NIT No. IITH/CMD/CIVIL/NIT/2026-27/ 14

भारतीय प्रौद्योगिकी संस्थान हैदराबाद
Indian Institute of Technology Hyderabad

Volume - 4

SCOPE OF WORK AND TECHNICAL SPECIFICATIONS FOR ELECTRICAL & MECHANICAL (E & M) COMPONENTS

Name of the work: Construction of Director's Residence cum Integrated Office Ancillary Buildings including Boundary wall at IIT Hyderabad, Kandi, Sangareddy.

Executive Engineer (Civil)
IIT Hyderabad

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Technical Specifications of E&M Works and Associated Services

Design, Planning, Supply, Installation, Testing and Commissioning of following E&M Works/Services with ultra-modern and state of the art best industry standards and practices, as per CPWD Specifications, Govt. Building Bylaws, Telangana State Fire Service, NBC 2016, ECBC 2017, CPCB, NABH, relevant IS Codes, Indian Electricity Rules and Acts all amended up to date.

- CPWD General Specifications for Electrical Works Part I Internal – 2023 as amended up to date.
- CPWD General Specifications for Electrical Works Part II (External) 2023 as amended up to date.
- CPWD General Specifications for Electrical Works (Part-III-Lifts & Escalators) – 2003 as amended up to date.
- CPWD General Specifications for Electrical Works Part IV Sub Station – 2013 as amended up to date.
- CPWD General Specifications for Electrical Works Part V Wet Riser & Sprinkler System– 2020 as amended up to date.
- CPWD General Specifications for Electrical Works Part VI Fire Detection and Alarm System – 2018 as amended up to date.
- CPWD General Specifications for Electrical Works Part VII D.G. Sets – 2013 as amended up to date.
- CPWD General Specifications for Heating, Ventilation & Air-Conditioning (HVAC) – 2024 as amended up to date.

Electricity for construction works shall be arranged by the contractor from Local Electricity supplier for which the contractor will pay the connection and electricity bill charges and recovery shall be made in case of any unauthorized usage of electricity at the site on pro-rata basis.

All other items which are essentially required for smooth and seamless functioning of IIT Hyderabad Director's Residence cum Integrated Office Ancillary Buildings and to make this building/scheme fully habitable, but not specifically mentioned in the scope of services, the same is deemed to be included within the scope of this tender and nothing extra shall be paid on this account. Complete wiring in the Director's Residence for light, power, communication etc. shall be done in appropriate size medium class PVC conduits. However, Fire alarm and Firefighting system wiring shall be done in MS (mild steel) conduit.

The responsibility of Investigations, Designing, Detailed Planning, Procurement, Construction, Safety, Quality, and Risk of Engineering lies with the Contractor. Contractor takes the full responsibility for the design and execution.

The Scope, Description of Work, Specifications, approved Conceptual Drawings for Engineering and Architectural Planning as provided in the Contract Documents is kept on record are indicative & minimum requirements, and a No Objection Certificate is recorded by the Engineer in Charge, for the Drawings prepared and submitted by the contractor after Proof Checking by competent Authority. Payment/Charges of Proof Checking and other incidental charges shall be in the scope of contractor, if any and shall be reimbursed by the department after payment by contractor.

The Complete wiring in the Director's residence for light, power, communication etc. shall be done in appropriate size of PVC conduits. However, for FAS wiring shall be one in MS conduit only. During the approval of design and drawings the contractor will submit the data sheets and catalogues of reputed manufacturers of the various equipment in support of their design.

Quality Assurance Policy shall be adopted as per QAP and Check List for E&M Services enclosed herewith, including Inspection & Testing of Materials & Process at Manufacturer's Works, 3rd Party Lab, etc. No additional payment shall be made to the contractor for initial inspection/testing at the manufacturer 's works by the representative of the Engineer-in- Charge. However, the department will bear the expenses of its representative deputed for carrying out initial inspection/testing, with prior permission of Competent Authority. However, decision of Engineer- in-charge shall be final and binding on contractor/associate agencies for items/products/equipment not listed in this Checklist. The contractor/associate agencies shall have to produce certified copy of proof of procurement of material/service from Manufacturer/OEM/authorized dealer etc. before claiming payment.

Scope of work and Technical Specifications for Internal Electrical wiring, Internal, Electrification installations, UPS System, Illuminated Signage's, street lighting, Lightning Protection System, Earthing System, etc.

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 FAS wiring shall be one in MS conduit only.

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

a) CPWD General Specification for electrical work part I Internal 2023 as amended up to date.
b) CPWD general specification for electrical work part II External 2023 as amended up to date.
c) CPWD general specification for electrical work part IV Sub-Station 2013 as amended up to date.
d) CPWD General Specifications for Electrical Works (Part-III-Lifts & Escalators) – 2003 as amended up to date.
e) CPWD General Specifications for Electrical Works Part IV Sub Station – 2013 as amended up to date.
f) CPWD General Specifications for Electrical Works Part V Wet Riser & Sprinkler System– 2020.
g) CPWD General Specifications for Electrical Works Part VI Fire Detection and Alarm System – 2018.
h) CPWD General Specifications for Electrical Works Part VII D.G. Sets – 2013, Amended (05.11.2024).
i) CPWD General Specifications for Heating, Ventilation & Air-Conditioning (HVAC) - 2024

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:

Sr. No.	Name of Building	Floor level
1	**Director's Residence cum Integrated Office Ancillary Buildings**	G+1

General Conditions

1. The contractor has to submit MOU with associated contractor (in case electrical contractor is associated), Engineers name credential email address & mobile no before start of work.
2. The contractor shall therefore employ Supervisory staff as per NIT provision who will be constantly in touch with the department and will sign site order book.
3. All the material to be used on this work by the contractor shall be got approved from the Engineer-in-Charge in advance before installation at the site.
4. Sound Engineering practice as approved by the Engineer – in – charge. Any additional item of work, if taken up subsequently, shall also confirm to the relevant specifications mentioned above.
5. All the equipment shall be delivered with (i) Manufacturer's test certificate,
   (ii) Manufacturer's technical catalogues and Installation / Instruction (O&M) manuals.
6. 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 change the layout as per requirement at site and the contractor shall not have any claim due to change in layout.
7. 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.
8. 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 in accordance with the building work.
9. 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.
10. 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.
11. The contractor or his engineer is bound to sign the site order book as and when required by the Engineer-in-Charge and to comply with the remarks therein.
12. The size of PVC/ MS conduit and wiring shall be got approved from the Engineer-in- Charge before the execution of work.
13. The contractor shall make his own arrangement at his own cost for Electrical/ General tools and plants required for the work. In case, proper tools are not available, the department will purchase the tools for Bonafide use of work at the risk & cost of the contractor.
14. The contractor must make his own arrangements for stores and watch & ward. No extra claim for this will be entertained.
15. The contractor shall make his own arrangements for electrical power supply for the construction activities. No extra payments for the same will be made.
16. The wiring and conduit route shall be marked by the contractor in the drawing first and shall be got approved from the Engineer-in-charge.
17. Main board and main distribution board : The work shall be carried out according to the drawing/details as approved by the Engineer-in-Charge. The contractor shall have to get the

sample approved before the whole lot is brought to site. The main board, distribution board shall be properly labelled.

18. No tax shall be separately paid by the department separately. The rates tendered should be inclusive all taxes and duties. Statutory deductions at source shall be made while releasing payment through running/final bills as applicable. A certificate specifying the rate and amount of deduction shall however be issued by the department. 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.
19. 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.
20. 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.
21. Nothing extra shall be paid for inter connections with thimbles/Wires/Tapes strips etc. used on the work.
22. 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 other Electromechanical accessories and other items, from the manufactures authorized outlets.
23. 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.
24. 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.
25. 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.
26. 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, etc., where wiring is not done along with IEI work, fish wire shall be invariably drawn.
27. The connection between incoming switch/isolator and bus bar shall be made with suitable size of thimble and cable at no extra cost.
28. Copper conductor of insulated cables of size 1.5 Sq.mm and above shall be stranded and terminals provided with crimped lugs.
29. 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.
30. All hardware items such as nuts/bolts/screws/washers etc. to be used in work shall be zinc/cadmium plated iron.
31. All Distribution Boards (DB) shall be prewired as per direction of Engineer-in-charge.
32. While laying conduit, suitable size junction boxes shall be provided for pulling the wire as per the decision of the E -in-C of E and M component.
33. 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. 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.

34. 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.
35. All switches shall be modular type with approved Makes and brand.
36. 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.
37. The materials used in the work shall be of make as per List of approved make and shall be approved by Engineer-In-charge before execution.
38. For all Electrical and Mechanical works, the contractor shall have to work as per the instructions of the Engineer-In-charge, Construction and Maintenance Department (CMD), IITH.
39. The firm should submit the warranty against manufacturer defect for a period of 5 years from the date of completion of work for LED fittings and products from the manufacturer.
40. 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.
41. 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.
42. The guarantee for LED fittings shall be submitted from the manufacturer in addition to the guarantee from the contractor. 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.
43. The agency shall stand guarantee for at least 5 years of all the LED fittings and provide 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.
44. Defect Liability Period: All the installations other than LED fittings shall be guaranteed for a period of 36 months from the date of completion. LED fittings shall be guaranteed for at least 5 years. Any defective materials and be replaced free of cost at the direction of the Engineer-in-Charge.
45. Before completion of defect liability period of Three years, the main contractor has to submit security deposit (in addition to 2.5%) of 5% of 80% of the price of LED fittings (based on invoices) for the remaining 2 years' warranty period for LED fittings in acceptable form i.e., FDR/ Bank guarantee, to the Engineer-in-Charge. The Security Deposit deducted from the bills of contractor shall be refunded to the main contractor only after submission of above security deposit for LED fittings by main contractor, failing which this LED security deposit shall be deducted from Security Deposit deducted for total work and balance amount only will be refunded after completion of defect liability period. The LED Security Deposit will be released after completion of warranty period of 5 years to the main contractor.
46. The Contractor shall submit a valid Electrical Contractor Licence for LT voltage levels, issued by the Telangana State Electrical Licensing Board.

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 or done by PVC insulated armoured FRLS cable based on requirement.
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. The input circuit from the distribution board to any lighting switchboard shall be provided using 4 sq.mm wiring only.
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 OFC distribution box/krone box at each floor and in the ELV room. The wiring shall be suitably tagged/marked 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.
7. There shall be separate shafts (upto the extend feasible) in the building each for Electrical works (LT cables), ELV works (CCTV, LAN, TV, Telephone, Fire alarm, etc) etc.
8. Required illumination level for general lighting shall be achieved as per CPWD General specification for Electrical part-I -2023/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 contractor shall provide all the Electrical fixtures i/c SITC as per the detailed Engineering design and services drawings provided alongwith the tender document. However any other items if required for the appropriate functioning of building as per applicable norms shall also be considered part of scope of contractor without any additional cost.

Note:

(i) In Bathroom / toilet, exhaust fan of suitable size (as approved by Engineer-in-charge) shall be of BLDC type only.

(ii) Above each wash basin LED type mirror light of approved design shall be provided.

(iii) In each room, RJ 45 Data & Telephone socket outlet i/c wiring, socket outlet for TV shall be provided.

(iv) Modular type call bell shall be provided, model as approved by E-in-C.

(v) Lux levels shall be as per NBC 2016

(vi) BLDC Ceiling fans shall be provided and model as approved by the Engineer –in- Charge.

(vii) 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.

(viii) Also, each LIFT lobby on every floor shall be provided with 01Nos. 16A 6 pin plug point for Housekeeping/Cleaning/Service purposes

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, total no. of power plug shall be varied in whole buildings.

2. Any other area not mentioned above but for functional requirement, any power point, LAN point, telephone point, TV point is required, 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.

(i) All internal electrical works shall be carried out with FRLS PVC insulated 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.

(ii) 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.

(iii) 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.

(iv) 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.

(v) Ceiling fans will be provided in every building and at each location except toilets / Bathroom. All ceiling fans shall be of 1200 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 El work 2023. 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.

(vi) 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.

(vii) 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.

(viii) Providing incoming television / telephone cables from outside of each building is not covered in the scope of this bid.

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	250-300 lux	Surface LED batten
2	Fire control room, Common Toilets	300 lux	Surface/ Recessed round LED Downlighters
3	Lift shaft, Terrace, Mumty, OH Tank wall	50 lux	LED Bulk head fitting with IP 65 protection
4	Corridor, lift Lobby, waiting area	150 lux	Surface/ Recessed round LED Downlighters
5	Staircase, basement, ramp area	150 lux	Surface round LED Downlighters
6	Entrance lobby waiting area	200 lux	Cove light/ Strip light/ downlight /Cylindrical surface LED light (Combination of Fittings and layout as per direction of E-in- C)
7	Staff rooms	300-500 lux	LED batten Indoor light
8	Road and Outdoor parking areas	15 lux	LED streetlights

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

(ix) All suspended light fittings shall use suspension GI wire and assembly either supplied by Light fitting manufacturer or by their recommended OEM/OEA.

(x) 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.

(xi) 1 no. call bell point along with call bell & switches shall be provided in all especially abled Toilets.

(xii) For LAN Cat-6A UTP, 4 pair cable shall be provided as per the design and to be terminated G.I. Junction box. & Wiring for cable TV with coaxial cable RG-6 grade, 0.7 mm solid copper conductor PE insulted with fine tinned copper braided & protected with PVC.

(xiii) 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 mumty, entrance of pump room and as per direction of E-in-C.

(xiv) 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.

(xv) LED Exit signages with 2 hours battery back with bicoloured LED status indicator & should visible from 40 mtrs, at every 6.00 m in corridor and at all conspicuous locations to indicate Exit, staircase location, 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.

(xvi) Staircase lighting shall be provided with LED emergency light with minimum 2 hours battery backup.

(xvii) 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.

(xviii) 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.

(xix) 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.

(xx) Inside the lift shaft there shall be arrangement of one light point with LED Bulkhead 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.

(xxi) 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 try shall not be less than 150 mm.

(xxii) Such cable tray on Parking area, Electrical Panel room at AC plant-05, Electrical Room 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.

(xxiii) 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≤ 300 mm & thickness 2 mm for cable trays with width > 300mm.

(xxiv) 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.

(xxv) 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.

(xxvi) AL/ Cu XLPE cable shall be use for power distribution in all buildings.

(xxvii) Cable size shall be decided as per maximum load of the building and 25% future expansion and shall got approved by Engineer – in –Charge.

(xxviii) 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).

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.

(xxix) If copper plate earthing is not possible at site due to very hard rock as per direction of E-I-C Copper bounded 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.

(xxx) 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.

(xxxi) All LT cables laid outside the building portion in open area shall be either laid in RCC HUME pipes or in ground with Sand cushioning and brick protection with route marker or in RCC trench or in DWC pipes or in cable tray as per CPWD Specification and direction of Engineer-in-Charge.

Light Fitting Technical specifications:

Sr. 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 ≤ 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 ≤ 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 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 ≤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	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.
5	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.
6	Spotlight (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.
7	Outdoor light (façade light)	Outdoor LED spotlight 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.
8	Street light	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.
9	Post Top/ Gate light Fitting	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.
10	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 directions of Engineer-In-Charge. 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 2023 (Section 2.10 and Table 2.5) & ECBC+ Building 2017 Table 6.4,6.5 & 6.6 & 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 of Legrand Arteor series or similar specification series 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.

EXTERNAL LIGHTING

The scope of this work consists of planning, designing and SITC of LED street lighting with poles and at least 1 meter 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.

Also disconnecting and dismantling existing street lights in the new building construction premises and shifting the poles as per the directions of Engineer-In-Charge.

Sl. No.	Item
1.	9-meter height hot dip galvanized pole along 7-meter 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 streetlight fitting of minimum 90W
5	1200 mm long Single arm 60 mm dia bracket
6	Feeder Pillar for streetlight (minimum 03Nos.)
7	Garden Bollard light
8	4-meter height Smart Post-top light

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 fitting. 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 dip galvanizing 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 atleast 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).

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).

2.0. For surface car parking, landscape, service area:

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 I/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 Director's Residence cum Integrated Office Ancillary Buildings every Entry / Exit of every blocks as per the approved drawing and directions of Engineer-In-Charge.

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 New School building at distance of 3-4 meter.

3.0. Streetlight 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 CPRI 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 withindividual astronomical timer in outgoings 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 shallbe 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 directly 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 try/ 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)-2023 and CPWD General Specifications Part-II (External)-2023.

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) - 300 mm dia.

