooling fan operating hours.
- VFD shall have a digital operator with program copy and storage functions to simplify set up of multiple drives. The digital operator shall be interchangeable for all drive ratings.
- VFD shall include a front mounted, sealed keypad operator, with an English language illuminated LCD display. The operator will provide complete programming, program copying, operating, monitoring, real time clock and diagnostic capability. Keys provided shall include



industry standard commands for Hand, Off, and Auto functions.

- VFD plain language display shall provide readouts of; output frequency in hertz, PI feedback in percent, output voltage in volts, output current in amps, output power in kilowatts, D.C. bus voltage in volts, interface terminal status, heatsink temperature and fault conditions. All displays shall be viewed in an easy-to-read illuminated LCD.
- VFD shall have an internal time clock. The internal time clock shall include a backup via battery. The time clock will be used to date and time stamp faults and record operating parameters at the time of fault. The internal time clock can be programmable to control start/stop functions, constant speeds, PID parameter sets and output Form-C relays.
- VFD unit shall include the following meters to estimate use of energy: 1. Elapsed Time Meter 2. Kilowatt Meter 3. Kilowatt Hour Meter
- VFD shall include a user selectable PI control loop, to provide closed loop set point control capability, from a feedback signal, eliminating the need for closed loop output signals from a building automation system. The PI controller shall have a differential feedback capability for closed loop control of fans and pumps for pressure, flow or temperature regulation in response to dual feedback signals.
- VFD shall have an independent, PI loop that can be used with a second analog input that will vary the VFD analog output and maintain a set point of an independent process (valves, dampers....).
- The VFD shall include HVAC specific application macros. The macros can be used to help facilitate start-up. The macros will provide initialization to program all parameters and customer interfaces for a particular application (Fans, Pumps and Cooling Towers) to reduce programming time
- An energy saving sleep function shall be available in both open loop (follower mode) and closed loop (PI) control, providing significant energy savings while minimizing operating hours on driven equipment. When the sleep function senses a minimal deviation of a feedback signal from set point, or low demand in open loop control, the system reacts by stopping the driven equipment. Upon receiving an increase in speed command signal deviation, the drive and equipment resume normal operation.
- VFD shall include loss of input signal protection, with a selectable response strategy including speed default to a percent of the most recent speed.
- VFD shall include electronic thermal overload protection for both the drive and motor. The electronic thermal motor overload shall be approved by UL. If the electronic thermal motor overload is not approved by UL, a separate UL approved thermal overload relay shall be provided in the VFD enclosure.
- VFD shall include the following program functions:
  1. Critical frequency rejection capability: 3 selectable, adjustable dead bands.
  2. Auto restart capability: 0 to 12 attempts with adjustable delay between attempts.
  3. Ability to close fault contact after the completion of all fault restart attempts.
  4. Stall prevention capability.
  5. "S" curve soft start / soft stop capability.
  6. Bi-directional "Speed search" capability, in order to start a rotating load.
  7. 14 preset and 1 custom volts per hertz pattern.

8. Heatsink over temperature speed fold back capability
9. Terminal status indication.
10. Program copy and storage in a removable digital operator.
11. Programmable security code
12. Current limit adjustment capability, from 30% to 200% of rated full load current of the VFD.
13. Motor pre-heat capability
14. Input signal or serial communication loss detection and response strategy.
15. Automatic energy saving function.
16. Under torque/Over torque Detection.
17. Fan failure detection and selectable drive action
18. Bump less" transfer between Hand and Auto modes
19. Seven preset speeds
20. VFD shall include factory settings for all parameters, and the capability for those settings to be reset.
21. VFD shall include user parameter initialization capability to re-establish project specific parameters
22. VFD shall include programmable HVAC specific application macros
23. USB Type B port for quick and easy PC Connection
24. VFD shall include the capability to adjust the following functions, while the VFD is running:
  - Speed command input.
  - Acceleration adjustment from 0 to 6000 seconds.
  - Deceleration adjustment from 0 to 6000 seconds.
  - Select from 7 preset speeds.
  - Analog monitor display.
  - Removal of digital operator.

### Electrical Panel

1. The control section shall contain a microprocessor controller providing operating and equipment protection controls.
2. The power section shall include VFD starters, a control transformer with primary and secondary fusing, microprocessor transformers with fusing, standard power blocks. The control panel shall have a hinged, tool-locked door.
3. **The starting current of the chiller should be less than RLA.**
4. The control system shall stage and load the compressors based on the leaving water temperature. Equipment protection devices controlled by the microprocessor shall include motor protection, high pressure, and loss of water flow, freeze protection, and low refrigerant pressure.
5. Controls shall include auto/stop switch, chilled water set point adjustment, anti-recycle timer, and digital display with water temperature and set point, operating temperatures and pressures, and diagnostic messages.
6. The following features and functions shall be included:
  - a. The control logic shall be designed to maximize operating efficiency and equipment life with protections for operation under unusual conditions.
  - b. The system shall intelligently stage the unit to sustain leaving water temperature precision and stability while minimizing compressor cycling.
  - c. Password protection for set point adjustment.
  - d. Durable liquid crystal display (LCD) screen type mounted on the unit controller. Default language and units of measure shall be English and I-P respectively. Messages shall be in plain English. Coded messages, LED indicators and LED displays are not acceptable.
  - e. Non-volatile program memory allowing auto-restart within 2 months after a power failure without requiring a UPS (un-interruptible power supply).
  - f. Start-to-start and stop-to-start cycle timers, providing minimum compressor off-time while maximizing motor protection.
  - g. Must have a lead-lag function with factory supplied compressor staging for part-load operation by manual selection or automatically by circuit run hours.

- h. Pro-active compressor unloading when selected operating parameters exceed design settings, such as high discharge pressure or low evaporator pressure.
  - i. Diagnostic monitoring of unit operation, providing a pre-alarm signal in advance of a potential shutdown, allowing time for corrective action.
  - j. Chilled water flow switch to be field mounted in the chilled water line and field wired to terminals in the control panel.
7. The unit controller shall support operation on a Modbus® network via a factory-installed communication module.