3.10. After completing the work, necessary test results as envisaged in CPWD General Specifications Part-I (Internal)-2023 and CPWD General Specifications Part-II (External)- 2023 shall be recorded and submitted to the department. The results shall be within 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. circuit layout 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. MCCB"s shall be suitable either for single phase AC 230 volts or three phase 415volts. The MCCB shall of thermal magnetic type upto 200A rating and MCCB above 250A rating shall be of microprocessor based having overload and short circuit protection. The incomer MCCB shall also have earth fault protection and time delay. The main incoming MCCB/ACB provided in the main panel of each building shall be microprocessor based and shall be suitable 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 aluminum 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 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.

ELECTRIC POWER DISTRIBUTION & WIRING

Introduction

The electric power will be received and distributed in a building, through following means: -

i. Cabling and switchgear to receive power.

ii. The building is divided into convenient number of parts, each part served by a rising main system to distribute power vertically/horizontally.

iii. Power flows from rising main through tap-off box to floor main board to final DBs and then to wiring.

iv. Dedicated circuit for different loads such as lighting, HVAC, power plug loads shall be provided, wherever possible.

v. Rising main, which takes care of general lighting and power outlet load of the building, should have independent cables for lighting as well as power, wherever possible. Other loads like lifts, water pump sets, other motor loads are fed by independent cables of suitable capacity fed from properly designed essential/ non- essential LT power panels with suitably designed switchgear having necessary control and safely features.

vi. Therefore, the distribution/wiring system essentially consists of provision of cables, switchgear, rising main, bus-ducting, earthing, laying of pipes/ conduits etc. (in surface or recess) based on proper detailed designing to decide on various sizes/ capacities of these components and various controls and safeties involved, to provide an efficient, reliable, safe and adequate electrical distribution and wiring system.

vii. A typical schematic diagram of power distribution of a building is enclosed.

System of Distribution and Wiring

(i) The wiring shall be done from a distribution system through main and/or branch distribution boards. The system design and location of boards will be properly worked out.

(ii) Each main distribution board and branch distribution board shall be controlled by an incoming circuit breaker/linked switch with fuse. Each outgoing circuit shall be controlled by a circuit breaker/switch with fuse.

(iii) For non-residential and residential buildings as far as possible DBs shall be separate for light and power.

(iv) Only MCCB/MCB/HRC fuse type DBs shall be used. Rewirable type fuses shall not be used.

(v) Three phase DBs shall not be used for final circuit distribution as far as possible.

(vi) 'Power' wiring shall be kept separate and distinct from light wiring, from the level of circuits, i.e., beyond the branch distribution boards. Conduits for light/power wiring shall be separate.

(vii) Essential/non-essential/UPS distribution each will have a completely independent and separate

distribution system starting from the main, switchboard upto final wiring for each system. As for example, conduit carrying non-essential wiring shall not have essential or UPS wiring. Wiring foressential and UPS supply will have their own conduit system. No mixing of wiring is allowed.

(viii) Generally, no switchboard will have more than one source of incoming supply. More than one incoming supply will be allowed only at main board with proper safety and interlocking so that only one source can be switched on at a time.

(ix) Each MDB/DB/Switch Board will have reasonable spare outgoing ways for future expansion.

(x) Balancing of 3-phase circuit shall be done.

3.3 Wiring

3.3.1 Submain & Circuit Wiring

(a) Submain Wiring

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

(b) Circuit Wiring

Circuit wiring shall mean the wiring from the distribution board to the 1st tapping point inside the switch box, from where point wiring starts.

3.3.2 Measurement of Submain and Circuit Wiring

(i) Circuit and submain wiring shall be measured on linear basis along the run of the wiring. The measurement shall include all lengths from end to end of conduit or channel as the case may be, exclusive of interconnections inside the switchboard etc. The increase on account of diversion or slackness shall not be included in the measurement.

(ii) The length of circuit wiring with two wires shall be measured from the distribution board to the nearest switch box from which the point wiring starts. Looping of switch boxes also will be counted towards circuit wiring, measured along the length of conduit/channel.

(iii) When wires of different circuits are grouped in a single conduit/ channel, the same shall be measured on linear basis depending on the actual number and sizes of wires run.

(iv) Protective (loop earthing) conductors, which are run along the circuit wiring and the submain wiring, shall be measured on linear basis and paid for separately.

Note: Conduit carrying submain will not carry circuit/point wiring. Similarly conduit carrying circuit wiring will not carry submain/point wiring. Conduit carrying point wiring will not carry submain/circuit wiring.

3.3.3 Measurement of Other Wiring Work

Except as specified above for point wiring, circuit wiring and submain wiring, other types of wiring shall be measured separately on linear basis along the run of wiring depending on the actual number and sizes of wires run.

3.4 Point Wiring

3.4.1 Definition

A point (other than socket outlet point) shall include all work necessary in complete wiring to the following outlets from the controlling switch or MCB.

(a) Ceiling rose or connector (in the case of points for ceiling/exhaust fan points, prewired light fittings, and call bells).

(b) Ceiling rose (in case of pendants except stiff pendants).

(c) Back plate (in the case of stiff pendants).

(d) Lamp holder (in the case of goose neck type wall brackets, batten holders and fittings which are not prewired).

3.4.2 Scope

Following shall be deemed to be included in point wiring:

(a) Conduit/channel as the case may be, accessories for the same and wiring cables between the switch box and the point outlet, loop protective earthing of each fan/ light fixture.

(b) All fixing accessories such as clips, screws, Phil plug, rawl plug etc. as required.

(c) Metal or PVC switch boxes for control switches, regulators, sockets etc, recessed or surface type, and phenolic laminated sheet covers over the same.

(d) Outlet boxes, junction boxes, pull-through boxes etc. but excluding metal boxes if any, provided with switchboards for loose wires/conduit terminations.

(e) Control switch or MCB, as specified.

(f) 3 pin or 6 pin socket, ceiling rose or connector as required. (2 pin and 5 pin socket outlet shall not be permitted.)

(g) Connections to ceiling rose, connector, socket outlet, lamp holder, switch etc.

(h) Bushed conduit or porcelain tubing where wiring cables pass through wall etc.

(**Note:** In areas where false ceiling are provided, termination of wires should be at the fittings. Flexible conduits from ceiling junction box to the fittings shall be provided duly coupled at both ends. This shall be included within the scope of point wiring.)

(i) Interconnecting wiring between switches within the switch box on the same circuit.

3.4.3 Measurement

(a) Point Wiring (other than socket outlet points)

(i) Unless and otherwise specified, there shall be no linear measurement for point wiring for light points, fan points, exhaust fan points and call bell points. These shall be measured on unit basis by counting, and classified as laid down in 3.4.4.

3.4.4 Classification

Points measured under 3.4.3 on unit basis shall be classified as under according to the type of building:

(a) Residential Buildings

(i) Group 'A', for point wiring for type I, type II and type III residential quarters and hostels.

(ii) Group 'B', for point wiring for type IV and above type of residential quarters and barracks.

(b) Non-residential Buildings

Group 'C' for all types of non-residential buildings such as offices, hospitals, laboratories, educational institutions, libraries etc.

(c) For any Other Type of Building

The group under which the points are to be classified shall be decided by the concerned Chief Engineer (Elect.).

3.4.5 Point Wiring for Socket Outlet Points

(i) The light plug (6 A) point and power (16 A) point wiring shall be measured on linear basis, from the respective tapping point of live cable, namely, switch box, another socket outlet point, or the sub-distribution board as the case may be, up to the socket outlet.

(ii) The metal/PVC box with cover, switch/MCB, socket outlet and other accessories shall be measured and paid as a separate item.

Note: There shall normally be no 'on the board' light plug point.

(iii) The power point outlet may be 16 A/6 A six pin socket outlet, where so specified in the tender documents.

3.4.6 Group Control Point Wiring

(i) In the case of points with more than one point controlled by the same switch, such points shall be measured in parts i.e. (a) from the switch to the first point outlet as one point and classified according to 3.4.4, and (b) for the subsequent points, the distance from that outlet to the next one and so on, shall be treated as separate point(s) and classified according to 3.4.4.

(ii) No recovery shall be made for non-provision of more than one switch in such cases.

3.4.7 Twin Control Light Point Wiring

(i) A light point controlled by two numbers of two way switches shall be measured as two points from the fitting to the switches on either side and classified according to 3.4.4.

(ii) No recovery shall be made for non-provision of more than one ceiling rose or connector in such

cases.

3.4.8 Multiple Controlled Call Bell Point Wiring

(i) In the case of call bell points with a single call bell outlet, controlled from more than one place, the points shall be measured in parts i.e.

(a) from the call bell outlet to one of the nearest ceiling roses meant for connection to bell push, treated as one point and classified according to 3.4.4, and

(b) from that ceiling rose to the next one and so on, shall be treated as separate point(s) and classified according to 3.4.4.

(ii) No recovery shall be made for non-provision of more than one ceiling rose or connector for connection to call bell in such cases.

3.5 Wiring System

(i) Wiring shall be done only by the looping system. Phase/live conductors shall be looped at the switch box. For point wiring, neutral wire/earth wire looping for the 1st point shall be done in the switch box; and neutral/earth looping of subsequent points will be made from point outlets.

(ii) In wiring, no joints in wiring will be permitted any where, except in switch box or point outlets, where jointing of wires will be allowed with use of suitable connector.

(iii) The wiring throughout the installation shall be such that there is no break in the neutral wire except in the form of linked switchgear.

(iv) Light, fans and call bells shall be wired in the 'lighting' circuits. 15A/16A socket outlets and other power outlets shall be wired in the 'power' circuits. 5A/6A socket outlets shall also be wired in the 'power' circuit both in residential as well as non- residential buildings.

(i) Colour Coding

Following colour coding shall be followed in wiring:

Phase : Red/Yellow/Blue. (Three phase wiring)

Live : Red (Single phase wiring)

Neutral : Black

Earth : Yellow/Green.

(ii)Termination of Circuit into Switchboard

Circuit will consist of phase/neutral/earth wire. Circuit will terminate in a switch board (first tapping point, where from point wiring starts) in following manner.

Phase wire terminated in phase connector. Neutral wire terminated in neutral connector. Earth wire terminated in earth connector.

The switchboard will have phase, neutral and earth terminal connector blocks to receive phase/ neutral/ earth wire.

3.2 Run of Wiring

(i) The type of wiring shall be as specified in the tender documents namely, surface conduit/recessed conduit, steel/PVC, channel.

(ii) Surface wiring shall run as far as possible along the walls and ceiling, so as to be easily accessible for inspection.

(iii) Above false ceiling, in no case, open wiring shall be allowed. Wiring will be done in recessed conduit or surface steel conduit.

(iv) In recessed conduit system, routes of conduit will be planned, so that various inspection boxes provided don't present a shabby look. Such boxes can be provided 5 mm above plaster level, and they can be covered with plaster of paris with marking of junction boxes.

(v) Where number of electrical services like electrical wiring, telephone wiring, computer cabling, pass through corridors, it may be proper to plan such service with properly designed aluminium/PVC channels duly covered by a false ceiling, so that subsequently such service can be maintained and additional cables can be provided.

(vi) Generally, conduits for wiring will not be taken in floor slabs. When it is unavoidable special precaution to be taken to provide floor channels with provision for safety and maintenance. Alternatively false flooring can be provided.

3.3 Passing through Walls or Floors

(i) When wiring cables are to pass through a wall, these shall be taken through a protection (steel/ PVC) pipe or porcelain tube of suitable size such that they pass through in a straight line without twist or cross in them on either porcelain, PVCor other approved material.

(ii) All floor openings for carrying any wiring shall be suitably sealed after installation.

3.4 Joints in Wiring

(i) No bare conductor in phase and/or neutral or twisted joints in phase, neutral, and/ or protective conductors in wiring shall be permitted.

(ii) There shall be no joints in the through-runs of cables. If the length of final circuit or submain is more than the length of a standard coil, thus necessitating a through joint, such joints shall be made by means of approved mechanical connectors in suitable junction boxes.

(iii) Termination of multistranded conductors shall be done using suitable crimping type thimbles.

3.5 Ratings of Outlets

(to be adopted for design).

(i) Incandescent lamps in residential and non-residential buildings shall be rated at 60W and 100W

respectively.

(ii) Ceiling fans shall be rated at 60W. Exhaust fans, fluorescent tubes, compact fluorescent tubes, HPMV lamps, HPSV lamps etc. shall be rated according to their capacity. Control gear loses shall be also considered as applicable.

(iii) 6A and 16A socket outlet points shall be rated at 100W and 1000W respectively, unless the actual values of loads are specified.

3.6 Capacity of Circuits

(i) Lighting circuit shall feed light/fan/ call bell points. Each circuit shall not have more than 800 Watt connected load or more than 10 points whichever is less. However, in case of CFL points where load per point may be less, number of points may be suitably increased.

(ii) Power circuit in non-residential building will have only one outlet per circuit.

(iii) Each power circuit in residential building can feed following outlets:

(a) Not more than 2 Nos. 16A outlets.

(b) Not more than 3 Nos. 6A outlets.

(c) Not more than 1 No.16A and 2 Nos. 6A outlets.

(iv) Load more than 1 KW shall be controlled by suitably rated MCB and cable size shall be decided as per calculations.

(v) Power Wiring with Bus Trucking

It is permitted to meet large-scale power requirement in a hall, or floor, with use of single phase or 3 phase bus bars running inside a metal enclosure. This will be provided with careful design and use of factory fabricated bus-trunking of reputed make, conforming to relevant BIS standards and with standard accessories like End feed unit, tap off with necessary safety features like over current, short-circuit and earth fault protection. Such trunking will be of specified breaking KA rating.

3.6 Socket Outlets

(i) Socket outlets modular type shall be 6A 3 pin, 16 Amp 3 pin or 16/6 Amp 6 pin. 5 pin socket outlets will not be permitted.

The third pin shall be connected to earth through protective (loop earthing) conductor. 2 pin or 5 pin sockets shall not be permitted to be used.

(ii) Conductors connecting electrical appliances with socket outlets shall be of flexible type with an earthing conductor for connection to the earth terminal of plug and the metallic body of the electrical appliance.

(iii) Sockets for the power outlets of rating above 1KW shall be of industrial type with associated plug top and controlling MCB.

(iv) Where specified, shutter type (interlocking type) of sockets shall be used.

(v) Every socket outlet shall be controlled by a switch or MCB, as specified. The control switch/MCB shall be connected on the 'live' side of the line.

(vi) 5A/6A and 15A/16A socket outlets shall be installed at the following positions, unless otherwise specified.

(a) Non-residential buildings – 23 cm above floor level.

(b) Kitchen – 23 cm above working platform and away from the likely positions of stove and sink.

(c) Bathroom – No socket outlet is permitted for connecting a portable appliance thereto. MCB/IC switch may be provided above 2 m for fixed appliances, and at least 1 m away from shower.

(d) Rooms in residences – 23 cm above floor level, or any other level in special cases as desired by the Engineer-in-charge.

(vii) Unless and otherwise specified, the control switches for the 6A and 16A socket outlets shall be kept along with the socket outlets.

3.7 Cables

(i) Copper conductor cable only will be used for submain/ circuit/ point wiring.

(ii) Minimum size of wiring:

Light Wiring: 1.5 sq.mm.

Power Wiring : 4.0 sq.mm.

Power circuit rated : More than 1 KW, Size as per calculation.

(iii) Insulation : Copper conductor cable shall be PVC insulated conforming to BIS Specification.

(iv) Multi stranded : Cables are permitted to be used.

3.8 Flexible Cable

(i) Conductor of flexible cables shall be of copper. The cross sectional area of conductor for flexible cable shall be as per design.

(ii) Only 3 core flexible cables shall be used for connecting single-phase appliances.

(iii) Unless the flexible cables are mechanically protected by armour, or tough rubber, or PVC sheath, these shall not be used in workshops and other places where they are liable to mechanical damage.

(iv) Flexible cable connection to bell push from ceiling rose shall be taken through steel conduit/metallic casing and capping.

3.9 Wiring Accessories

(a) Control Switches for Point

(i) Control switches (single pole switch) carrying not more than 16A shall be modular type. The switch shall be 'On' when the knob is down.

(ii)(a) In type I, II & III quarters, Barracks & school buildings (except principal's & staff rooms) etc. Piano type switches shall be provided (unless specifically asked for by the user department / Architect.)

(b) Modular type switches to be provided for remaining types of buildings

i.e. in all types of remaining non-residential buildings & residential buildings of type IV & above & Transit hostel or as may be decided by the Architect/ user department. (Note: Provision is meant for new constructions and in existing buildings during rewiring if the building work renovation is also in progress in the area. Otherwise existing type of piano switches will be continued.)

(iii) It is recommended to provide double pole MCB in proper enclosure as power outlet for window type AC units, geysers etc.

(b) Switch Box

(i) Switch box shall be hot dip galvanized, factory fabricated, suitable in size for surface/ recess mounting and suitable in size for accommodating the required number of switches and accessories (where required to be usedfor applications other then modular switches/ sockets).

(ii) Switch box also can be of non-metallic material. The technical sanctioning authority will approve specified makes of reputed quality and specifications.

(c) Switch Box Covers (for application other than modular type)

Phenolic laminated sheets of approved shade shall be used for switch box covers. These shall be of 3 mm thick synthetic phenolic resin bonded laminated sheet as base material and conforming to grade P- I of IS 2036 : 1974.

Note: Specification for switch boxes is covered in the chapters on the various types of wiring.

(d) Ceiling Rose

(i) A ceiling rose shall not be used on a circuit, the voltage of which normally exceeds 250V.

(ii) Only one flexible cord shall be connected to a ceiling rose. Specially designed ceiling roses shall be used for multiple pendants.

(iii) A ceiling rose shall not embody fuse terminal as an integral part of it.

(e) Lamp Holders

(i) Lamp holders may be batten, angle, pendant or bracket holder type as required. The holder shall be made of brass and shall be rigid enough to maintain shape on application of a nominal

external pressure. There should be sufficient threading for fixing the base to the lamp holder part so that they do not open out during attention to the lamp or shade.

Lamp holders for use on brackets and the like shall have not less than 1.3 cm nipple, and all those for use with flexible pendant shall be provided withcord grips.

(iii) All lamp holders shall be provided with shade carriers.

(iv) Where center contact Edison Screw lamp holders are used, the outer or screw contact shall be connected to the 'middle wire', or the neutral conductor of the circuit.

(f) Fittings

Types: The type of fittings shall be as specified in tender documents.

Indoor Type Fittings

(i) Where conductors are required to be drawn through tube or channel leading to the fitting, the tube or channel-must be free from sharp angles or projecting edge, and of such size as will enable them to be wired with the conductors used for the final circuit without removing the braiding or sheathing. As far as possible all such tubes or channels should be of sufficient size to permit looping back.

(ii) Wires used within prewired fittings shall be flexible with PVC insulation and 14/0.193 mm (minimum) copper conductors. The leads shall be terminated on built-in-terminal block, ceiling rose or connector, as required.

(iii) Fittings using discharge lamps shall be complete with power factor correction capacitors, either integrally or externally. An earth terminal with suitable marking shall be provided for each fitting for discharge lamps.

(iv) Fittings shall be installed such that the lamp is at a height of 2.4m above floor level, unless otherwise directed by the Engineer-in-charge.

(v) Fittings made of CRCA shall be phosphatized and powder/epoxy painted. For coastal areas and humid area like toilets, kitchen, for prolonging the life of such fittings, corrosion free materials like engineering plastic, aluminum, stainless steel etc. should be used.

Outdoor Fittings

Outdoor fittings shall have suitable IP protection. It is preferable that street light fittings are of cast aluminum body of IP 65, for reducing recurring maintenance cost and improved performance. Where required IP 66 fittings also can be provided for reducing maintenance frequency and cost.

Other fittings, which are not available with tested IP 65/54 protection, can be properly fabricated with weatherproof features, proper gasketing etc. As far as possible corrosion free material like cast aluminums, stainless steel, engineering plastics may be used for fabrication of such fittings, to prolong life of such fittings. There should not be any exposed wiring in such outdoor fittings.

3.10 Attachment of Fittings and Accessories

(a) Conduit Wiring System

(i) All accessories like switches, socket outlets, call bell pushes and regulators shall be fixed in flush pattern inside the switch/regulator boxes. Accessories like ceiling roses, brackets, batten holders etc. shall be fixed on outlet boxes. The fan regulators may also be fixed on outlet boxes, if so directed by the Engineer-in-charge.

(ii) Aluminum alloy or cadmium plated iron screws shall be used to fix the accessories to their bases.

(iii) The switch box/regulator box shall normally be mounted with their bottom 1.25 m from floor level, unless otherwise directed by the Engineer-in-charge.

(b) Fixing to Walls and Ceiling

(i) Wooden plugs for fixing to wall/ceiling will not be allowed. Fixing will be done with the help of PVC sleeves/Rowel plugs/ dash fasteners as required.

(ii) Drilling of holes shall be done by drilling machines only. No manual drilling of hole will be allowed.

3.11 Fans, Regulators and Clamps

(a) Ceiling Fans

(i) Ceiling fans including their suspension shall conform to relevant Indian Standards.

(ii) The capacity of a ceiling fan to meet the requirement of a room with the longer dimension D meters should be about 55 D m3/min.

(iii) The height of fan blades above the floor should be (3H + W)/4, where H is the height of the room, and W is the height of the work plane.

(iv) The minimum distance between fan blades and the ceiling should be about 0.3 meters.

(v) When actual ventilated zone does not cover the entire room area, then optimum size of ceiling fan should be chosen based on the actual usable area of the room, rather than the total floor area of the room.

(vi) The number of fans and the optimum sizes for rooms of different dimensions are given in the following table:

Optimum Size/Number of Fans for Rooms of Different Sizes

Room Width	***Room Length***										
m	*4m*	*5m*	*6m*	*7m*	*8m*	*9m*	*10m*	*11m*	*12m*	*14m*	*16m*
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*
3	1200/1	1400/1	1500/1	1050/2	1200/2	1400/2	1400/2	1400/2	1200/3	1400/3	1400/3
4	1200/1	1400/1	1200/2	1200/2	1200/2	1400/2	1400/2	1500/2	1200/3	1400/3	1500/3
5	1400/1	1400/1	1400/2	1400/2	1400/2	1400/2	1400/2	1500/2	1400/3	1400/3	1500/3
6	1200/2	1400/2	900/4	1050/4	1200/4	1400/4	1400/4	1500/4	1200/6	1400/6	1500/6
7	1200/2	1400/2	1050/4	1050/4	1200/4	1400/4	1400/4	1500/4	1200/6	1400/6	1500/6
8	1200/2	1400/2	1200/4	1200/4	1200/4	1400/4	1400/4	1500/4	1200/6	1400/6	1500/6
9	1400/2	1400/2	1400/4	1400/4	1400/4	1400/4	1400/4	1500/4	1400/6	1400/6	1500/6
10	1400/2	1400/2	1400/4	1400/4	1400/4	1400/4	1400/4	1500/4	1400/6	1400/6	1500/6
11	1500/2	1500/2	1500/4	1500/4	1500/4	1500/4	1500/4	1500/4	1500/6	1500/6	1500/6
12	1200/3	1400/3	1200/6	1200/6	1200/6	1400/6	1400/6	1500/6	1200/7	1400/9	1400/9
13	1400/3	1400/3	1200/6	1200/6	1200/6	1400/6	1400/6	1500/6	1400/9	1400/9	1500/9
14	1400/3	1400/3	1400/6	1400/6	1400/6	1400/6	1400/6	1500/6	1400/9	1400/9	1500/9

Note: This table is indicative only. Case specific design should be done by field officers based on site conditions & constraints.

(vii) Energy Efficient fans with BEE 3–5-star rating or complying with IS 374: 1979, shall be used. The minimum service value of fans shall be 3.5 m3/min/W and air delivery 200 m3/min.

The values of service factor and air delivery for ceiling fans with 1200 mm

Star Rating Index Calculation for Ceiling Fans (1200 mm sweep)

Star Rating	*Service Value for Ceiling Fans**
1 Star	> 3.2 to < 3.4
2 Star	> 3.4 to < 3.6
3 Star	> 3.6 to < 3.8
4 Star	> 3.8 to < 4.0
4 Star	< 4.0

* Where x is the base service value as per IS 374 : 1979. BEE has proposed a base service value of 3.2 at present and would upgrade it to higher value once the BIS value is finalised.

* The BIS has proposed from the year 2010 the service value of 3.5.

* All ceiling fans covered under this standard shall comply with minimum air Delivery of 210 m3/min.

For other fan size (mm) the following table may be considered

Standard Power with Air Delivery of Fan as per the IS 374 Code

Fan Size	*Type*		*Minimum Air Delivery*	*Minimum Service Value*	*Maximum Power Input*
(mm)			m^3/min	$m^3/min/W$	*W*
900	Capacitor	AC	130	3.1	42
		DC	130	3.4	38
1050	Capacitor	AC	150	3.1	48
		DC	150	3.4	44
1200	Capacitor	AC	200	4	50
		DC	200	4.6	44
1400	Capacitor	AC	245	4.1	60
		DC	245	4.8	51
1500	Capacitor	AC	270	4.3	63
		DC	270	5.1	53

Note: Air delivery values are on the basis of air velocity measurements up to 15m/ min.

(viii) Step Type Electronic regulators should be used instead of resistance type regulators for controlling speed of fans.

(ix) All ceiling fans shall be wired to ceiling roses or to special connector boxes, and suspended from hooks or shackles, with insulators between hooks and suspension rods. There shall be no joint in the suspension rod.

(x) For wooden or steel joists and beams, the suspension shall consist of GI flat of size not less than 40 mm x 6 mm, secured on the sides of the joists or beams by means of two coach screws of size not less than 5 cm for each flat. Where there is space above the beam, a through-bolt of size not less than 1.5 cm dia, shall be placed above the beam from which the flats are suspended. In the latter case, the flats shall be secured from movements by means of another bolt and nut at the bottom of the beam. A hook consisting of MS rod of size not less than 1.5 cm dia shall be inserted between the MS flat through oval holes on their sides. Alternatively, the flats may be bent inwards to hold tightly between them by means of a bolt and nut, a hook of 'S' form.

(xi) In the case of 'I' beams, flats shall be shaped suitably to catch the flanges and shall be held together by means of a long bolt and nut.

(xii) For concrete roofs, a 12 mm dia. MS rod in the shape of 'U' with their vertical legs bent horizontally at the top at least 19 cm on either side, and bound to the top reinforcement of the roof

shall be used, as shown in Fig. 5.

(xiii) In buildings with concrete roofs having a low ceiling height, where the fan clamp mentioned under sub-clause (v) above cannot be used, or wherever specified, recessed type fan clamp inside metallic box, as shown in Fig. 6 shall be used.

(xiv) Canopies on top of suspension rod shall effectively hide the suspension.

(xv) The leading in wire shall be of nominal cross sectional area not less than 1.5 sq. mm. and shall be protected from abrasion.

(xvi) Unless otherwise specified, all ceiling fans shall be hung 2.75 m above the floor.

(xvii) In the case of measurement of extra down rod for ceiling fan including wiring, the same shall be measured in units of 10 cm. Any length less than 5 cm shall be ignored.

(xviii) The wiring of extra down rod shall be paid as supplying and drawing cable in existing conduit.

(b) Exhaust Fans

(i) Exhaust fans shall conform to relevant Indian Standards.

(ii) Exhaust fans shall be erected at the places indicated by the Engineer-in- charge. For fixing an exhaust fan, a circular opening shall be provided in the wall to suit the size of the frame, which shall be fixed by means of rag bolts embedded in the wall. The hole shall be neatly plastered to the original finish of the wall. The exhaust fan shall be connected to the exhaust fan point, which shall be wired as near to the opening as possible, by means of a flexible cord, care being taken to see that the blades rotate in the proper direction.

(iii) Exhaust fans for installation in corrosive atmosphere, shall be painted with special PVC paint or chlorinated rubber paint.

(iv) Installation of exhaust fans in kitchens, dark rooms and such other special locations need careful consideration; any special provisions needed shall be specified.

(c) Regulators

The metallic body of regulators of ceiling fans/exhaust fans shall be connected to earth by protective conductor.

3.12 Marking of Switch Boards

(i) Schematic Diagram

First a comprehensive schematic diagram for each building is to be prepared, starting from Main LT Panel, rising main, submain boards, DBs, etc. and the manner in which they are connected. This will include essential, non-essential and UPS systems. Sizes of interconnecting main/submain cables shall be indicated.

(ii) Marking of each Main Board

Each main board/submain board shall be marked indicating rating of each incoming/ outgoing switch and the details of load/area it feeds. Detail/size of incoming and outgoing cable also shall be marked indicating from where the incoming cable has originated.

(iii) Marking of Distribution Board

Each Distribution Board shall be marked indicating detail of incoming switch (Size of cable and from where it is fed) and marking of each outgoing MCB indicating the area it feeds. Suitable marking sticker will be suitably fixed to indicate such details.

(iv) Marking of Power/Light DBs

Power/light DBs shall be marked 'P' and 'L' respectively.

(v) Marking for Non-essential/Essential/UPS/Switch Boards

Each switchboard shall be marked essential/non-essential/UPS to indicate the nature of such switchboards.

(vi) Marking of Main Earthing Terminal

Main Earthing terminals in main/submain switchboard shall be permanently marked, as "Safety Earth – Don't Remove".

3.13 LT Distribution Switchgear

Only following type switchboards will be used:

(a) Main/Submain switchboard of cubicle type.

(b) DBs – Conventional DBs of reputed makes can also be used with the approval of technical sanctioning authority in addition to prewired DB.

(c) Specially designed switchboards.

Also specially designed switchboards can be used with detailed specification and fabrication drawings approved by the technical sanctioning authority.

(d) Specifications of cubicle panel and pre-wired DB are given in Clause 7.1.2 of Chapter 7.

3.14 Location of Switchboards

(i) Switchboards are to be located in common areas like corridors, lobby etc. and not to be located in locked room.

(ii) Switchboard shall be located only in dry situation and in well-ventilated space. They shall not be placed in the vicinity of storage battery or exposed to chemical fume.

(iii) Switchboards shall not be erected above gas stove, or sinks or within 2.5 meterof any washing unit in washing rooms of launderings or in the bath rooms, toilets, or kitchen.

(iv) As far as possible main boards shall not be located in basement. Such main boards can be located in ground floor.

(v) It is preferable to locate floor main boards in rising main shafts of adequate size, with steel doors (having ventilation) or in suitable room.

(vi) Similarly DBs can be in suitable nitches in corridor walls having doors.

(vii) Locating main boards under staircase or standing open in corridor is not a desirable practice, besides being highly unaesthetic.

(viii) The main switchboard, which receives power to the building, should be invariably located in a switch room, having round the clock access, for emergency attendance to the switchboard.

3.15 Guidelines for Planning Residential Areas

(i) U.G. System of Power Distribution, Street Lighting, Telephone Cabling and TV Cabling

For long-term economical maintenance, better reliability of service, safety, protection against heavy rains, storm, wind etc. and aesthetics, underground cable system will be generally followed. Also considering the high cost of land, underground system results in better economic utilization of land area, otherwise substantial land route has to be earmarked for overhead lines.
(ii) Efficient working of street lights and staircase lighting is required for security of the colony and safety and convenience of the residents. Therefore, adequate street lighting, staircase lighting is to be provided. Generally back lanes of residential blocks remain dark. Such areas are also to be covered by basic street lighting for security.
(iii) Kitchen

(i) Exhaust fans opening with one point outlet to be provided irrespective of yardstick of provision of exhaust fans.

(ii) In addition to one 16 A 6-pin power outlet for kitchen, one 3 pin 6 Amp. outlet to be provided for water filter.

(iv) Washing Machine

Location to be finalized in consultation with the Architect. A power outlet plus water supply/drainage to be coordinated with Architect/Civil Engineer.

(v) Meter Board

(For a Block of Quarters)

Generally for a block of quarters of 2/3/4 storied, electric supply for each block is received in a meter board, where a cubicle meter panel is provided with system of power distribution to each quarter.

At present such meter boards are invariably located under staircase. This is not a desirable practice from technical/aesthetic viewpoint.

It is technically desirable to coordinate with Architect to provide separate meter room for each block of quarters or a number of blocks.

(vi) Stair Case Lighting

Stair case lighting is to be treated as an extension of street lighting, for security and convenience of the residents. CFL (1 x 11 Watt) type stair case lighting may be provided to reduce load. As for example, need of 200 quarters can be met with 100 CFL fitting (each of 11 watt), with connected load of 1.5 KW only. Incandescent stair case lighting and bulk head fittings should not be provided, in view of excessive energy consumption and low burning hours.

(vii) Emergency Electric Supply

For ensuring essential water supply and security lighting, a D.G. set to be provided for each colony to take care of water supply pump set, street lighting and essential load requirement of buildings like CGHS Dispensary, Community Center etc.

(viii) Fittings

Subject to limit of yardstick of fittings for various types of quarters following guidelines to be provided.