**Automatic Tube Cleaning System for Chiller:**

**Scope of work includes Supply, Installation & Testing and Commissioning of Auto Tube Cleaning System suitable to chiller capacity.**

Auto Tube cleaning System is the most efficient and automatic on-line solution for keeping shell and tubes heat exchangers continuously clean and working at full capacity.

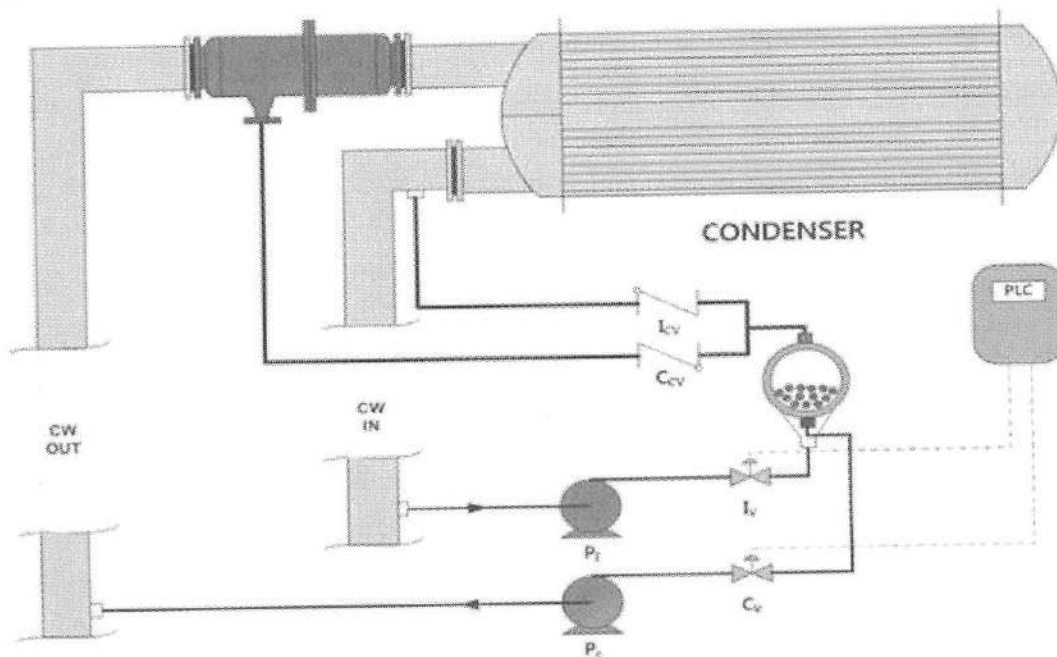
Individual PLC logic-controlled motors pump set to be provided for circulation of balls in the condenser along with all required accessories and power cables.

NOTE: (i) All the HVAC Equipment including Chillers, Pumps, Cooling Towers, building Radiant Cooling system Equipment shall be BMS communicable and the contractor shall provide all the necessary equipment and hardware to ensure and establish the BMS communication with third party BMS system.

(ii) All the HVAC pumps and Cooling Towers at HVAC Plant room(High side) shall be provided with VFD based starter only with standby suitable starter in case of failure of VFD.

(iii) The Chiller Plant Manager(CPM) shall be provided for the new chillers with all the necessary equipment and the same shall be smoothly integrated with the existing CPM at AC Plant-2. The contractor shall submit all the technical details to the Engineer-In-charge for approval before the procurement of the same at site.

**ATCS:**



**System Description:**

ATCS Process consists of injection of sponge ball through the condenser / heat exchanger tubes which keeps the tube clean. ATCS consist of specially designed sponge balls which are injected with the help of small booster pump operating periodically in main water line with some velocity. These balls are somewhat bigger than diameter of tubes and then these sponge balls pass through the tubes removing deposits, because of their frequent operation the balls doesn't allow any accumulation of deposits in the tubes and then balls are trapped in ball trap which is fitted to outlet pipe of condenser and balls are carried back to the collector.

Pi = Injection Pump

Pc= Collector Pump

Entire design, supply, installation of ATCS should be as per the recommendations of Chiller Original Equipment Manufacturer.

### **ELECTRICAL FOR HVAC EQUIPMENT**

All Electrical items & BMS Specification for HVAC to be considered from electrical & BMS services specifications respectively.

### **PAINTING WORK**

All equipment shall be painted as specified under respective headings. Grilles/ diffusers shall be powder coated as per approved colour matching with interiors. The contractor has to get approval of the quality and colour of paints for all types of painting work.

All pipes for chilled water shall be painted with two coats of minimum 80 DFT of each coat as per standard code of practice and arrows indicating direction of flow of water shall be marked.

### **Color scheme for the plant and equipment**

- i. Colour scheme for equipment like pumps, AHUs etc shall be as per manufacturer's standard colour scheme,
- ii. The scheme of colour code painting of pipe work services for air conditioning installation shall be as per National building code and is indicated below:
- iii. Colour bands shall be 150mm wide, superimposed on ground colour to distinguish type and condition of fluids. The spacing of band shall not exceed 4.0m.

In addition to the colour bands specified above all pipe work shall be legibly marked with black or white letters to indicate the type of service and the direction of flow identified as follows:-

Description	Ground colour	Lettering colour	First colour band
Chilled water piping	Sea Green	Black	Black
Central heating piping Below 60 deg C	Sea Green	Black	Canary Yellow
Central heating piping 60 deg C to 120 deg C	Sea Green	Black	Dark Violet
Drain pipe	Black	White	
Vents	White	Black	

Valves and pipe line fittings	White with black handles	Black	
Belt guard	Black & Yellow diagonal strips		
Machine Bases, Inertia Bases and Plinth	Charcoal Grey		
Steel Support	Black		
Pump sets	Battle Ship Grey		
Direction of flow of water	White arrows		
Electrical Panel/Sub Panel/ Remote Control Console	Light grey or any approved colour		
Cable Trays & Duct Support	Black		

#### NOISE CRITERION AND VIBRATION ISOLATION:

All air conditioning equipment and materials (like chillers, pumps, cooling towers, motors, fans, ducts, grilles, acoustic lining etc.) will be selected, designed and installed in such a manner that the system shall be free of vibration and disturbing sound. The noise levels in conditioned occupied spaces due to all air conditioning equipment will not exceed as specified in bill of quantities and as listed below.

S.No.	Item	Max. Noise Level dB (A) 1m	Vibration isolators requirement
1	Water cooled Chillers	80	Cushy foot mounts or neoprene rubber pads with GI sheet between them as per manufacturer's product catalogue.
2	Water circulating pumps	80	Cushy foot mounts as per manufacturer's product catalogue.
3	Cooling Tower	80	Cushy foot mounts as per manufacturer's product catalogue.
4	Axial flow fans	65 (if not mentioned in BoQ)	Spring type vibration isolator in the hanging arrangement

#### NOTES

##### A. Test Instruments

- All instruments for testing shall be provided by the contractor.
- Thermometers used for measurement of temperature of *water* / refrigerant shall have graduation of 0.1 deg C and shall be got calibrated from N.P.L. or any recognized test house before hand.
- Thermometers used in the psychrometers shall have graduations of 0.2 deg C and shall be calibrated as at (2) above.
- Pressure gauges shall also be got calibrated before hand from a recognized test house.
- Orifice type of flow meters shall be used for measuring flow rate through the condensers and chillers.

##### B. CAPACITY COMPUTATIONS

###### 1. Condensing unit:

The capacity shall be computed from the water temperatures and water flow rate measurements of the condenser water and the compressor motor current readings. A reference may be made, if necessary to the manufacturer's motor performance characteristics for arriving at the B.H.P. consumption.

2. Water chilling unit:

The capacity shall be computed from the water temperature and water flow rate measurements of the chiller. Heat rejection from the condenser shall be computed from the water temperature and water flow rate measurements at the condenser.

3. Cooling Tower:

Water quantity measured at the condenser and the temperature of water at the cooling tower shall be recorded. Wet bulb approach shall be checked against design data recorded in the tender documents. Capacity and specifications of the Cooling tower will be as specified or approved by Engineer-In-Charge.

4. For the purpose of system capacity, the refrigeration tonnage obtained from the main refrigeration plant will be accepted.

5. If due to any reason, internal load mentioned in the tender specifications is not available psychometric computations for actual load conditions will be done and the plant, if found satisfactory will be accepted.

## **INSPECTION, TESTING AND COMMISSIONING**

### **Scope**

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

### **Factory Testing:**

One chiller unit of each type and capacity shall be factory tested for performance at 4 points as per recommendation of Engineer-In-Charge at the rated conditions by simulating the actual design conditions and witnessed by representatives nominated by Engineer-In-Charge. All the chillers shall be witnessed physically during the factory testing. All the expenses for travel, boarding, lodging, testing etc. shall be borne by contractor. All controls and switchgear shall be tested for proper functioning and set of design values. The capacity in kcal/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 within tolerances as stipulated by AHRI. All instruments and personnel for tests shall be provided by the contractor. Contractor shall inform the Employer about the chiller testing schedule min. 12 to 15 days before the chiller is ready for factory testing.

The testing procedure for cooling tower shall be as per CTI standards & codes.

### **Initial Inspection & testing at Manufacturer's Works**

i) Initial inspection of materials & equipment at manufacturer's works will be done by the Engineer-In-Charge or his representative. For item/ equipment requiring initial inspection at manufacturer's works, the contractor will intimate the date of testing of equipment at the manufacturer's works before dispatch. The contractor shall give sufficient advance notice regarding the dates proposed for such tests to the department's representative(s) to facilitate his presence during testing. The Engineer-In-Charge at his discretion may witness such testing. Equipment will be inspected at the manufacturer/ authorized dealer's premises, before dispatch to the site by the contractor.

ii) The Engineer-In-Charge also reserves the right to inspect the fabrication job at factory and the successful tenderer has to make arrangements for the same.

iii) The materials duly inspected by Engineer-In-Charge or his authorized representative shall be dispatched to site by the contractor.

## **Initial Inspection at Site**

### Electric motors

Electric motors should be of specified make, manufacturer's test certificate for electric motor shall be furnished.

### Pipes and Valves

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

### Insulation and acoustic lining

- a) Physical verification for thickness and make should be made as per contract before application of insulation.
- b) Manufacturer's test certificate for density should be furnished.

## **Final Inspection & Testing**

Final Inspection & testing will be witnessed by the Engineer-In-Charge or his representative.

- i. After completion of the entire installation as per specification in all respects, the contractor shall demonstrate trouble free running of the AC equipment and installation for a period of minimum 120 hours of running.
- ii. After the trial run, the contractor shall offer the plant for the seasonal test, namely test for summer or monsoon whichever occurs earlier.
- iv. The equipment capacity computations shall be carried out.
- iii. The input kW of the unit/ TR at full load shall also be checked against contract requirements, if any
- iv. Pressure drops across chiller and condenser at specified flow rates shall be checked against the contract requirements.
- v. All instruments for testing shall be provided by the contractor. The accuracy of the instruments shall be as follows:
  - Temperature: Liquid in glass thermometer having accuracy  $\pm 1$  deg. C as per IS:4825.
  - Wet bulb Temperature: Sling psychrometer confirming to IS: 6017.

Scale Error: For less than 0 deg. C: 0.3 deg.C  $\pm$  0.2 deg.C

For over 0 deg. C: 0.2 deg.C  $\pm$  0.1 deg.C

Pressure Gauge: With the accuracy of  $\pm 1\%$  for maximum scale value from 12 to 90% and  $\pm 1.9\%$  for maximum scale value for rest of the scale conforming to IS:3695.

Water flow meter: Water flow shall be measured using the arrangement installed as per schedule of work.

## **Safety measures**

All equipment shall incorporate suitable safety provisions to ensure safety of the operating personnel at all times. The initial and final inspection reports shall bring out explicitly the safety provisions incorporated in each equipment.

## **Testing Of Air-Conditioning System**

Routine and type tests for the various items of equipment of the system shall be performed at the Contractor's own cost and test certificates are to be submitted.

The performance tests to determine whether or not the full intent of the specification is met shall be conducted by the contractor. After notification to Engineer-In-Charge that the installation has been completed and the plant has run continuously for a period of at least one week. The contractor shall conduct under the direction and the presence of Engineer-In-Charge such tests as specified to establish the capacity of various equipment supplied and installed by the contractor.