(i) Every room to be provided with one fluorescent fitting for energy saving.

(ii) Kitchen to be provided with a fluorescent fitting, tapped from a batten holder (through an adopter), so that in case of need batten holder can be usedwith bulbs

(iii) Incandescent bulkhead fittings not to be used.

(iv) Quality fittings of reputed make to be used.

(ix) Main Board of Each Quarter

It shall be MCB type with provision of ELCB with the incoming MCB. It shall be located in a nitch with ventilated door cover, in the room connecting to the entry of the quarter. MCB DB shall be pre-wired type, for trouble free service.

(x) Corrosion Free Fittings

Coastal areas and humid areas like kitchen, toilet are subject to corrosion, which substantially reduces the useful life of such fittings, besides giving an ugly look on account of rusting.

Therefore for coastal areas, and other humid areas corrosion free type of fittings (like aluminium, stainless steel, engineering plastic) should be used, for ensuring long life of such fittings and to achieve life cycle economy, after taking into account recurring expenditure on account of painting of fittings.

(xi) Telephone Wiring

Telephone wiring is to be provided for each quarter. One outlet up to type III quarters, two outlets up to type IV quarters and three outlets above type IV quarters. Such telephone wiring to be brought to a tag-block at a suitable point in ground floor. Provisions shall be kept for suitable entry-pipe for laying incoming telephone cable.

(xii) TV Cabling

Internal TV cabling shall be provided, with two outlets up to type III quarters and three outlets for type IV quarters and above. Similarly, from suitable point at ground floor, TV cabling shall be provided. With use of suitable splitters, such TV cabling to be connected to each quarter.

(xiii) Lighting for Parks

Colonies are provided with parks. Such parks should be provided with adequate lights to include area lights, pathway lights etc. so that the parks can be effectively used by the residents and they remain secure during night time.

(xiv) External Pipe Network for Laying Telephone and TV Cabling for the Colony

Starting from a suitable room, pipe network may be provided to lay telephones/TV cables for the colony. Suitable road cross pipe and manholes to be provided for drawing such cables and their maintenance.

(xv) Preliminary Estimate to Take Care of Telephone/TV Cabling in a Colony

At present, such services are provided in a very crude manner making use of existing poles and hanging cables. Apart from making colonies shabby, such services are subject to damages and unsatisfactory service. Therefore preliminary estimate should provide for such TV/Telephone cabling for the colony.

(xvi) Other Allied Services

Modern residential colonies require support services like CCTV (for Gate and house security), intercom system, basic security system etc. for the safety and convenience of the residents. Therefore, preliminary estimate should provide for basic provisions for such safety/security systems. Most of these services pay for themselves within 3 / 4 years of installation, besides providing security, which sometimes amount to life saving instances.

3.16 Guidelines for Planning Office Buildings

(i) The main objective is to avoid possible fire hazards, which calls for sound detailed designing and use of quality equipments and materials executed with sound workmanship and supervision.

(ii) All control LT Panels, controlling power supply to the entire building will be located in a centralized room, from where centralized control and monitoring of the entire power supply system can be made.

(iii) Earth fault protection shall be provided for each individual building at the LT receiving point i.e. Main LT Panel. ELCB shall not be provided as a matter of routine in distribution boards. These can be provided, if required, by the Chief Engineer (E), in charge.

(iv) Office buildings are prone to fire hazard during night hours. Therefore, after office hours, all the LT Panels should be switched off. Based on need of the building, only the specified LT panel to be kept 'ON' which feed the loads during night hours. Such panel, called common service panel, may feed following loads, which are normally used after office hours:-

a) Some specified lifts.

b) Staircase/ Corridor/ Compound light.

c) Fire protection loads.

d) Pump Sets.

e) Other loads which are kept 'ON' after office hours.

f) Reliability of Power Supply

Minimum two transformers to be provided to provide certain redundancy. Also a smaller size transformer may be provided to take care of reduced load during 'after office' hours to have energy saving of transformer, after proper technical evaluation.

(v) It is preferable to plan for a separate service building, to combine all electrical and mechanical services of the building, so that the services can be maintained comprehensively at a lower cost and also reducing the overall area requirement. Such service building can combine electric sub-station, DG Sets, UPS, Air- conditioning Plant, water supply pump sets, etc.

(vi) While planning, maintainability of various services to be ensured, like providing facilities like access, approachability of various equipment's, maintenance space etc.

METALLIC CONDUIT WIRING SYSTEM

4.0 Scope

This chapter covers the detailed requirements for wiring work in metallic conduits. This chapter covers both surface and recessed types of works.

4.1 Application

(i) Recessed conduit is suitable generally for all applications. Surface conduit work may be adopted in places like workshops, plant rooms, pump rooms, wiring above false ceiling/below false flooring, and at locations where recessed work may not be possible to be done. The type of work, viz. surface or recessed, shall be as specified in the respective works.

(ii) Flexible conduits may only be permitted for interconnections between switchgear, DBs and conduit terminations in wall.

4.2 Material

4.2.1 Conduits

(i) All rigid conduit pipes shall be of steel and be ISI marked. The wall thick- ness shall be not less than 1.6 mm (16 SWG) for conduits upto 32 mm dia and not less than 2 mm (14 SWG) for conduits above 32 mm dia. These shall be solid drawn or reamed by welding, and finished with galvanized or stove enameled surface.

(ii) The maximum number of PVC insulated cables conforming to IS 694 : 1990 that can be drawn in one conduit is given size wise in Table I, and the number of cables per conduit shall not be exceeded. Conduit sizes shall be selected accordingly in each run.

(iii) No steel conduit less than 20 mm in diameter shall be used.

4.2.2 Conduit Accessories

(i) The conduit wiring system shall be complete in all respects, including their accessories.

(ii) All conduit accessories shall be of threaded type, and under no circumstances pin grip type or clamp grip type accessories shall be used.

(iii) Bends, couplers etc. shall be solid type in recessed type of works and may be solid or inspection type as required, in surface type of works.

(iv) (a) Saddles for surface conduit work on wall shall not be less than 0.55 mm (24 gauges) for conduits upto 25 mm dia and not less than 0.9 mm (20 gauges) for larger diameter. The corresponding widths shall be 19 mm & 25 mm.

(b) The minimum width and the thickness of girder clips used for fixing conduits to steel joists, and clamps shall be as per Table II.

4.2.3 Outlets

(i) The switch box or regulator box shall be made of metal on all sides, except on the front. In the case of cast boxes, the wall thickness shall be at least 3 mm and in case of welded mild steel sheet boxes, the wall thickness shall not be less than 1.2 mm (18 gauge) for boxes upto a size of 20 cm x 30 cm, and above this size 1.6 mm (16 gauge) thick MS boxes shall be used. The metallic boxes shall be duly painted with anticorrosive paint before erection as per chapter 15 of these Specifications.

(ii) (a)Outlet boxes shall be of one of the size, covered in the Schedule of Rates (Elect.), 2012

(b) Where a large number of control switches and/or fan regulators are required to be installed at one place, these shall be installed in more than one outlet box adjacent to each other for ease of maintenance.

(iii) An earth terminal with stud and 2 metal washers and terminal block shall be provided in each MS box for termination of protective conductors and for connection to socket outlet/metallic body of fan regulator etc.

(iv) A metal strip shall be welded/screwed, to the metal box as support if tumbler type of control switches, sockets and/or fan regulators in flush pattern.

(v) Clear depth of the box shall not be less than 60 mm and this shall be increased suitably to accommodate mounting of fan regulators in flush pattern.

(vi) The fan regulators can also be mounted on the switch box covers, if so stipulated in the tender specifications, or if so directed by the Engineer-in-charge.

(vii) Except where otherwise stated, 3 mm thick phenolic laminated sheets as per clause 3.14(c) shall be fixed on the front with brass screws, or aluminium alloy/ cadmium plated iron screws as approved by the Engineer-in-charge.

4.3 Installation

4.3.1 Common Aspects for Recessed and Surface Conduit Works

(i) Conduit Joints

(a) The conduit work of each circuit or section shall be completed before the cables are drawn in.

(b) Conduit pipes shall be joined by means of screwed couplers and screwed accessories only. Threads on conduit pipes in all cases shall be between 13 mm to 19 mm long, sufficient to accommodate pipes to full threaded portion of couplers or accessories.

(c) Cut ends of conduit pipes shall have no sharp edges, nor any burrs left to avoid damage to the insulation of the conductors while pulling them through such pipes.

(d) The Engineer-in-charge, with a view to ensuring that the above provision has been carried out, may require that the separate lengths of conduit etc., after they have been prepared, shall be submitted for inspection before being fixed.

(e) No bare threaded portion of conduit pipe shall be allowed, unless such bare threaded portion is treated with anticorrosive preservative or covered with approved plastic compound.

(ii) Bends in Conduit

(a) All necessary bends in the system, including diversion, shall be done either by neatly bending the pipes without cracking with a bending radius of not less than 7.5 cm, or alternatively, by inserting suitable solid or inspection type normal bends, elbows or similar fittings, or by fixing cast ironinspection boxes, whichever is most suitable.

(b) No length of conduit shall have more than the equivalent of four quarter bends from outlet to outlet.

(c) Conduit fittings shall be avoided as far as possible on conduit system exposed to weather. Where necessary, solid type fittings shall be used.

(iii) Outlets

(a) All outlets such as switches, wall sockets etc. may be either flush mounting type, or of surface mounting type, as specified in the Additional Specifications.

(b) All switches (except piano type switches), socket outlets and fan regulators shall be fixed on metal strips which shall be screwed / welded to the box. Piano type switches and accessories shall be fixed on the phenolic laminated sheet covers in flush pattern.

(iv) Painting after Erection

After installation, all accessible surfaces of conduit pipes, fittings, switch and regulator boxes etc. shall be painted in compliance with the clauses under Chapter 15 "Painting".

4.3.2 Additional Requirements for Surface Conduit Work

(i) Painting before Erection

The outer surface of conduit including all bends, unions, tees, junction boxes etc. forming part of the conduit system, shall be adequately protected against rust when such system is exposed to weather, by being painted with 2 coats of red oxide paint applied before they are fixed.

(ii) Fixing Conduit on Surface

(a) Conduit pipes shall be fixed by saddles, secured to suitable approved plugs with screws in an approved manner at an interval of not more than one meter, but on either side of the couplers or bends or similar fittings, saddles shall be fixed at a distance of 30 cm from the center of such fittings.

(b) Where conduit pipes are to be laid along the trusses, steel joists etc. the same shall be secured by means of saddles or girder clips or clamps as required by the Engineer-in-charge.

(c) In long distance straight run of conduit, inspection type couplers at reasonable intervals shall be provided, or running threads with couplers and jam nuts shall be provided.

(iii) Fixing Outlet Boxes

Only portion of the switch box shall be sunk in the wall, the other portion being projected out for suitable entry of conduit pipes into the box.

4.3.3 Additional Requirements for Recessed Conduit Work

(i) Making Chase

(a) The chase in the wall shall be neatly made and of ample dimensions to permit the conduit to be fixed in the manner desired.

(b) In the case of buildings under construction, the conduits shall be buried in the wall before plastering, and shall be finished neatly after erection of conduit.

(c) In case of exposed brick / rubble masonry work, special care shall be taken to fix the conduit and accessories in position along with the building work.

(ii) Fixing Conduits in Chase

(a) The conduit pipe shall be fixed by means of staples, J-hooks, or by means of saddles, not more than 60 cm apart or by any other approved means of fixing.

(b) All threaded joints of conduit pipes shall be treated with some approved preservative compound to secure protection against rust.

(iii) Fixing Conduits in RCC Work

(a) The conduit pipes shall be laid in position and fixed to the steel reinforcement bars by steel binding wires before the concreting is done. The conduit pipes shall be fixed firmly to the steel reinforcement bars to avoid their dislocation during pouring of cement concrete and subsequent tamping of the same.

(b) Fixing of standard bends or elbows shall be avoided as far as practicable, and all curves shall be maintained by bending the conduit pipe itself with a long radius, which will permit easy drawing in of conductors.

(c) Location of inspection / junction boxes in RCC work should be identified by suitable means to avoid unnecessary chipping of the RCC slab subsequently to locate these boxes.

(iv) Fixing Inspection Boxes

(a) Suitable inspection boxes to the minimum requirement shall be provided to permit inspection and to facilitate replacement of wires, if necessary.

(b) These shall be mounted flush with the wall or ceiling concrete. Minimum 65 mm depth junction boxes shall be used in roof slabs and the depth of the boxes in other places shall be as per IS 2667 : 1988.

(c) Suitable ventilating holes shall be provided in the inspection box covers.

(v) Fixing Switch Boxes and Accessories

Switch boxes shall be mounted flush with the wall. All outlets such as switches, socket outlets etc. shall be flush mounting type, unless otherwise specified in the Additional Specifications.

(vi) Fish Wire

To facilitate subsequent drawing of wires in the conduit, GI fish wire of

1.6 mm/1.2 mm (16/18 SWG) shall be provided along with the laying of the recessed conduit.

(vii) Bunching of Cables

(a) Cables carrying Direct Current may, if desired, be bunched whatever their polarity, but cables carrying alternating current, if installed in metal conduit shall always be bunched so that the outgoing and return cables are drawn into the same conduit.

(b) Where the distribution is for single phase loads only, conductors for these phases shall be drawn in one conduit.

(c) In case of three phase loads, separate conduits shall be run from the distribution boards to the load points, or outlets as the case may be.

4.3.4 Earthing Requirements

(i) The entire system of metallic conduit work, including the outlet boxes and other metallic accessories, shall be mechanically and electrically continuous by proper screwed joints, or by double check nuts at terminations. The conduit shall be continuous when passing through walls or floors.

(ii) A protective (loop earthing) conductor(s) shall be laid inside the conduit between the metallic switch boxes and distribution switch boards and terminated with proper earth lugs/ terminals. Only PVC insulated copper conductor cable of specified size green in colour shall be allowed.

(iii) The protective conductors shall be terminated properly using earth studs, earth terminal block etc. as the case may be.

(iv) Gas or water pipe shall not be used as protective conductor (earth medium).

TABLE I

Maximum Number of PVC Insulated 650/1100 V grade Aluminium / Copper Conductor Cable conforming to IS 694 : 1990

Nominal cross sectional area of conductor in sq.mm	*20 mm*		*25 mm*		*32 mm*		*38 mm*		*51 mm*		*64 mm*	
	S	*B*	*S*	*B*	*S*	*B*	*S*	*B*	*S*	*B*	*S*	*B*
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
1.50	5	4	10	8	18	12	–	–	–	–	–	–
2.50	5	3	8	6	12	10	–	–	–	–	–	–
4	3	2	6	5	10	8	–	–	–	–	–	–
6	2	–	5	4	8	7	–	–	–	–	–	–
10	2	–	4	3	6	5	8	6	–	–	–	–
16	–	–	2	2	3	3	6	5	10	7	12	8
25	–	–	–	–	3	2	5	3	8	6	9	7
35	–	–	–	–	–	–	3	2	6	5	8	6
50	–	–	–	–	–	–	–	–	5	3	6	5
70	–	–	–	–	–	–	–	–	4	3	5	4

Note:

(1) The above table shows the maximum capacity of conduits for a simultaneous drawing in of cables.

(2) The columns headed 'S'apply to runs of conduits which have distance not exceeding 4.25 m between draw in boxes and which do not deflect from the straight by an angle of more than 15 degrees. The columns headed 'B' apply to runs of conduit, which deflect from the straight by an angle of more than 15 degrees.

(3) Conduit sizes are the nominal external diameters.

TABLE II

Girder Clips or Clamps

[Clause 4.2.2 (iv) b]

Size of Conduit	*Width*	*Thickness*
(i) 20 mm	19 mm	0.9 mm (20 SWG)
(ii) 25 mm	19 mm	0.9 mm (20 SWG)
(iii) 32 mm & above	25 mm	1.2 mm (18 SWG)

NON METALLIC CONDUIT WIRING SYSTEM

5.0 Scope

This chapter covers the detailed requirements for wiring work in non-metallic conduits. This chapter covers both surface and recessed types of wiring work.

5.1 Application

5.1.1 Recessed conduit work is generally suitable for all applications. Surface conduit work may be adopted in places like workshops etc. and where recessed work may not be possible to be done. The type of work shall be as specified in individual works.

5.1.2 Flexible non-metallic conduits shall be used only at terminations, wherever specified.

5.1.3 Special Precautions

a. If the pipes are liable to mechanical damages, they should be adequately protected.

b. Non-metallic conduit shall not be used for the following applications:-

i. In concealed/inaccessible places of combustible construction where ambient temperature

ii. exceeds 60 degrees C.

iii. In places where ambient temperature is less than 5 degrees C.

iv. For suspension of fluorescent fittings and other fixtures.

v. In areas exposed to sunlight.