#### **TEST PROCEDURE:**

##### **Design Conditions:**

The inside and outside conditions shall be recorded on hourly basis. The outside and inside dry bulb and wet bulb temperatures shall be recorded by means of a sling psychrometer with mercury thermometers. The relative humidity shall be computed from the psychometric chart. The inside dry bulb temperature and relative humidity shall fall within the specified limits.

##### **Capacity of the Plant:**

The following aspects shall be checked before conducting the performance tests:

- a. The outside conditions shall be as close to the design values as possible.
- b. The internal loads of various spaces shall be close to the design values as far as possible. Otherwise, internal loads shall be simulated to a value required to satisfy the design condition.
- c. The plant shall be fully loaded and the temperature stabilized.
- d. Hourly readings of water flow shall be recorded.
- e. Hourly readings of pressure, temperature, electrical current, voltage and power factor shall be recorded.

#### **Compressor**

The following readings shall be recorded:

- a) Suction gas pressure
- b) Discharge gas pressure
- c) Suction gas temperature
- d) Discharge gas temperature
- e) Readings of ammeter, voltmeter & power factor meter.

Same pressure gauge shall be used for different measurements and the same thermometer shall be used for different temperature measurements. The capacity of the compressor shall be computed from the performance chart supplied by the manufacturer.

$$\text{KW/Ton of the compressor} = \frac{\text{Power Input in KW}}{\text{Compressor capacity in TR}}$$

#### **Water System**

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

- Test and adjust all pumps to deliver the proper GPM. Record rpm, motor amperage, discharge and suction pressure. Pumps shall operate without objectionable noise or cavitation. Plot actual pump and system performance points on manufacturer's pump curves.
- Check all expansion tanks for proper filling pressurization. Verify operation of automatic fill and relief valves.
- Check the operation of all automatic valves.
- Test and adjust correct water flow through chiller, major items of equipment and main water circuits. The balancing valves, provided on the equipment shall be used for adjustment.



- Check capacity output of chillers and set water flow rate for proper data.
- Check and adjust each coil to provide proper GPM. Record water and air temperature changes and water pressure drop.
- Set pressure drops across coil by-pass to match coil full-flow pressure drop.

**Balancing Tolerance:**

Systems shall be balanced within the following tolerances:

Duct leakage Rates (at operating pressures)  
 Low pressure ducts                    5% of full flow  
 (0 to 0.5 kPa)

Medium Pressure ducts                1% of full flow  
 (0.5 to 3 kPa)

High Pressure ducts                    1% of full flow  
 (Greater than 3 kPa)

Air flow rates

Under 70 l/s                            12% of flow

Over/ at 70 l/s 5% of flow

Water flow rates

Chilled Water                          2% of flow  
 Other                                      5% of flow

Head flow rates  
 Heat exchangers                        5% of design capacity

**Performance Testing at Various Loading Conditions:**

The performance tests shall be conducted for various loads such as 120%, 75%, 50% and 25% of the capacity of the plant.

**Functional Tests**

**Electrical Equipment:**

All the cables shall be tested for continuity and absence of cross phasing. Insulation resistance between the phase conductors and the earth shall be measured with the help of a 500 V megger.

**Motors:**

- Insulation Resistance of all motors shall be tested with megger and the value shall not be less than 1 Meg-ohm.
- Starting current shall be recorded.
- Starter operation shall be checked for single phasing by removing one of the phases.
- Overload protection shall be checked by altering the starter thermal overload setting.

**Safety Devices & Controls:**

- Interlocks for compressor motor with that of chilled water pumps shall be checked.
- Flow switches in chilled water lines shall be checked.
- High pressure-stat shall be checked by varying the setting of the cutout.
- Low pressure stat shall be tested by closing the pilot solenoid valve.
- Anti-freeze thermostat shall be tested by varying the setting.
- Oil failure switch shall only be tested by varying the setting.
- Functions of safety device and controls to be checked.

## CAPACITY CONTROL:

The capacity control arrangement shall be tested by varying the load on the plant. Any other procedure recommended by the manufacturer's may be adopted with prior permission.

The following readings shall be recorded hourly during the tests and capacity of the plant shall be computed.

- **Compressor**
  - a. Suction pressure - kg/cm<sup>2</sup> (psi)
  - b. Suction temperature - oC (oF)
  - c. Discharge pressure - kg/cm<sup>2</sup> (psi)
  - d. Condensing Tempr. - oC (oF)
  - e. Oil pressure - kg/cm<sup>2</sup> (psi)
  - f. Compressor Speed - RPM
- **Compressor motor:**
  - a. Rated capacity - HP
  - b. Rated volts - Volts
  - c. Rated current - Amps
  - d. Starting current - Amps
- **Power consumption for 120%, 75%, 50% & 25% loads**
  - a. Motor current in amps. - Amps
  - b. Voltage - Volts
  - c. Starting current. - Amps
- **Condensor**
  - a. Refrigerant condensing pressure - kg/cm<sup>2</sup> (psi)
  - b. Refrigerant condensing Temp. - oC (oF)
  - c. Temp. of water entering - oC (oF)
  - d. Temp. of water leaving - oC (oF)
  - e. Water flow rate - lit/sec. (gpm)
- **Evaporator**
  - a. Réfrigérant evaporating pressure - kg/cm<sup>2</sup> (psi)
  - b. Réfrigérant evaporating Temp. - oC (oF)
  - c. Water flow rate - lit/sec. (gpm)
  - d. Entering water temp. - oC (oF)
  - e. Leaving water temp. - oC (oF)
  - f. Pressure drop through chiller - kg/cm<sup>2</sup>

## RUNNING IN PERIOD & DATE OF ACCEPTANCE

- a. After the installation work has been completed by the contractor, tests shall be conducted by the contractor and necessary adjustments shall be made satisfying that the plant including low side equipment is capable of continuous running. There after contractor will offer to the employer a running-in period of 7 days subject to a minimum aggregate of 120 hrs at his cost. The duty cycle of the plant during this running in period shall be same as that specified in the tender documents. In case of multiple compressor installations, all the compressors should be run by rotation. The plant will be operated and a log of all parameters will be maintained during this period. The contractor will be free to carry out necessary adjustments etc. during this period without stopping the plant. Record of inside conditions will be made during this period to check the same are as per tender requirements. The plant will be said to have successfully completed the running-in-period, if no break down or abnormal/ unsatisfactory operation of any machinery occurs during this period. After this the plant will be made available for beneficial use. After the plant has operated without any major break down/ trouble and inside conditions are maintained as per tender requirements for the above specified running in period, it shall be taken over by the employer subject to guarantee clause mentioned below. This date of taking over of plant after trouble free operation during the running in period shall be the date of acceptance.

- b. Any loss of refrigerant or oil during the running in period shall be made good by the contractor free of charge.
- c. Capacity test of the chilling unit & other major equipment shall be carried out as and when conditions become stabilized
- d. Seasonal testing may be carried out as & when outside conditions become suitable.

#### **GUARANTEE**

- a. The contractor shall guarantee that the air-conditioning plant and system shall maintain the desired inside temperature within  $\pm 1$  °C and relative humidity within  $\pm 5\%$ .
- b. The contractor shall guarantee the system to be free from disturbing vibrations and noise.
- c. The contractor shall guarantee that the capacity of various components as well as the whole system shall not be less than specified.
- d. The contractor shall guarantee that the power of various components as well as the whole system shall not be more than specified.
- e. The contractor shall guarantee the complete system to maintain the specified conditions under all conditions of ambience and internal loads subject to the condition that designed outside conditions & designed internal loads are not exceeded. Also, the inlet / outlet temperatures at the specified flow of water in the chiller unit shall be guaranteed.
- f. All equipment shall be guaranteed for a period of 12 months from the date of acceptance and taking over of the installation by the employer against unsatisfactory performance and/or breakdown due to defective design, material, manufacture, workmanship or installation. The equipment or component or any part thereof so found defective during the guarantee period shall be repaired or replaced free of cost to the satisfaction of the Engineer-In-Charge. In case it is felt by the employer that undue delay is being caused by the contractor in doing this, the same will be got done by the employer at the risk & cost of the contractor. The decision of Engineer-In-Charge in this regard shall be final.
- g. Any leakage of refrigerant and/or oil due to defective design, manufacture, and workmanship installation during the guarantee period shall be made good by the contractor free of charge.

#### **TENDER DRAWINGS FOR APPROVAL & COMPLETION DRAWINGS**

The drawings provided to the bidder with the tender documents give a general scheme of the system and are not meant to be the working drawings. The contractor shall furnish the shop drawings (fabrication drawings) to be sent to the Engineer-In-Charge, of all the equipment/ layouts after award of the contract and the same shall be approved by the Engineer-In-Charge. No work shall be allowed to be executed without the approved shop drawings.

Drawings for approval on award of the work

- a. The contractor shall prepare & submit four sets of following drawings and get them approved from the Engineer-In-Charge before the start of the work. The approval of drawings however does not absolve the contractor not to supply the equipment/ materials as per agreement, if there is any contradiction between the approved drawings and agreement.
- b. Layout drawings of the equipment to be installed in various rooms such as plant room, cooling tower and other equipment.

- c. Drawings including section, showing the details of erection of entire equipment including their foundations, water basin for the cooling towers etc.
- d. Plumbing drawings showing the layout of entire piping, dia & length of pipes, valves and isometric drawings showing connections to various equipment.
- e. Electrical wiring diagrams for all electrical equipment and controls including the sizes and capacities of the various cables and equipment,
- f. Dimensioned drawings of all electrical and control panels,
- g. Drawings showing the details of all insulations and vapour barrier works,
- h. Drawings showing details of supports for pipes, cable trays etc.
- i. Any other drawings relevant to the work.

### **Completion Drawings**

Three sets of the following laminated drawings shall be submitted by the contractor while handing over the installation to the Engineer-In-Charge. Out of this one of the sets shall be laminated on a hard base for display in the A.C. Plant room. In addition, one set will be given on compact disc.

- a. Plant installation drawings giving complete details of all the equipment, including their foundations.
- b. Plumbing layout drawings include insulation giving sizes and lengths of all the pipes and the sizes and locations of all types of valves, and including isometric drawings for the entire piping including the pipe connections to the various equipment and insulation details wherever required.
- c. Line diagram and layout of all electrical control panels giving switchgear ratings and their disposition, cable feeder sizes and their layout,
- d. Control wiring drawings with all control components and sequence of operations to explain the operation of control circuits,

### **DOCUMENTS TO BE FURNISHED ALONGWITH SUBMISSION OF TENDER DOCUMENT**

Quality assurance plan for equipment to be submitted by the contractor.

### **DOCUMENTS TO BE FURNISHED ON COMPLETION OF INSTALLATION**

Three sets of the following documents shall be furnished to the department by the contractor on completion of work:

- a. Completion drawings as per "TENDER DRAWINGS FOR APPROVAL & COMPLETION DRAWINGS"
- b. sets of manufacturer's technical catalogues of all equipment and accessories.
- c. Operation and maintenance manual of all major equipment, detailing all Adjustments, operation and maintenance procedure, Mandatory & Recommended spares list for each equipment.
- d. A detailed list of inventory of HVAC system shall be compiled and submitted to the Engineer-In-Charge for his approval as per approved format