5.2 Materials

5.2.1 Conduits

(i) All non-metallic conduit pipes and accessories shall be of suitable material complying with IS 2509

: 1973 and IS 3419 : 1989 for rigid conduits and IS 9537 (Part 5) : 2000 for flexible conduits. The interior of the conduits shall be free from obstructions. The rigid conduit pipes shall be ISI marked.

(ii) The conduits shall be circular in cross-section. The conduits shall be designated by their nominal outside diameter. The dimensional details of rigid non-metallic conduits are given in Table III.

(iii) No non-metallic conduit less than 20 mm in diameter shall be used.

(iv) Wiring Capacity

The maximum number of PVC insulated aluminium/copper conductor cables of 650/1100 V grade conforming to IS 694 : 1990 that can be drawn in one conduit of various sizes is given in Table I under clause 4.2.1 (ii). Conduit sizes shall be selected accordingly.

5.2.2 Conduit Accessories

(i) The conduit wiring system shall be complete in all respect including accessories.

(ii) Rigid conduit accessories shall be normally of grip type.

(iii) Flexible conduit accessories shall be of threaded type.

(iv) Bends, couplers etc. shall be solid type in recessed type of works, and may be solid or inspection type as required, in surface type of works.

(v) Saddles for fixing conduits shall be heavy gauge non-metallic type with base.

(vi) The minimum width and the thickness of the ordinary clips or girder clips shall be as per Table IV.

(vii) For all sizes of conduit, the size of clamping rod shall be 4.5 mm (7 SWG) diameter.

5.2.3 Outlets

(i) The switch box shall be made of either rigid PVC molding, or mild steel, or cast iron on all sides except at the front. The regulator boxes shall however be made only of mild steel or cast iron.

(ii) PVC boxes shall comply with the requirements laid down in IS 14772 : 2000. These boxes shall be free from burrs, fins and internal roughness.

The thickness of the walls and base of PVC boxes shall not be less than 2 mm. The clear depth of PVC boxes shall not be less than 60 m.

(iii) The specifications for metallic boxes shall be as per requirements of clause 4.2.3.

(iv) 3 mm thick phenolic laminated sheet covers for all types of boxes shall be as per requirements of clause 3.14(c).

5.3 Installation

5.3.1 Common Aspects for Both Recessed and Surface Conduit Works

(i) The erection of conduits of each circuit shall be completed before the cables are drawn in.

(ii) Conduit Joints

(a) All joints shall be sealed/cemented with approved cement. Damaged conduit pipes/fittings shall not be used in the work. Cut ends of conduit pipes shall have neither sharp edges nor any burrs left to avoid damage to the insulation of conductors while pulling them through such pipes.

(b) The Engineer-in-charge, with a view to ensuring that the above provision has been carried out, may require that the separate lengths of conduit etc. after they have been prepared shall be submitted for inspection before being fixed.

ii) Bends in Conduit

(a) All bends in the system may be formed either by bending the pipes by an approved method of heating, or by inserting suitable accessories such as bends, elbows or similar fittings, or by fixing non-metallic inspection boxes, whichever is most suitable. Where necessary, solid type fittings shall be used.

(b) Radius of bends in conduit pipes shall not be less than 7.5 cm. No length of conduit shall have more than the equivalent of four quarter bends from outlet to outlet.

(c) Care shall be taken while bending the pipes to ensure that the conduit pipe is not injured, and that the internal diameter is not effectively reduced.

(iv) Outlets

All switches, plugs, fan regulators etc. shall be fitted in flush pattern. The fan regulators can be mounted on the switch box covers, if so stipulated in the tender specifications, or if so directed by the Engineer-in-charge.

(v) Painting

After installation, all accessible surfaces of metallic accessories shall be painted in compliance with clauses under Chapter 15 "Painting".

5.3.2 Additional Requirements for Surface Conduit Work

(i) Conduit pipes shall be fixed by heavy gauge non-metallic saddles with base, secured to suitable approved plugs with screws in an approved manner, at an interval of not more than 60 cm, but on either side of couplers or bends or similar fittings, saddles shall be fixed at a closer distance from the centre of such fittings. Slotted PVC saddles may also be used where the PVC pipe can be pushed in through the slots.

(ii) Where the conduit pipes are to be laid along the trusses, steel joists etc. the same shall

be secured by means of saddles or girder clips as required by the Engineer- in-charge.

Where it is not possible to use these for fixing, suitable clamps with bolts and nuts shall

be used.

(iii) If the conduit pipes are liable to mechanical damage, they shall be adequately protected.

5.3.3 Additional Requirements for Recessed Conduit Work

(i) Making Chase

Requirements under clause 4.3.3 (i) shall be complied with.

(ii) Fixing Conduits in Chase

(a) The conduit pipe shall be fixed by means of staples, or by means of non- metallic saddles,

placed at not more than 60 cm apart, or shall be fixed by any other approved means of

fixing.

(b) At either side of the bends, saddles/staples shall be fixed at a distance of 15 cm from the

centre of the bends.

(i) Erection in RCC Work

Requirements under clause 4.3.3 (ii) shall be complied with.

(iv) Fixing Inspection Boxes

Requirements under clause 4.3.3 (iv) shall be complied with.

(v) Fixing Switch Boxes and Accessories

Requirements under clause 4.3.3 (v) shall be complied with.

(vi) Fish Wire

Requirements under clause 4.3.3 (vi) shall be complied with.

(vii) Bunching of Cables

For ease of maintenance, cables carrying direct current or alternating current shall always be

bunched so that the outgoing and return cables are drawn in the same conduits.

5.3.4 Earthing Requirements

(i) A protective (earth) conductor shall be drawn inside the conduit in all distribution circuits to provide for earthing of non-current carrying metallic parts of the installation. These shall be terminated on the earth terminal in the switch boxes, and/or earth terminal blocks at the DBs.

(ii) Gas or water pipe shall not be used as protective conductors (earth medium).

TABLE III

Dimensional Details of Rigid Non-metallic Conduits

[Clause 5.2.1(ii)]

(All dimensions in mm)

	Outside Diameter (in mm)	*Maximum Outside Diameter (in mm)*	*Minimum Inside Diameter (in mm)*	*Maximum Permissible Eccentricity (in mm)*	*Minimum Permissible Ovality (in mm)*
		20 + 0.3	17.2	0.2	
		25 + 0.3	21.6	0.2	
		32 + 0.3	28.2	0.2	
		40 + 0.3	35.8	0.2	
		50 + 0.3	45.0	0.4	

TABLE IV

Ordinary Clips or Girder Clips

[Clause 5.2.2(vi)]

Size of Conduit	*Width*	*Thickness*
(1) 20 mm & 25 mm	19 mm	20 SWG (0.9144 mm)
(2) 32 mm & above	25 mm	18 SWG (1.219 mm)

CABLE WORKS

5.1 SCOPE

This section covers supply, laying and jointing as required and testing and energizing all cable work.

5.2 SPECIFICATION OF CABLE

5.2.1 11 KV grade XLPE insulated PVC sheathed armoured Aluminum/ Copper cable shall be 3 core earthed of sizes as specified. The cable shall conform to IS 1554, Part II

5.2.2 1.1 KV grade XLPE insulated PVC sheathed armoured Aluminum / Copper cable shall be 3 ½ /4 core of sizes as specified. The cable shall conform to IS 1554 Part I.

5.2.3 All control wires shall be 650 V grade copper conductor Halogen free fire retardant or FRLS PVC insulated, conforming to IS 1554-Part I. The minimum size of the control wires shall be 1.5 sq. mm.

5.3 INSTALLATION

Cable shall be laid in ground, trenches, cable trays and on walls as specified. Installation shall include all supports and clamps as required. The complete work shall be in accordance to CPWD General Specifications for Electrical Works - Part II (External) 1994 amended upto date. As far as possible cables shall not be fixed on walls directly but laid on cable trays.

5.4 JOINTING FOR 11 KV GRADE CABLE GLANDS

Jointing work shall be carried out only by licensed experienced cable jointer and shall be in accordance to CPWD General Specifications for Electrical Works - Part II (External) 1994 amended upto date.

5.5 EARTHING FOR 11 KV GRADE CABLE GLANDS

All HV cable glands shall be connected to the earth with 2 Nos. 38.6 mm copper or equivalent G.I. conductors.

5.6 Selection shall be made as per tables given under Table V of CPWD General Specifications for Electrical Works Part-II (External) - 1994 amended upto date.

5.7 TESTING

Testing of the complete cable installation shall be as per clause 2.8.2 and 2.8.3 of CPWD General Specifications for Electrical Works - Part II (External) 1994 amended upto date.

5.8 POWER DISTRIBUTION SYSTEM LOSSES

The power cabling shall be adequately sized as to maintain the distribution losses not to exceed 1% of the total power usage. Record of design calculation for the losses shall be maintained.

The cables be designed as per the voltage drop regulations at peak load, and the losses be calculated on the basis of the assessed load during the day, week and year and should not be limited to the peak load.

TRUNKING CABLE MANAGEMENT SYSTEM

6.0 Scope

This chapter covers the requirements of mini trunking (casing wiring) and adaptable metallic or PVC trunking ("otherwise also called wire ways").

6.1 Adaptable trunking shall be used for power cables and data cables to run parallel in two different compartments with partition.

6.1.1 Mini Trunking is suitable for surface wiring work indoors where necessitated, either due to aesthetics or technical requirements, such as case of extension of existing wiring, avoidance of recessed wiring in RCC columns etc. PVC insulated cables and / or other approved insulated cables conforming to IS 694 : 1990 shall be used in this type of work.

Wherever data cables are used for information outlets, adaptable trunking shall be used.

6.1.2 (i) This system using PVC trunking shall be adopted in residential buildings, or office building where there is a need of tidy wiring system.

(ii) PVC trunking for distribution of Voice Data and Power should be used for cable management and should accept RJ45 Data socket and Power socket or other wiring accessory like switches, indicators etc.

(iii) Where the trunking has to be necessarily adopted in situations under (i) above, PVC trunking shall be used.

(iv)Preferred size of the mini trunking should be 25 x 16 mm, 32 x 16 mm, 40 x 25 mm, 40 x 40 mm and for adaptable trunking it should be 100 x 34 mm or 100 x 50 mm or 160 x 50 mm or 200 x 50mm for making upto four isolated compartments.

(v) Trunking should be equipped with rail on its surface on which clip-on partition can be clipped which should accept frames/plates for wiring devices upto 6/8 modules.

(vi) Trunking should have insulation rating of 5 mega Ohm. Trunking should have the following fire resistance characteristics:

-Operating temperature between – 40 Deg to 60 Deg. C

-Glow wire test 960 Deg. C

-Oxygen index – 50 ± 5

-UL94 – VO

6.2 Material

6.2.1 The mini trunking and adaptable trunking shall be of the same material, viz. either PVC or anodized aluminums in extruded sections.

6.2.2 The mini trunking shall have a square or rectangular body. The trunking cover shall be "CLIP-ON" type with double grooving in the case of PVC wire-ways, and CLIP-ON type for the metallic wire ways. All surfaces shall have smooth finish inside and outside. The top of the side walls of the body shall be suitable for the above types of fixing arrangement of trunking. PVC trunking or Aluminium trunking should have uniform thickness throughout its length and shall be of factory finish.

6.2.3 PVC trunking shall be of good quality PVC, free from defects like deformation, unevenness, blisters, cavities etc.

6.2.4 Dimensions

(i) The sizes of mini trunking for the various sizes of cables and the maximum number of 650/1100

V grade PVC insulated aluminium / copper conductor cables that can be carried in one trunking are given size wise in Table V.

(ii) The thickness of the mini trunking & adaptable trunking shall be 1 mm minimum.

(iii) When mini trunking cover is clipped onto the trunking body, cover should completely overlap on the base (casing).

6.2.5 Outlet Boxes

The outlet boxes such as switch boxes, regulator boxes and their phenolic laminated sheet covers shall be as per requirements.

6.3 Installation

6.3.1 Attachment to Wall and Ceiling

(i) The mini trunking and adaptable trunking shall be fixed by means of suitable screws to approved type of asbestos or fibre fixing plugs, at intervals not exceeding 60 cm for all sizes for mini trunking. In case of Adaptable trunking, the screwing distance shall be such that the weight of the trunking & cable hold firmly on the wall or ceiling. On either side of the joints, the distance of the fixing arrangement shall not exceed 15 cm from the joint.

(ii) All trunking body shall be fixed directly on wall or ceiling as above.

(iii) Trunking shall be used only on dry walls and ceiling, avoiding outside walls as far as possible and shall not be buried in walls not fixed in proximity to gas, steam or water pipes or immediately below the heater.

(iv) Adaptable trunking shall be with pill off cover for protection against dust. Pill off cover shall be removed only on completion of painting of walls.

6.3.2 Passing through Floors or Walls

When conductors pass through floors, the same shall be carried in an approved PVC conduit, or heavy gauge steel conduit properly bushed at both ends. The conduit shall be carried 20 cm above floor level and 2.5 cm below ceiling level and neatly terminated into the casing. Steel conduit pipes wherever accessible shall be securely earthed.

6.3.3 Joints in Casing and Capping

(i) The wire ways in straight runs should be in single piece as far as possible so as to avoid joints. Trunking shall be of 2 m or 3 m standard length for the ease of installation.

(ii) All joints shall be scarfed or cut diagonally in longitudinal section, and shall be smoothed down by filing to make the joints a very close fit as far as possible and without burrs. They shall be screwed at joints with two or more screws as would be necessary.

(iii) Joints arising out of bends or diversion shall be done using standard accessories like Internal angle, External angle, Flat angle (elbows), Flat junction (T) and end caps. For the separation of data and power cables there shall be partition in both trunking and accessories. Internal and external

angle shall have variable angle for the alignment at the wall corners. In no case the radius of curvature of the cables inside a bend shall be less than 6 times their overall diameter.

6.3.4 Trunking should be of white colour in case of PVC trunking and of white or grey colour in case of Aluminum trunking.

(i) Mini Trunking attached to ceiling shall be carried completely across the ceiling/ wall whenever required by the Engineer-in-charge, instead of being stopped at an outlet location and in all such cases, dummy mini trunking must be provided.

6.3.5 Attachment of Capping

(i) Wherever required by the Engineer-in-charge, capping shall not be fixed until the work has been inspected with the wires in position and approved. The inspection will be done from time to time as the work progresses.

(ii) Cover shall be attached to body after all the insulated wires are laid inside.

(iii) No screws or nails shall be used for fixing PVC cover to the body.

(iv) Aluminium cover shall be fixed by using cadmium plated flat head / round head screws with an axial spacing not exceeding 30 cm.

6.3.6 Installation of Cables

(i) For ease of maintenance, cables carrying direct current or alternating current shall always be bunched so that the outgoing and return cables are drawn in the same trunking.

(ii) Mini trunking shall be of such a design that it holds the wires inside the trunking body (casing) at suitable intervals, so that at the time of opening of the trunking cover (capping), the wires may remain in position in the trunking body (casing) and do not fall out.

6.3.7 Earth Continuity

(i) A protective (earth continuity) conductor shall be drawn inside for earthing of allmetallic boxes of the installations as well as for connections to the earth pin of the socket outlets.

(ii) In the case of metallic trunking there shall be a metallic link between adjacent trunking covers with screw connections, and also connections from the end casing to the earth terminal of metallic boxes / outlets / switch boards as per the case may be, for the complete body earthing of the system.

TABLE V

Maximum Number of PVC Insulated 650/1100 Volt Grade Aluminium/Copper Conductor Cable conforming to IS 694 : 1990

[Clause 6.2.4(i)]

Nominal Cross Section Area	*10/15 mm x 10 mm*	*20/15 mm x 10 mm*	*25/15 mm x 16 mm*	*32 mm x 16 mm*	*40 mm x 25 mm*	*40 mm x 40 mm*
1.5	3	5	6	8	12	18
2.5	2	4	5	6	9	15

4	2	3	4	5	8	12
6		2	3	4	6	9
10		1	2	3	5	8
16			1	2	4	6
25				1	3	5
35					2	4
50					1	3
70					1	2

Note : Dimensions shown above are outer dimensions of mini trunking

M.V PANEL & DISTRIBUTION BOARD

7.0 Scope

This covers supply/ erection/ testing and commissioning of the equipments suitable for 415 Volt, 3 Phase, 50 HZ 4 wire system.