**List of Approved Makes of Material**  
**For**  
**Electrical and Mechanical components**

## Electrical System:

Material/ Equipment	Approved Make
ACB	ABB, Schneider, Siemens, L&T
Battery Charger	Max. Power , CALDYNE, VOLSTAT, HBL
Button Holder, Angle Holder Ceiling Rose	Anchor , CPL, Havells
Cable Gland	Comet , Dowell's, Jainson, HMI,
Cable Lugs	Comet, Dowell's ( Biller India) , Jainson , 3D
Cable Trays	OBO ,Indiana, Legrand, Profab Engineers
BLDC Ceiling Fan	Usha , Orient, Atomberg, Havells
Control Cable (ISI Approved)	Finolex, RR Kabel, Havells, Polycab, Lapp India
Copper Conductor PVC Insulated Wires/ Stranded Flexible Wires (FRLS)	Finolex, RR Kabel, KEI, HAVELLS, POLYCAB, Lapp India
Current Transformer (Cast Resin Epoxy Coated)	Automatic Electric, Gilbert & Maxwell, Kappa, Pragati,
Cable Management System (Wire Trunking) Raceway	OBO, Legrand , MK
Distribution Boards (MCB DBs)	Legrand, Schneider, Hager, L&T, ABB
Electronic Digital Meter, Multifunction meter with LED Display.	Schneider (Conzerv), Secure, Elmeasure, HPL, L&T
Fan Box	MS Type Only as approved by E-in-C
HRC Fuse and Fuse Fitting	ABB, GE, Siemens, L&T, Schneider
Indicating Lamps	L&T, Siemens, Schneider, ABB
LED Lamp(where ever required)	Cree, Osram, Nichia, Philips.
Light Fixtures (Internal)	Philips, Wipro, Osram, Havells
Light Fixtures (External)	Philips, Wipro, Osram, Havells, Bajaj, Jaquar
Lighting Control	Lutron, Schneider, Crestron, ABB, Philips
Lightning Protection System	Dehn, OBO, ABB, L&T
MCB/RCCB / SPD/RCBO	Legrand,Schneider, Hager, L&T, Siemens, ABB
MCCB	ABB, Schneider, Siemens, L&T
Metal Clad Plug & Socket (Industrial)	Legrand, Schneider, Neptune, Mennekes, Hager, ABB
Modular Switches with accessories, Socket Outlets and Wiring Accessories with moulded Cover Plate.	Schneider(Opale), Legrand( Arteor), MK(Blenz), Havells (Athena Plus), ABB (Zenit)
MS Black Stove Enameled ERW Conduits (ISI Approved)	AKG, BEC, Steel kraft
Ready made pole	Bajaj, Philips, Schreder, Crompton

Fabricated pole/Customized pole	As per tender description
Power Distribution Panels (TTA) Totally Type Tested (As per IEC- 61439 - 1 & 2)	Siemens , Schneider, ABB , I & T (Approved OEM Vendors only)
Power Distribution Panels (Non -TTA)	(Project specific Authorized / Approved OEM Vendors only)
Potential Transformer	Automatic Electric, Rishabh, Kappa, Pragati ,
Push Buttons	ABB, L&T, Schneider , Rishabh
PVC Conduit (FRLS) & Accessories (ISI Approved)	Precision ,BEC, AKG, Polycab
Power cables 1100V grade	Universal, Finolex, Polycab, Havells, Gloster
PVC Tape	Anchor, Steelgrip
Sandwiched Type Bus Duct/Rising mains	Schneider, Legrand(Zucchini), IIGM-EAE, L&T , C&S , Henikwon
Sealed Maintenance Free Batteries	Exide, HBL, Amar Raja, Hitachi
Selector Switches (ASS/VSS)	Kaycee, ABB, Siemens,Schneider, L&T, Salzer
Sensor(Occupancy Sensor)	Honeywell, Wipro, Hager, Philips, Theben
Terminal Block	Wago, Jainson, Elmex, Connectwell, Phoenix
Themoplastic Boxes	Hensel, Splesberg, OBO, Syntex, Hager
Timers	Schneider, Siemens,L&T, ABB , Theben, Legrand
UPS	Vertiv, Schneider (APC) ,Numeric, Socomec , Eaton, GE
Elevator(LIFTS)	Kone, Schindler, Mitsubishi
Exhaust Fan	Crompton, Khaitan, Havells, Orient , Atomberg
HT/ LT Jointing Kit & Termination Kits	Birla-3M, Raychem, Safe Kit M seal
VCB : 11 KV & HT Panels	ABB , Siemens, Schneider Electric ,L&T
DG SET with AMF panel	Kirloskar, Cummins, Caterpillar
Anti Vibration Mountings	Gerb, Resistoflex , Dunlop
Motors	ABB , Crompton, Siemens
Flexible Coupling	Resistoflex , Kanwal
Residential Silencer	Same as Engine make
Semi Rotary type hand fuel filling pump	Rotodel, Kitty Binks
Hybrid Capacitor Panels	P2 Power Solutions, Schneider, EPCOS
Master Plan & Parking & Plaza Light Fixtures	Bollard Lighting Preferred make Wipro/ PHILIPS / Osram  Street Lighting Preferred make Wipro / PHILIPS / Osram  Post Top Lighting Preferred make Wipro / PHILIPS / Osram
Geysers	AO Smith/Racold/Jaguar/Havells

## ELV SYSTEM

Material/ Equipment	Approved Makes
2 X 1.5 Sq. Mm. FRLS flexible wire/ armoured cable for Fire Detection & Alarm and PA system	FINOLEX, HAVELL'S, POLYCAB ,R.R. KABLE
F/UTP CAT6A Cabling System – Cables, IO, Patch Panels and other components	COMMSCOPE -SYSTIMAX, BELDEN, PANDUIT-PANNET, R & M
Communication Cables / Signal Cable	COMMSCOPE -SYSTIMAX, BELDEN, FINOLEX, FUSION, POLYMER
UTP CAT6 Cables (for IBMS System)	COMMSCOPE -SYSTIMAX, BELDEN, PANDUIT-PANNET, R & M
Networking Switches for IBMS System	Cisco, HP, JUNIPER
Fiber Optics Cables & Components (Data & Voice/Telecom, Single Mode – Cables, LIUs, Shelves, Pigtails, Patch-cords, Connectors, Adapters, Cassettes, Couplers, Splices/Splice closure Kit / Splice trays – Indoor / Outdoor Fiber Cabling Infrastructure	COMMSCOPE -SYSTIMAX , BELDEN, PANDUIT-PANNET, R & M
Telephone Tag Block/MDF	KRONE, POUYET
SFP Module	HPE/CISCO/DELL
Networking Racks, Data Centre racks, Distribution Racks – from sizes 15U to 42U	APW-VERO PRESIDENT, NETRACK, PANDUIT, RITTAL
Addressable Fire Alarm System (UL/CE/FM, EN/Vds Listed)	BOSCH, EDWARD, ESSAR, MIRCOM, NOTIFIER, SIEMENS, Schneider.
Public Address System	ATEIS, BOSCH, HONEYWELL, TOA
IBMS Server	DELL, HP, LENOVO
IBMS Workstation/Client PC/LED Monitor	DELL, HP, LENOVO
A3 Size Laser color Printer	CANON, EPSON, HP
IBMS Software Suite	HONEYWELL-TREND, JOHNSON CONTROLS, SCHNEIDER, SIEMENS, TRANE
Standalone 32 bit BacNet Based DDCs & Modbus/ BacNet Integrators, Gateways, Routers, Network area controller	HONEYWELL-TREND, JOHNSON CONTROLS, SCHNEIDER, SIEMENS, TRANE
DDC Panel (Enclosure)	BHARTIYA CUTLER HAMMER, RITTAL, SCHNEIDER ELECTRIC
DP Sensor – Water	DWYER, HONEYWELL, HUBA CONTROL, JOHNSON CONTROLS, OMICRON, SCHNEIDER, SIEMENS, TRANE
DP Switch – Air	DWYER, HONEYWELL, JOHNSON CONTROLS, OMICRON, SCHNEIDER, SIEMENS
DP Switch - Water	DWYER, HONEYWELL, JOHNSON CONTROLS, OMICRON, SCHNEIDER, SIEMENS, TRANE



<b>Material/ Equipment</b>	<b>Approved Makes</b>
Duct / Room Humidity Sensor	DWYER, HONEYWELL, JOHNSON CONTROLS, OMICRON, SCHNEIDER, SIEMENS, TRANE
Duct / Room Temperature Sensor	DWYER, HONEYWELL, JOHNSON CONTROLS, OMICRON, SCHNEIDER, SIEMENS, TRANE
Duct Static Pressure sensor – Air	DWYER, HONEYWELL, JOHNSON CONTROLS, OMICRON, SCHNEIDER, SIEMENS, TRANE
Immersion Temperature Sensor	DWYER, HONEYWELL, JOHNSON CONTROLS, OMICRON, SCHNEIDER, SIEMENS, TRANE
Outside Air Temperature Sensor	DWYER, HONEYWELL, JOHNSON CONTROLS, OMICRON, SCHNEIDER, SIEMENS, TRANE
Hardness/TDS/PH Analyzer	ABB, EMERSON, FORBES MARSHAL, HACH, JUMO, KELE, OMICRON, THERMO SCIENTIFIC, YOKOGAWA
Pressure Sensor – Water	DWYER, HONEYWELL, HUBA CONTROL, JOHNSON CONTROLS, OMICRON, SCHNEIDER, SIEMENS, TRANE
Terminals/Lugs	PHOENIX, WAGO
Water Flow Switch	DWYER, HONEYWELL, JOHNSON CONTROLS, OMICRON, SCHNEIDER, SIEMENS, TRANE
Level Switch/Flameproof Level Switch	BANNER, GENERAL INSTRUMENTS CONSORTIUM, LEVCON INSTRUMENTS PVT. LTD., MAGNETROL INDUSTRIAL INC., NIVELCO, OMICRON
Manageable Network switch	ARUBA/CISCO/HPE
POE Switch	ARUBA/CISCO/HPE
Distribution switch	ARUBA/CISCO/HPE
Wifi Access Point	ARUBA/CISCO/HPE

#### **HVAC System**

<b>Material/ Equipment</b>	<b>Approved Make</b>
'TF' Quality expanded polystyrene	Beardsell/ Styrene/ Toshiba
2-way/ 3-way Modulating Valves and Thermostat	Johnson Controls/ Siemens/ Honeywell/ Danfoss/ Belimo
Air handling Units /treated fresh air units	Zeco/ Edgetech/ VTS/ Systemair/ Citizen
Air Washer / Scrubber	Zeco/ Edgetech/ Systemair/ Ravi Aircon/ Citizen
Radiant cooling system	GIACOMINI /REHAU / OVENTROP
Dehumidifier	Bryair
BTU Meter	FORBES MARSHAL, HONEYWELL, KAMSTRUP, OMICRON, SIEMENS, SHINETECH
Air Separator	Anergy/ Xylem/ Armstrong

<b>Material/ Equipment</b>	<b>Approved Make</b>
Al. Sheets	Hindalco/ Balco/ Nalco
Aluminum tape	Johnson/Birla 3M
Anchor/Fastener	Hilti/Fisher/ Rawl Plug
Auto Air Vent	Anergy/ Rapid Cool/ SKS/ SANT/ Honeywell
Balancing Valves	Advance /Honeywell/ Danfoss/ Castle
Ball Valves set with & without Y strainer For FCU	Honeywell/ Emerald/ Zoloto/ Sant Industries
Butterfly Valves & Ball Valve	Audco/ Oventrop/ Advance/ Honeywell/Zoloto
Cabinet Fans	Zeco/ Edgetech/ Systemair/ Citizen
Centrifugal Fans for ventilation/ AHUs/ Air washer/ Scrubber	Kruger/ Nicotra/ Comefri/ Green heck
Check Valves	Advance/ Honeywell/ Oventrop/Castle/ Emerald
Closed Cell Nitrile rubber insulation/ EPDM insulation	Armacell / K- Flex/ A-Flex
Differential Pressure Switch (Water)	Johnson/ Staefa/ Honeywell/ Huba
Expansion Bellows/ Pipe Supports/ Vibration Isolators/ Duct Flexile Connections	Resistoflex/ Kanwal (Easyflex)/ Cori
Fan coil Units	Zeco/ Edgetech/ VTS/ Systemair/ Citizen
Filters (Pre, Fine, Hepa)	Spectrum/ AAF/ Camfil/ Thermadyne
Flexible Duct	Twiga/ Atco/ Kimmco
Fibre Glass Insulation	Owens corning/U.P.Twiga
Flow switch	Rapid cool/ Siemens/ Anergy
FRP Material	Reichhold/ Equivalent
G.I. Pipes	Sail/ Tata/ Jindal
G.I. Sheets	Sail/ Tata/ Jindal
Grills/ Diffusers/ Fire Dampers/ Louvers/ Volume Control Dampers/ Back Draft Dampers/ Sound attenuator	Systemair/ Titus/ Brightflow/ Caryaire/ Tristar/ Cosmos/Trox
GSS Factory Fabricated Ducts/ Duct Flanges	Rolastar/ Zeco/ Ductofab/ Ecoduct/ Dustech
Inline Fans	Kruger/ Green heck/ Air flow/ Caryaire/ Systemair/ Maico
M.S. Pipes	Tata/ Jindal Hissar / Sail
M.S. Sheets	Sail/ Tata/ Jindal
Motorized Actuator For Valves & Damper	Belimo/ Honeywell/ Siemens/ Johnson Controls
Motorized Butterfly valves	Johnson Controls/ Oventrop/ Belimo/ Siemens
Motors	ABB/ Siemens/ CGL/ BBL
PIBC Valves	Danfoss/ Oventrop/ Siemens/ TA
Plug Fans	Ziehlabegg/ Kruger/ Nicotra
Pot/Y-Strainers	SM/ Sandhu/ Emerald/ Zoloto/ Honeywell
PPGL sheets for Ducts	JSW/ Shreya Polymers/ Malur Tube/ HV metal Arc
PPGL Ducts Manufacturer	Corrosion Control equipment/ Sagar Plastic/ Ppi projects/