7.1 Requirements

(i) For each equipment, required IP rating and short circuit rating capacity will be specified. Governing BIS also will be specified.

(ii) All the equipments will be factory fabricated in an approved factory having modern fabrication and testing process. It shall have seven tank pre-treatment process comprising of degreasing, rinsing, de-rusting, rinsing, phosphatising, rinsing and passivation followed by powder coat painting having a paint thickness of 60 microns or as specified. The powder paint will be subjected to oven-heated process. All panels will be provided with suitable gasket to make it dust/ vermin proof.

7.1.1 Specification of LT Cubicle Panel

(i) Cubicle panel shall be floor mounted (on a base frame) totally enclosed and extensible type. The general construction shall conform to IS 8623 : 93. The design shall include all provisions for safety of operating and maintenance personnel. Degree of IP protection shall be IP-42 for indoor application and IP-54 for outdoors, unless otherwise specified.

(ii) The panel shall be compartmentalized type having space and arrangement for incoming cable/ bus ducting, incoming switchgear/ switchgears, bus coupler, insulated and properly supported compartmentalized bus bars, outgoing compartmentalized switchgear, bus bar supports, joint shrouds, cable alleys of suitable size for cabling routing, support and terminations, inter-connection between bus bars and switchgear with auxiliary bus bars/ insulated conductors/ strips etc. Also the panel will be provided with necessary instrumentation like CTs, PTs, Ammeters, Voltmeters, phase indicating lamps, other required instruments, wiring, fuses etc.

(iii) It shall be fabricated out of CRCA sheet not less than 2.0 mm thick for load bearing members and 1.6 mm for doors of LT panels. The framework may be Angle Iron/ Channel/ Bolted type construction. General constructions shall employ the principle of compartmentalization and

segregation of each circuit. Unless otherwise approved, incomer and bus section panels shall be separate and independent and shall not be mixed with sections required for feeders. Each section of the rear accessible type board shall have hinged access door at the rear. Operating handle of the highest unit shall be at a height not more than 1.7 mt. Overall height of the board shall not exceed 2.3 metre.

(iv) Arrangement for Incoming/Outgoing Cable Termination

Cable entries shall be provided either from the rear or from the front through cable alleys of suitable size. Removable gland plate to be provided for each cable entry. Cable support arrangement to be provided inside cable alley so that cables are neatly arranged and fixed. From each outgoing switch, insulated strip/ conductor of suitable size to be provided up to suitable terminal block, which will receive incoming/ outgoing cable termination. It is desirable that cables are not terminated directly to switchgear, but terminated through proper terminal blocks.

(v) Specification of Cable Terminal Block

Terminal block of reputed make shall be used. The housing material shall be polyamide having unbreakable and fire-retardant characteristic. All the metal parts shall be made up of copper alloy including the screws. Mounting shall be 'Din' or 'G-rail' type. Screws shall be self captive type. No protection cover is required, and the block should be touch proof.

(vi) Bus bars/ Supports/ Clearances

The bus bar system may comprise of a system of main/ auxiliary bus bars run in bus bar alleys.

For bus bar material, ratings, current density, insulation, supports, bus bar clearances and joints see para 7.2 (iii).

(vii) Earthing

2 Nos. 20 x 3 mm copper strip for LT panel upto 400 Amp. capacity or 2 Nos. 20 x 5 mm copper strip for LT panel of higher capacity shall be fixed all around the panel connected to 2 Nos. earth bus copper strips connected to incoming earth conductors.

(Typical Cubicle Panel is explained in Fig. 8)

(viii) Commissioning

After erection, the LT panel will be commissioned after:

(a) Tightening of all nuts and bolts.

(b) Closing any left out holes to ensure the entire panel is insect proof.

(c) Megger testing.

(d) Earth testing.

7.1.2 Specification of Prewired DB

As a general practice only prewired MCB/HRC type DBs shall be used, on account of their superior technical features, compared to conventional DBs, which don't allow for proper wiring space and wiring termination. Rewirable fuse type DBs shall not be used.

Prewired DBs shall have following features:

(i) Recess/ Surface type with integral loose wire box.

(ii) Phase/ neutral/ earth terminal blocks for termination of incoming & outgoing wires.

(iii) Din Channel for mounting MCBs.

(iv) Arrangement for mounting incomer MCB/ RCCB/ RCBO/ MCCB as required.

(v) Copper Bus bar.

(vi) Earthing terminals.

(vii) Wiring from MCBs to phase terminal block.

(viii) Interconnection between terminal block/ incoming switch/ bus bar/ neutral terminal block/ earth terminal connector with specified size of FRLS preinsulated copper conductor cable duly fitted with copper lugs/ thimbles.

(ix) Terminal blocks should be suitable for termination of conductor/ cable of required size but minimum rated cross section of the terminal blocks should be 6 sq. mm.

(x) Terminal block shall be made of flame retardant polymide material.

(xi) Colour terminal blocks and FRLS wires for easy identification of RYB Phases, Neutral and Earth.

(xii) Prewired DB shall be provided with a detachable cassette for safe removal of MCBs, RCCBs. Terminal connectors from the DB without loosening the internal cable connections of phase and neutral circuits. (This is an optional feature.)

(xiii) The prewired DB shall have peelable poly layer on the cover for protection from cement, plaster, paints etc. during the construction period.

(xiv) Detachable plate with Knock out holes shall be provided at the top/ bottom of board. Complete board shall be factory fabricated and pre-wired in factory ready for installation at site. The box and cover shall be fabricated from 1.6mm sheet steel, properly pre-treated, phosphatized with powder coated finish.

Where specified it shall be of double door construction provided with hinged cover in the front. (See Fig. 9)

Note: Prewired DB will be factory manufactured by reputed manufacturer of MCB DBs.

INTERNAL BUILDING POWER DISTRIBUTION SCHEME FOR DIRECTOR'S RESIDENCE CUM INTEGRATED OFFICE ANCILLARY BUILDINGS:

A. **For New Director's Residence Cum Integrated Office Ancillary Buildings**

1) In this Project, there are 01Nos. **Director's Residence Cum Integrated Office Ancillary Buildings** proposed for construction. The incoming power supply to this building will be given from the existing source of HVAC Plant-5. (i.e Normal Power Supply and Emergency Power Supply)
2) There shall be one LT Electrical panel with suitable arrangement of Bus Coupler with source of Normal Power and Emergency Power from AC Plant-05
3) The Main incoming Normal power supply (source-I) shall be given from Main Normal Panel at HVAC Plant -5 and another incoming power supply (Source-II) shall be given from Main Emergency panel at HVAC Plant -5 to the Electrical Panel room at **Director's Residence Cum Integrated Office Ancillary Buildings**. 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) These Main Normal Power Panel and Main Emergency Power panel at HVAC AC Plant-05 will be given power supply to the LT Electrical Power panel at Director's Residence Cum Integrated Office Ancillary Buildings.
5) Power distribution for all essential loads like UPS, Lifts, Washrooms, water supply pumps, Common area lighting, Incoming power supply to 100kVA DG set, etc. shall be distributed properly in the LT Electrical Panel at Building level.

NOTE:

(i) All the MCCBs 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 outgoings 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 besolid 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 internally pre-wired 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 loaddistribution 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 studsand the other earth link should be provided with base insulator in such a way that link should in contactwith 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 torroidal transformer. Its accuracy should be ± 5 %. It should operate even incase of neutral failure. It should trip at a present leakage current within 30 M.S. It's enclosure should beas per IP 30. It's mechanical operation life should be more than 20,000 operations. It should conformto all national and international standards like BIS, BS 4293 - 1983, CEE 27 (International commissionRules 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 andhaving 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 withmechanical "ON" and "OFF" indications.

The circuit breaker dollies shall be of trip free pattern to prevent closing the breaker on a faulty 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

chutesshall be provided to quench the arc immediately. MCB's shall be provided with magnetic fluid plunger relay3 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 andcertified as per Indian Standard, prior to Installation.

For protection of electric circuits with equipment that does not cause surge current (i.e. lighting and socketoutlet 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 suppliedto house various capacities and combination of MCB, MCCB, Switches, Fuses, Indicating Lamps, BusbarPanels 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 outgoingfeeder-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 asrequired/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 offposition. 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 beprovided in an independent compartment for connection of outgoing cables. Terminals should be anti- loosening type and suitable for required sq. mm-copper/aluminum.

Caution plates shall be provided on the inspection covers to avoid opening without isolation. Nameplatesshall 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 ovensin dust free atmosphere. Panel finish shall be free from imperfections like pinholes, orange peels, runoffPaint etc. All unpainted steel parts shall be cadmium plated /stain less steel or suitably treated to preventrust formation. All moving elements shall be properly greased.

4.0 CABLE TRAY AND RACEWAY:

CABLE TRAY

The cable tray shall be fabricated out of 2 mm thick slotted/ perforated MS 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 painted with minimum painting thickness (say 75 to 80 microns).

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 memberswith 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 Trucking made up of Pre Galvanized sheet metal with zinc coated steel sheet double folded and arcwelded. 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, powerand 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 weldedwith 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 toaccommodate three compartment trucking to run Mains Voltage & Extra Low Voltage cables. The system must have Positive Double Earthling 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 17modules of citric wiring accessories. The data plates are angular designed for flexible connection of RJ45outlets. 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

PROTECTION OF BUILDING AGAINST LIGHTNING

Scope:

New standard IS/IEC 62305 supersedes old IS 2309:1989 standard for lightning protection This Section covers necessary requirement of protection of structure from external lightning using new Indian standard IS / IEC 62305, following the various methods and internal lightning protection using surge protection, as defined in the said standard. Please refer IS/IEC 62305 for detail.

Standard - Brief:
New standard define & mentions the requirement for Lightning protection via its four chapters i.e.

- IS/IEC 62305-1:2010, Protection against lightning – Part 1: General Principles
- IS/IEC 62305-2:2010, Protection against lightning – Part 2: Risk management
- IS/IEC 62305-3:2010, Protection against lightning – Part 3: Physical damage to structures and life hazard
- IS/IEC 62305-4:2010, Protection against lightning – Part 4: Electrical and electronic systems in structures.

Before designing, it is essential to determine the risk involved as per IS/IEC 62305-2, in the structure and depending on the risk involved, level of protection is determined which is basis of designing as per IS/IEC 62305-3.

The design shall be made according to IS/IEC 62305-3 using any or combination of three 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.

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 special cable - High voltage insulated (HVI) cable, as a down conductor to compensate the need of the separation distance, as per IS/IEC 62305 & NBC 2016.

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

Special measure has to be taken for building above 60m, while designing Lightning protection, to protect the building above against side flashes.
Metal compatibility shall be ensured to avoid corrosion and contact resistance at connection point.

External Lightning Protection (ELP):

The design shall be made according to IS/IEC 62305-3 using any or combination of three method - Rolling sphere, Angle of protection and Mesh method as per defined lightning protection level and same shall be approved by consultant for zone of protection.

Lightning Protection components shall be tested for natural weathering and exposure to corrosion in 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.
Risk Analysis: The design shall be accompanied with proper Risk Analysis as per IS/IEC 62305-2 to determine level of protection required for particular structure which will be basis of design.

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

Air terminal
It shall be made of Aluminum or it's alloy, complying to EN 62561-2. It shall be mounted in such a way that as far as possible drilling shall be avoided on roof top. The terminal shall withstand wind velocity of 145KM/hour. The length of the Air-terminal rod varies from 1mtr to 4mtr or even higher on special occasion, depending on design to finalize Bill of Material.

Fixing Accessories
Suitable fixing accessories used with Air-terminal to withstand Lightning current and suitable clamp complying to EN 62561-1 for connecting Air terminal with roof conductor.

Down conductor
Preferably round conductor (long length, minimum joints) shall be made of Aluminum or it's alloy or GI or Copper or Stainless Steel, min dia 8 mm, complying to complying to EN 62561-2. Wherever, it is not possible to maintain the separation distance, special islaoted cable (like HVI) can be used to avoid separation distance.

Separation distance:
It is necessary to maintain separation distance of down conductors as per IS/IEC 62305-3, to prevent dangerous flashover between the parts of the external lightning protection system and conductive parts inside the structure (electrical / electronic equipment, pipes, ventilation ducts, etc.) resulting from a direct lightning strike. In case separation is not possible, Special conductors / cable (HVI Cable), according to EN 62305-3 & NBC 2016, may be used for discharging the lightning current to earth while maintaining a sufficient separation distance. High-voltage-resistant insulated down conductor for keeping the separation distance from conductive parts

Natural components made of conductive materials, which will always remain in/on the structure and will not be modified (e.g. interconnected steel-reinforcement, metal framework of the structure, etc.) may be used as parts of an LPS. The reinforcing rods of walls or concrete columns and steel structural frames may be used as natural down-conductors.

As per clause E.4.3.1 of IS/IEC 62305-3:2010, It is to be ensured for continuity and maximum overall

resistance of 0,2 ohm shall be achieved and can be checked by measuring the resistance between the
air-termination system and a ground plate (grounding bus-bar / grounding termination) at ground level.

Roof Conductor

Preferably round conductor (long length, minimum joints) shall be made of Aluminum or it's alloy or GI or Copper or Stainless Steel, min dia 8 mm, complying to EN 62561-2

Fixing Accessories
suitable fixing accessories to be considered to support Roof conductor @ 1meter as per IS/IEC 62305-3.

Clamp for support to conductor
The conductor shall be made of Stainless Steel/GI and shall be supported with the structure at every 1 mtr, as far as drilling shall be avoided on roof top. The clamps shall be tested for natural weathering and exposure to corrosion in i.e Salt Mist Treatment test according to EN 60068-2-52 and Humid Sulphurous Atmosphere treatment test according to BS EN ISO 6988. In special application, if drilling is not possible, special adhesive clamp is recommended to hold roof conductor on roof / shed.

Test clamps
It shall be made of Stainless Steel/GI and shall be used for every down conductor at 1meter (approx) above to ground level (connection / disconnection purpose).

Earthing system
Each down conductor shall be terminated to either earth electrode or ring earth, Earth electrode shall be 17.2mm dia, 10 feet long, UL listed, min 254-micron copper coating over mild steel, -Each earth electrode shall be supported with RoHS certified, low resistivity (≤0.2ohm mtr) Ground Enhancement Material (min22.6Kg), performs in all soil condition, increases the contact area with earth electrode. The final resistance using one rod or ring, shall be ≤ 10 Ω.

GI Strip for Earthing
The strip used for connecting down conductor from test link to earth Electrode. Metal: Galvanized Iron, Size: 30X3.5, Coating of Galvanization: Min 70 micron

Equi-potential bond
All metal (natural conductor) components shall be bonded together with roof/down conductor for equi-potential bonding.

Quantity
Quality to be determined for each and individual building / structure as per IS/IEC 62305-2 & 3.

Lightning Flash Recorder:
The Lightning system shall be installed complete with the Lightning flash recorder/counter with digital recording.

The Lightning flash recorder, complying to EN 62561-6, shall consist of a mechanical 3 digit display which will register all Lightning discharges with a sensitivity of up to 100KA 10/350 µs Lightning impulse current.

The Lightning flash recorder shall be housed in IP 65 rated enclosure and will operate without reliance on batteries or an external power source.

It shall be installed on the most direct down conductor, at height of about 2 meter above ground level or as per user guideline.

Internal Lightning Protection

The Internal Surge Protection Device shall be selected as per zone of protection described in IEC 62305, 61643-11/12/21, 60364-4/5. Depending on Zone concept of provided in IEC 62305 – 1 & 4.

LPZ -OB & LPZ 1 : At Mains entry point (Main LT Panel): Type 1 + 2, i.e. SPD Combined Arrester with Integrated Backup Fuse.

LPZ1 & LPZ 2 : Sub distribution panel at each floor will be used with Type 2 SPD i.e SPD with integrated fuse - for each Sub Distribution Panel

CCTV control room Panel + Server room Panel + IT building panel will be used with Type 2 SPD for each Panel

All data network will be protected using suitable Surge Protection Device.

1. Power Line Protection

Main Distribution Board shall have Type 1 SPD to discharge Lightning current surges for 415 V AC, 3 phase 4 wire (TT) configuration. UPS / Sub Distribution Board shall have Type 2 SPD to discharge switching surges for 415 V AC, 3 phase 4 wire (TT) configuration. Server and sensitive equipments shall have Type 3 SPD at their power input to discharge switching surges.

Type 1, Type 2 and Type 3 devices shall be from same manufacturer to achieve the co-ordination

Type 1 SPD (with inbuild Fuse) - at Main LT Panel

a) The device shall be non-exhausting metal encapsulated, spark gap based technology.
b) The device shall be tested as per latest and valid IEC 61643-11:2011 or EN 61643-11:2012 standards
c) The device shall be rated for 255 V (Uc) between L-N and N-E.
d) The SPD should be tested for Temporary overvoltage and it shall with stand 440 V / 120 minutes.
e) The device shall be capable to discharge Lightning current (10/350µs) of 25kA (L-N) and 100kA(N-E).

f) The device shall have voltage protection level of device shall be ≤ 1.5 KV including inbuilt fuse for L-N.

g) The device shall have Follow current extinguishing capability [L-N]/[N-PE] : 100 kArms / 100 Arms

h) The device shall have follow current limitation/Selectivity resulting in no tripping of a 20 A gL/gG fuse up to 50 kArms between L-N.

i) The device shall have built in fuse and operation of SPD shall be independent of Line current for L-N SPD. The short circuit with stand capability of the device shall be 100 KArms for L-N SPD.

j) The device shall have mechanical indication for both the states (green for 'healthy' and red for failure) on L-N and N-PE connected SPD.

k) The device shall be certified by KEMA or VDE as per IEC 61643-11:2011 or or EN 61643-11:2012.

Type 2 SPD (with inbuild Fuse) - at Each Sub Distribution Panel – for Load current more than 125A

a) The device shall be single shield high duty discharge capacity Zinc Oxide Varistor between L-N and single shield high discharge capacity spark gap between N-Earth.

b) The device shall be suitable for 3 phase 4 wire (TT) OR 1 Phase 2 wire system with nominal voltage parameters of 230 Vac ±10% between L-N and 415 Vac ±10% between L-L

c) The device shall be capable to discharge 12 KA (10/350 µs, lightning current) between N-PE and 40 KA (8/20 µs switching surges)

d) Voltage Protection level of device shall be ≤ 1.5 KV including built in fuse (for L-N SPD).

e) The device shall have built in fuse and operation of SPD shall be independent of Line current for L-N SPD.

f) The device shall have mechanical indication for both the states (green for 'ok' and red for failure) on all modules (L-N and N-PE)

g) The device shall have pluggable option to change cartridge without disconnection.

h) The device shall be tested for Vibration and Shock as per EN 60068-2

i) The device shall be certified by KEMA as per IEC 61643-11:2011 or EN 61643-11:2012.

Note: it is important select proper Type 1 and Type 2 SPDs to ensure achieve co-ordination.

Type 2 SPD: For CCTV Control Room Panel, Server room panel & IT room panel (for load current less than 125A)

a) The device shall be single shield high duty discharge capacity Zinc Oxide Varistor between L-N and single shield high discharge capacity spark gap between N-E.

b) The device shall be suitable for 3 phase 4 wire (TT) OR 1 Phase 2 wire system with nominal

voltage parameters of 230 Vac ± 10% between L-N and 415 Vac ±10% between L-L

c) The device shall be capable to discharge 12 KA (10/350 µs, lightning current) between N-PE and 40 KA (8/20 µs switching surges)

d) Voltage Protection level of device shall be ≤ 1.5 KV

e) The device shall have mechanical indication for both the states (green for 's' and red for failure) on all modules (L-N and N-PE)

f) The device shall have pluggable option to change cartridge without disconnection.

g) The device shall be tested for Vibration and Shock as per EN 60068-2.

h) The device shall be certified by KEMA as per IEC 61643-11:2011 or EN 61643-11:2012.

2.Data Line Protection:

Telephone line at MDF

Shall consist of Lightning current protector directly coordinated with fine suppressor.

Lightning current arrestor shall be expandable to a combined lightning current and surge arrester by means of coarse and fine suppressor protective plug.

The integrated disconnection block contacts allow for testing, measuring and patching with plugged-in protection. The three-pole gas discharge tubes have a fail-safe function with visual fault indication.

Fault indication:	Visual color change
Nominal voltage:	180 V DC
Max Continuous Operating Voltage:	180 V DC
Max Continuous Operating Voltage:	127 V AC
D1 total 10/350 µs (Iimp)	5KA
D1 per line 10/350 µs (Iimp)	
2.5	KA
C2 total Nominal Discharge (In) (8/20 µs)	10 KA

Voltage protection level:

≤500 V

Shall comply IEC 61643-21 and approved by third party like EAC

RF Protection:

Protection for UHF/VHF co-axial cable with "N" termination:

Lightning current arrester

SPD class TYPE 1, for coaxial 50 Ohm antenna systems, shall be tested acc. to EN 61643-21, suitable for remote supply, exchangeable gas discharge tube.

- Max. continuous operating voltage (d.c.): 180 V
- D1 Lightning impulse current (10/350 µs): 5 kA

- C2 Nominal discharge current (8/20 µs): 20 kA
- Frequency range: 0-2.5 GHz

CCTV:

The IP based camera shall be installed with suitable surge protection device for communication interface over POE at both the ends.

General Specification of SPD

a) The device shall be capable to discharge lightning impulse current (at 10/350µs) of 0.5KA & 10 KA total nominal discharge current (at 8/20µs).

b) The device shall be suitable for maximum continuous DC voltage of 48V.

c) Voltage Protection level (line to line / line to ground) of device shall be ≤ 700V.

d) The device shall be enclosed within Zinc die cast material.

e) The device shall be DIN rail mounted adopter type with sockets.

f) The device shall comply to IEC 61643-21/ EN 61643-21 and shall be UL approved.

g) Cut-off frequency shall be minimum 100 MHz.

Earthing system:

In general, a low earthing resistance is recommended. The recommended value of the overall earth resistance of 10 Ω is fairly conservative in the case of structures in which direct equi-potential bonding is applied. The resistance value shall be as low as possible in every case but especially in the case of structures endangered by explosive material. **(Refer to IS/IEC 62305-3 Clause E.5.4.1)**

Above ground metal piping in the process/valve area (subject to non Cathodically protected) shall be earthed **(Refer IEC 62305-3, Annex 'D' Para D.5)**
From the viewpoint of lightning protection, a single integrated structure earth-termination system is preferable and is suitable for all purposes (i.e. lightning protection, power systems and telecommunication systems). By interconnecting the earthing system of a number of structures, a meshed earthing system is obtained. This will give low impedance between buildings and has significant LEMP protection advantages.

Thus, different earthing systems like lightning protection earthing, electrical earthing, safety earthing, electronics earthing etc shall be interconnected. And places where direct interconnection is non-permissible then use of **isolating spark gaps (ISG)** is recommended to create equi-potential bonding throughout the earthing system at the event of lightning.

ISG shall be complying to IEC 62561-3, used at the places where direct interconnection is non-permissible to create equi-potential bonding throughout the earthing system at the event of lightning with lightning impulse current (10/350 µsec / limp) up to 100 KA and rated impulse sparkover voltage of ≤1.25 KV with IP 67 degree of protection.

Earthing (Internal)

Scope

This chapter covers the essential requirements of earthing system components and their installation. This shall be read with Appendix F, which lays down criteria for their design. For details not covered in these specifications IS code of Practice on Earthing (IS 3043 : 1987) shall be referred to.

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 equipments 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 alongwith 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 may be referred to).

- Pipe earth electrode.
- Plate earth electrode.
- 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 15m. 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).

(a) 4 mm dia. (8 SWG) copper wire,
(b) 25 mm x 4 mm in the case of GI strip, or
(c) 20 mm x 3 mm 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*
Upto 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

(i) 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.

(ii) 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).

(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).

(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. In such cases, excavation for earth electrode shall be increased as per the dimensions indicated in these figures.

Watering Arrangement

(i) 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. Afunnel with mesh shall be provided on the top of this pipe for watering the earth.

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

(iii) The watering funnel attachment shall be housed in a masonry enclosure of size not less than 30 cm x 30 cm x 30 cm.

(iv) 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 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.

Earth Resistance

(i) 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.

(ii) 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

(i) Earth bars/terminals at all switch boards shall be marked permanently, either as "E" or as

(ii) Main earthing terminal shall be marked "SAFETYEARTH–DONOTDISCONNECT".

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

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

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

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

UPS Scope:

The scope covers supply, installation, testing & commissioning of 20 KVA UPS system complete with batteries & all accessories.

The UPS shall be provided in the following buildings:

Sr.No.	Name of Building	UPS qty.	UPS rating	Used
1	Director's Residence cum Integrated Office Ancillary Buildings	1	15 kVA	Emergency Lighting & Power Sokets
		1	5 kVA	Networking System, Wifi

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 UninterruptiblePower 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 UPSshall 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 switch for 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 capableof 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 tothe 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 backon-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/maintance and automaticallywith 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 thebypass 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 possibleto 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 includes weight & dimension.

12. Any other information/clarification asked by Engineer/consultant/Employer related to design andproduct 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 electronicsand 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 as specified in BOQ shall be rated for 0.8 Pf output:Input:
16. AC input nominal voltage:As specified in BOQ
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 1mc.

INPUT PFC POWER STAGE

The input PFC power stage of the UPS shall constantly rectify the power imported from the mains input ofthe 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_I 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. Thisshall 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 temperatureof 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 ofthe output power stage (inverter).

Overload Capability: The output power stage (inverter) shall be capable of withstanding 150% overload for30 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 persist 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 thebattery 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 orsevere 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 cannotsupport 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 followingfunctions:

- 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 SmartSlot 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 logof 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 minimumset 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 displayunit. 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 communicationports 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 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 thatcould 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 controlier battery charge and optimize the battery life. The UPS must charge batteries with and 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 al batteries at the same capacity. Battery charger calculation sizing to be provided by contractor for approval.

ACCESSORIES

REMOVABLE INPUT/OUPUT ELECTRICAL TERMINAL

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

The removable input and output trays shall contain a means of configuring the system for 1 or 3 phaseinput 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 monitoringfor the systems detailed on the following web link:

EXECUTION

START-UP

Start-up is requested, factory trained service personnel shall perform the following inspections, testprocedures, 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 chassisMechanical 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 (for 40KVA and Above rating)
- 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 sitewithin 24 hours.

MAINTENANCE CONTRACTS

A complete offering of preventative 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 instruction by Engineer-in-charge.

	DATA SHEET FOR UPS SYTEM	
SL. No.	DESCRIPTION	TENDER REQUIREMENT
	RATING OF UPS	15 KVA and 5KVA
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	REQURIED
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	30 Min.
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	Telenet service- communication with LAN for sending	REQUIRED
8.0	Losses in KW	BY VENDOR

MV CABLES AND LAYING for EXTERNAL SERVICE CONNECTION:

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 INDIAN STANDARDS; ATTACHED IN THE DOCUMENT

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 ofannealed 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 shallconfirm to the requirement of BIS-5831.

Core identification shall be provided with prominent and indelible Arabic numerals on the outer surfaceof 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 XLPEcompound.

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 confirmingto the requirement of compound of BIS-5831 for protection of the cable against atmospheric effect. Pollution rodent and termite attack suitable chemicals 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 ofcable.

All routine and acceptance tests in accordance with the relevant standard shall be conducted on eachsize 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 takeoff end fully protected against mechanical damage. The wood used for construction of the drum shall beproperly 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 ofcable, 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 ofthe drum. Cable shall be supplied in drum length as follows.

Workmanship for cable

Installation

(ii) 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.

(iii)Cables, running indoors shall be laid on walls, ceiling, inside shafts or trenches. Single cables laid shallbe laid in GI/PVC pipe and not to fix on wall slab directly or drawn through GI / PVC pipes fixed on wallor ceiling and supported at not more than 500 mm. Where number of cables is run, necessary laddertype 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 properlydressed and at least 50 mm space shall be kept between the cables.

(iv)Cables shall be bent to a radius not less than 12 (twelve) times the overall diameter of the cable or inaccordance with the manufacturer's recommendations whichever is higher.

(v) 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 onall 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 beprovided with cables markers at every 20 meters and at all loop points.

(vi)The general arrangement of cable laying is shown on drawings. All cables shall be full runs from panelto panel without any joints or splices. Cables shall be identified at end termination indicating the feedernumber and the Panel/Distribution board from where it is being laid. cable termination for conductorsupto 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.

(vii) In case of cables entering the buildings. It would be done duly only through pipes. The pipes shall belaid 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 theentry of water light.

(viii) All cables shall be provided with stainless steel/Aluminum cable identification tags at a maximum distance of 30m.

(ix)All cables to be laid should be properly dress and at least 50 mm space should be kept between thecables.

Testing:

MV cables shall be tested upon installation with a 1000V/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 nack 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 necktype 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 typeshall 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 controlcable 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 andleakages. 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 (Ics=Icu). Where Ics is service breaking capacity and Icu is ultimate breaking capacity and they should be of approved make. The MCB/MCCB shall be same make ofapproved company.

2. LT Distribution Panels: In all buildings, the panel boards shall be of modular type and fabricated as per CPWD Specifications. The incomers, outgoings, 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. 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.

5. 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.

6. The wiring and conduit route plan/drawings shall be submitted by the contractor and shall be got approved from the Engineer-in-charge.

7. 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.

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

9. 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.

10. After completing the work, necessary test results as envisaged in CPWD General Specifications Part-I (Internal)-2023 & 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.

11. Lightning arresters shall be provided for all buildings irrespective of height as per IS 2309-1989 asamended up to date and CPWD specifications for internal work – 2023.

12. Isolator and RCCB of 30 ma sensitivity of suitable rating shall be provided as Incomer of each Distribution boards.

13. Lighting luminaries (LED type) in all buildings shall be decided as per functional requirement, design anddrawing approved.

14. In each building, wherever lift is provided, power supply to DBs located in Lift shaft at suitable locationas approved by Engineer-in-charge shall be done using suitable XLPE insulated armored cable. Supply of cable shall be in the scope of work.

15. 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.

16. 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.

17. The scope of work includes 1.1 KV XLPE LT UG Armoured Alluminium 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.

18. Size of distribution board shall be as per number of light / power circuits. All distribution boards shall bedouble door type RCBO of suitable rating shall be provided as main incomer in all DBs.

19. In vertical DBs used for power distribution main incomer shall be MCCB of suitable rating breakingcapacity not less than 16KA, Ics=Icu.

20. 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.

21. Each LT Panel shall be fabricated from1.6 mm thick M.S. sheet powder coated 7 tank process and shall be equipped 4 pole MCCBs, MCBs, Bus bar, digital voltmeter, ammeter, KWH meter, LED indicating lamp extended rotary handle and all accessories as required.

22. 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.

23. 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 2023.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 shall be laid through DWC pipes of required size with 50% space capacity. Pipe 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/signalling 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 minimum 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.

Form of Completion Certificate

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 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:

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 from nearby Precast staff Housing and Earthing System for the following sub heads mentioned in the payment schedule. (New Scope need to be add)

SCOPE AND SPECIFICATIONS FOR L.T. POWER DISTRIBUTION SCHEME FOR Director's Residence Cum Integrated Office Ancillary Buildings

Scope:

1. **For Director's Residence Cum Integrated Office Ancillary Buildings**

The scope of work includes Design, supply, installation, testing & commissioning and handover of Power distribution system to supply electricity through LT cables to make **Director's Residence Cum Integrated Office Ancillary Buildings**E&M services functional complete as per approved design and drawings and instructions of E-I-C.

A) Main Power Distribution (From HVAC Plant No-05):

1. The Power supply to the **Director's Residence Cum Integrated Office Ancillary Buildings** will be given from the existing LT Main Normal power supply Panel and the existing LT Main Emergency power supply panel at HVAC Plant no. 05
2. Sufficient length, multiple runs of suitable size LT cable shall lay from the HVAC Plant No. 05 to the proposed LT Panels located at the Proposed **Director's Residence Cum Integrated Office Ancillary Buildings**, in surface, cable tray, RCC Humes/DWC pipes wherever required. The cables shall be with multiple runs.
3. The contractor has to provide separate set of multiple runs LT cables for normal power and separate set of multiple runs for Emergency Power from the nearby AC Plant-05 till the New **Director's Residence Cum Integrated Office Ancillary Building** main LT Electrical Panel
4. 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.
5. Decision of laying LT cable in RCC cable trench, DWC, surface, cable tray, RCC Humepipe etc shall be on complete discretion of Engineer-In-charge and same shall be binding,hence bidders are requested to quote accordingly.
6. Also the contractor shall measure the actual required length of cables on site and quote the rates accordingly. However the tentative routing plan along with the approximate span distance from nearby HVAC Plant no. 05 to the new **Director's Residence Cum Integrated Office Ancillary Buildings** is given in the Tender document.
7. As per the above proposed power distribution scheme, the contractor has to prepare and submit a detailed Design Basis Report (DBR), including load sheets cable schedule, voltage drop calculations and electrical SLD in accordance with the relevant electricity/IS Codes.