Material/ Equipment	Approved Make
	Citizen
Pressure Gauge	Feibig/ H. Guru/ Emerald
Pressure Relief Dampers	Trox/ Titus/ Systemair
Propeller Fans	Kruger/ Green heck/ Air flow/ Caryaire/ Systemair/ Maico
Puff pipe support	Malanpur/ lloyd/ Beardsell
PVC Eliminators	Munterz/ BKB extrusions
PVC Pipes	Finolex/ Prince/ Supreme/ KML Classic
Refrigerant Piping	Mandev/ Rajco/ Indigo/ RR Shramik
Rock Wool insulation	Roxul-Rockwool/ Rockwool india/ Lloyd
Screw Water chilling machine	Carrier/Trane/York/Daikin-Mcquay
Spiral Round/ Oval ducts	GP Spira/ Dustech/ Ductofab
Split / Window AC	Carrier/ Daikin/ Hitachi / Toshiba/LG/Blue star
VRF	Toshiba/Daikin/ LG/Samsung/ Mitsubishi Electric
Star bond/Lag Protective Coating	Paramount polytreat/ Pidilite
Thermometers	Feibig/ H. Guru/ Emerald
Tube Axial flow Fans	Kruger/ Green heck/ Air flow/ Nicotra/ Systemair/ Maico
Air curtain	Euronics/ Cosyst/ Systemair/Russel Airflow/ Dyna
Vane Axial flow Fans	Kruger/ Green heck/ Air flow/ Nicotra/ Systemair/ Maico
Variable frequency drive	ABB/ ALLEN BRADLEY/ DANFOSS/ Siemens
VAV Boxes	Trox/ Trane/ Johnson Controls
Water Pumps	Armstrong/ Xylem/ Grundfos
Welding Rods	Advani/ L&T/ ESAB
HVLS Fans	Nutech/ Ecoair/ RREL
Chiller plant manager	Daikin/ York/ TRANE/ Carrier/ Siemens/ Honeywell
Makeup water Tank	Sintex/ Supreme/ Plasto
Chilled water Hi wall	Bhutoria/ Cruise/ GE Tech/ Daikin
Electrostatic precipitator for Scrubber	Trion/ Rydair
Auto tube cleaning system	CET ENVIRO/Ecomax/Ecoair
Note:-All electrical items makes to be considered from electrical list of makes	

### Fire fighting system

Material/ Equipment	Approved Make
Air Vessel	Fabricated
Batteries	AMCO / Amar Raja / Exide
Sluice Valve	Audco / Leader / Sant / Zoloto
Branch pipe & Coupling	Minimax / Newage / Swati / Safex / SBJ / Winco
Fire Pumps	Grundfos / Mather & Platt - Wilo / Xylem / Kirloskar
Coating wrapping material for underground pipe	IWL / STP / Tikidan
Diesel Engine	Caterpillar / Greaves / KOEL / Cummins
Fire Alarm Valve	HD / Newage / Tyco / Viking
Fire Bridged Inlet Connection	Minimax / Newage / Safex / Shah Bhogilal Jethalal

Fire Extinguishers	Cease Fire / Minimax / Safex
Flow Switch	Honeywell / Potter / Switzer / Danfoss / Newage
Ball Valve	Leader / Sant / Zoloto
Hydrant Valve	Minimax / Newage / Safex / Shah Bhogilal Jethalal
Hose Pipe	Minimax / Newage / Safex / Shah Bhogilal Jethalal
Hose Reel	Minimax / Newage / Safex / Shah Bhogilal Jethalal
Hose Box	Minimax / Newage / Safex / Shah Bhogilal Jethalal
Sprinklers & Flexible Hose	HD / Viking / Tyco / Newage
Kitchen Fire Suppression System	UL Listed of approved make

### MECHANICAL WORKS

Material/ Equipment	Approved Make
<b>Electro-mechanical Equipment's &amp; Plants</b>	
<b>Pumps</b>	
Motors	Xylem / Grundfos / Wilo / Kirloskar
Hydro Pneumatic System	Xylem / Grundfos / Wilo / Kirloskar
Submersible Pumps	Xylem / Grundfos / Wilo / Kirloskar
De watering Pump for Rain water	Xylem / Grundfos / Wilo / Kirloskar
Mud pump for Drainage	Xylem / Grundfos / Wilo / Kirloskar
<b>Drinking Water Equipment's</b>	
Domestic UV system	Aquila / Kent / Eureka Forbes
Water Cooler	Blue Star/ Voltas/ Usha
Drinking Water Combined System of Cooler with R.O. Plant	Blue Star/ Oasis/ Voltas/ Aquatek
<b>Hot Water Equipment's</b>	
Electric Geyser	A O Smith / Racold / Jaquar
Heat Pump H.W.S.	A O Smith / Daikin / Racold/ BOSCH
Solar HWG	Racold / BOSCH/EMMVEE/RASHMI
Thermostat	Honeywell / Zoloto / Sant
Temperature Gauges	Honeywell / Zoloto / Sant
Hand drier	Jaquar / Euronics/Kohler