B) LT Distribution:

S.No.	Name of Building	Type of Building	Quantit	Scope of Work
1	**Director's Residen cum Integrated Offi Ancillary Buildings**	G+1	1	a) Design, supply, installation, testing and commissioning of LT Panels which shall be feeding the Campus School Building (1 nos.) which is having 4P, 415V, microprocessor based MCCB/ACB incomer and MCCB/ACB outgoings of suitable rating for feeding E&M service requirements of respective block.

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.

2. 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).

Main L.T. Panel (both Normal Power Panel and Emergency Power panel)	Main Panels for Emergency supply, Normal supply, Utility supply (Lifts, corridor lights, stair case lights, common area lights) Type: Extensible type Bus bars : Aluminium bus bar Incomer : Air circuit breaker of designed capacity No. of ACBs /MCCBs : As per design No. of Bus coupler : As per design Outgoings: MCCBs as per load requirement with spare MCCBs provision 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 & above. The rated service breaking capacity should be equal to rated ultimate breakingcapacities (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.

	No. of outgoing 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.

Outdoor Feeder Pillars	(i) Protection Class : IP 65 (ii) Type : Free standing, double door type (iii) Material of enclosure : 2 mm MS sheet (iv) Incomer : MCCBs of designed rating (v) Bus Bar : Aluminium conductor (vi) Outgoing : MCCBs/MCB's (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.
L.T. cables	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.
Earthing	Earthing work for Body and Neutral earthing of LT Panels shall be donein accordance of provision laid down in CPWD specification for internal El and substation buildings.

COMMERCIAL AND ADDITIONAL CONDITIONS

1.0 GENERAL

1.1 This specification covers Design, manufacture, testing as may be necessary before dispatch, delivery at site, all preparatory work, assembly and installation, commissioning putting into operation of sub- station equipment consisting of LT panels, LT cabling etc. and final testing of equipment at IIT Hyderabad, kandi, sangareddy.

1.2 The work shall be executed as per CPWD General Specifications for Electrical Works Part-I Internal- 2023, Part II External-2023 and Part IV substation-2013, as amended up to date, relevant I.E. Rules, BIS/IEC and as per directions of Engineer-in-charge. These additional specifications/conditions are to be read in conjunction above and 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.

1.3 GUARANTEE

All equipment shall be guaranteed for a period of 36 months, from the date of taking over the installation by the department, against unsatisfactory performance and/or break down due to defective design, workmanship or material. The equipment or components, or any part thereof, so found defective during guarantee period shall be forth repaired or replaced free of cost, to the satisfaction of the Engineer-in-Charge. In case of replacement or repair requiring more than 7 days, the agency shall temporarily install the equipment so that the system becomes operational. In case itis felt by the department that undue delay is being caused by the contractor in doing this, the same will be got done by the department at the risk and cost of the contractor. The decision of the Engineer-in-Charge in this regard shall be final & binding on the contractor.

1.4 The contractor shall guarantee, among other things, the following:

(a) Quality, strength and performance of the material used as per manufacturers standards.

(b) Safe mechanical and electrical stress on all parts under all specified conditions of operation.

(c) Satisfactory operation during the maintenance period.

1.5 ACCEPTABLE MAKES OF VARIOUS EQUIPMENT

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

1.6 DATA MANUAL AND DRAWINGS TO BE FURNISHED BY THE CONTRACTOR

a) The contractor shall furnish detailed technical 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 like LT panels in the buildings with complete dimensions for approvals by the Engineer in charge.

(ii) Any other drawings are necessary for the job.

1.7 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 relevantdata 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 joint shall be permissible.

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 support for overhead bus ducts, cables and MS channels for erection of panels &

INSPECTION AND TESTING

a) All major Equipment i.e. LT panel and feeder pillar boxes etc. shall be offered for initial inspection at manufacturers 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. 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 COMPLIANCE REGULATIONS AND INDIAN STANDARDS

4.1 All works shall be carried out in accordance relevant regulation, both statutory and those specified bythe Indian Standards related to the works covered by this specification at his own expenses by the tenderer. In particular, the equipment and installation will comply the following:

(i) Factories Act.
(ii) Indian Electricity Rules and Indian Electricity Act.
(iii) B.I.S. & other standards as applicable.
(iv) Workmen's compensation Act.
(v) Statutory norms prescribed by local bodies like CEA, Power Supply Co., etc.

4.2 Nothing in this specification shall be construed to relieve the successful tenderer of his responsibility for the design, manufacture and installation of the equipment, all accessories in accordance currently applicable statutory regulations and safety codes.

4.3 Successful tenderer shall at his own expenses, arrange for compliance statutory provisions

of safety regulations and departmental requirements of safety codes in respect of labour employed directly or indirectly on the work by the tenderer. Failure to provide such safety requirement would make the tenderer liable for penalty of Rs. 2000/- for each default. In addition, the department will be at libertyto make arrangement for the safety requirements at the cost of tenderer and recover the cost thereof from him.

5.0 TRAINING

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

6.0 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.

7.0 INTERPRETING SPECIFICATIONS

In interpreting the specifications, the following order of decreasing importance shall be followed in case of contradictions:

(a) Technical specifications
(b) General specifications.
(c) Relevant BIS or other international code in case BIS code is not available.
(d) Drawing (if any)

8. SAFETY PROCEDURE

1. The Indian Electricity Rules 1956, as amended upto date, are to be followed in their entirety. Any installation or portion of installation which does not comply with these rules should be got rectified immediately.

2. The detailed instructions on safety procedures given in B.I.S. Code No. 5216-1969-"Code of Safety Procedures and Practices in Electrical Works" shall be strictly followed.

3. No inflammable materials shall be stored in places other than the rooms specially constructed for this purpose in accordance with the provisions of Indian Explosives Act. If such storage is unavoidable, it should be allowed only for a short period and in addition, special precautions, such as cutting off the supply to such places at normal times, storing materials away from wiring and switch boards, giving electric supply for a temporary period with the permission of Engineer-In-Charge shall be taken.

4. The electrical switchgears and distribution boards should be clearly marked to indicate the areasbeing controlled by them.

5. Before energizing an installation after the work is completed, it should be ensured that all tools have been removed and accounted, no person is present inside any enclosure of the switch board etc., any earthing connection made for doing the work has been removed.

9.0. LT Distribution – GENERAL

9.1. For feeder pillars for street light, ancillary blocks, security blocks and terrace LT 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-54 for outdoor applications with canopy.
9.2. The connection between incoming switch / isolator and bus bar shall be made with suitable size of thimble and cable.
9.3. RCBO of 30 mA/100mA/300mA sensitivity of suitable rating shall be provided as Incomer of each Distribution boards.
9.4. 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.
9.5. 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.
9.6. 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.
9.7. In MCB DBs used for power distribution, main incomer and outgoings shall be of suitable rating breaking capacity not less than 16KA, Ics=Icu.
9.8. 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.
9.9. 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.
9.10. The laying of LT power cables and control cables shall be done in RCC cable trenches or/and in DWC pipes wherever required shall be laid underground at depth not less than 120 cm from finished level or as recommended by OEM of DWC pipes whichever is more. The DWC pipes shall be at least 50% vacant for future provision, hence the number of runs shall be appropriate to accommodate the same. The excavation, refilling, compaction and restoring the site to its original condition for trenching and laying of DWC pipe is included in the scope of contractor. The pipes shall be compatible with IS 16205 part 24, 2017 and wherever required 1 Nos additional DWC pipe shall be laid in the same route to accommodate communication cables. The DWC pipes used shall not be less than SN-8. The DWC pipes shall be confirming to IS 16205 part 24, 2017.
9.11. Decision of laying LT cable in RCC cable trench, DWC, surface, 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.
9.12. 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.
9.13. 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.

9.14. The LT Panels 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, all the outgoings shall be provided with Energy Meter with a communication port.

9.15. All MCCBs coming at the level of LT panels, Distribution boards, end feed units, feeder pillars etc **shall be controlled 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).

Scope of work and Technical specification for Lifts

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 provided 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	**Director's Residence cum Integrated Office Ancillary Buildings**	G + 1	1	8 passengers	1

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 worm and helical gear box.	IS-7403-1974 Reaffirmed 1991
13.	Iscmetrics 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
- Bombay Lift Act 1939
- Delhi Lift Rules
- 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. TECHNICAL PARAMETERS

Technical parameters given in Appendix-I give requirement of passenger, Service & Goods lifts. Tenderers shall fill in their item wise confirmation/comments in the column provided for the purpose in this annexure. Deviations, if any, from tender requirements shall be clearly brought out in this annexure, failing which it shall be presumed that the offer conforms to the tender requirements fully. Tenders in which Appendix-I is not duly filled in by the tenderers are liable to be summarily rejected.

4. 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.

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 WITHREGEN DRIVE) control withmicroprocessor 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 confirm 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. This has been specified in Schedule of Quantities.
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 CAR LIGHTING & INTERCOM	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/ Scratch proof/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 scratch proof, 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 liftshall 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 andat 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 (liftshould 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 ofthe 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 outof 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 forcontrol 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 nopassenger 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 steelrequired 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 foreach 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 floornearer to landing door to operate the lift manually
	(k) Features for physically challenged persons	The lift shall be equipped brail system, stainless steel mirror finishhand 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, BeltInspection 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.

COMMERCIAL AND ADDITIONAL CONDITIONS

a) The work shall be executed as per CPWD General Specifications for Electrical Works Part-III, Lifts & Escalators-2003 as amended upto date and as per relevant IS and as per direction of Engineer-in-charge. These additional specifications are to be read in conjunction above and in case of variations; specifications given in this additional condition shall apply. However, nothing extra shall be paid on account of these additional specification & conditions as the same are to be read along schedule of quantities for the work.

b) The tenderer should in his interest visit the site and get familiarize the site conditionsbefore tendering.

c) No T &P shall be issued by the Department and nothing extra shall be paid onaccount of this.

d) Technical particulars, Annexure I as appended with the tender documents has to bedully filled & uploaded by the tenderer failing which tender is liable to be rejected.

(2) STORAGE AND CUSTODY OF MATERIALS

The room, if available, may be used for storage of sundry materials and erection Equipmentor else the agency has to make his own arrangements. No separate storage accommodation shall be provided by the department. Watch and ward of the stores and their safe custody shall be the responsibility of the contractor till the final taking over of the installation by thedepartment.

(3) CARE OF THE BUILDING:

Care shall be taken by the contractor while handling and installing the various Equipment and components of the work to avoid damage to the building. He shall be responsible for repairing all damages and restoring the same to their original finish at his cost failing which the same shall be got rectified/made good at the risk and cost of the contractor by the department and will be recovered in the bill. He shall also remove every day at his cost all unwanted and waste materials arising out time to time of the installation from the site of work.

(4) GUARANTEE

a) All equipment shall be guaranteed for a period of 36 months, from the date of taking over the installation by the department, against unsatisfactory performance and/or break down due to defective design, workmanship or material. The equipment or components, or any part thereof, so found defective during guarantee period shall be forth repaired or replaced free of cost, to the satisfaction of the Engineer-in-Charge. In case it is felt by the department that undue delay is being caused by the contractor in doing this, the same will be got done by the departmentat the risk and cost of the contractor. The decision of the Engineer-in-charge in this regard shall be final & binding on the contractor.

b) The tenderer shall guarantee among other things, the following:

i) Quality, strength and performance of the materials used as per manufacturer's standards.

ii) Safe mechanical and electrical stress on all parts under all specifiedconditions of operation.

iii) Satisfactory operation during the maintenance period.

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

a) Tender: After the award of work, the successful bidder shall furnish along the tender, detailed technical literature, pamphlets and performance data for appraisal, evaluation and approval by the Engineer-In-charge.

b) After award of work:
The successful tenderer would be required to submit the following drawings in 15 days of award of work for approval before commencement of installation.

- 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.

(6) The successful tenderer 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.

(7) **INSPECTION AND TESTING**

a) All major equipment i.e. lift shall be offered for initial inspection at manufacturers 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 willbe 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 outat the manufacturer's premises shall be furnished to the Engineer-in-charge andconsignee.

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

8. 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.
(e) Overload protection.
(f) Car and counterweight buffers with contract load and contract Speed.
(g) Manual operation of elevator at mid-way travel
(h) Emergency operation
(i) Tests on completion shall also be performed to the satisfaction of Inspector of Lifts.

(8) COMPLIANCE REGULATIONS AND INDIAN STANDARDS:

a) All works shall be carried out in accordance relevant regulation, both statutory and those specified by the Indian Standards related to the works covered by this specification. In particular, the equipment and installation will comply the following:

i) User technical specifications of contract documents
ii) Factories Act.
iii) Indian Electricity Rules.
iv) B.I.S. & other standards as applicable.
v) Workmen's compensation Act.
vi) Statutory norms prescribed by local bodies like CEA, Power Supply Co., etc.

b) After completion of the installation, the same shall be offered for inspection by the representatives of the Lift Inspector of State/ Centre Govt., client Authority and security authority. The contractor will extend all help including test facilities to the representatives. The observations of theirs if any will be attended by the contractor. The installation will be commissioned only after getting clearance from clients that the system is perfectly working.

c) Nothing in this specification shall be construed to relieve the successful tenderer of his responsibility for the design, manufacture and installation of the equipment all accessories in accordance currently applicable statutory regulations and safety codes.

(9) 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.

(10) 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.

(11) 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.

(12) TRAINING:

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

1.0. GENERAL

The equipment and installation covered by specifications and drawings shall conform to codes of practice and highest standards of workmanship and materials. This work shall be done in accordance with the provisions of the Lifts Act, and subsequent provisions, as also any state or local Act in force and latest Indian Standard 14665, 15330.

The Electrical wiring shall strictly comply with IS:732 and the entire installation shall be in accordance with the Indian Electricity Act 2003 and Indian Electricity Rules 1966 as amended to-date. The electrical works shall also conform to CPWD General Specifications for Electrical works Part - I (Internal) 2023 , Part – II (External) 2023 and Part -III (Lifts and Escalators) 2003 as amended up to date wherever relevant. **All Lifts shall have a minimum warranty of 3 years (in DLP). Bidders are requested to quote accordingly.**

The Contractor shall follow all statutory requirements as well as best trade practices in the manufacture & installation of elevators. The Contractor shall arrange to obtain the approval of the Inspectorate of Lifts for commissioning of the Lifts and getting RR number and handover for operation after satisfactory tests.

2.0. 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.

3.0. 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.

4.0. CAR

4.1. **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.

4.2. **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.

4.3. **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.

4.4. **Doors**
Provision shall be made of SS and central opening

4.5. **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.

4.6. **Emergency Lighting**
Emergency lighting with battery backup shall be provided.

4.7. **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.

4.8. **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.

4.9. **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.

4.10. **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.

4.11. **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 0.65 m / sec by continuous operation of a button

4.12. **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.

4.13. **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.

5.0. STATUTORY APPROVALS

All statutory approvals from concept to commissioning of lifts shall be obtained by the Contractor from the Inspector of Lifts, Chief Fire Officer and other authorities as applicable. However the Department shall provide all necessary assistance for providing documents, drawings and certificates pertaining to other contractors, as may be required. The Department shall reimburse the statutory fees paid in connection with the approval of installation of elevators.

6.0. ADDITIONAL FEATURES REQUIRED

6.1. **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.

6.2. **Anti – Nuisance**

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

6.3. **Home Landing Facility**
A car shall return to a pre-determined landing after the last call is answered

6.4. **Load Non stop**
When the car load exceeds a predetermined limit the lift shall not respond to hall calls.

6.5. **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.

6.6. **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.

6.7. **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 in operative but the Door Open button and the safety shoe shall remain operative

6.8. **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.

6.9. **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.

6.10. **Selective floor Service**
Programming for selective floors services shall be software driven.

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

6.12. **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 m/sec.

Scope of work and Technical Specifications for Automatic Fire Alarm System, Fire Extinguishers, Lift shaft Pressurization System.

CONDTIONS 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 shown on the drawings and specified herein.

Scope of ELV Sub-Contractor shall also include the integration of Fire alarm system with Fire Dampers, Smoke Exhaust Fans, Access control doors, Elevators, PA equipment, etc. 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 provided in the entire Director's Residence cum Integrated Office Ancillary Buildings.

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:

- **Director's Residence cum Integrated Office Ancillary Buildings - 01No.**

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 incompliance 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 CAT6A 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, AC 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 smouldering 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: ±12° 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 H2 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

As per the above proposed scheme, the contractor has to prepare and submit a detailed Design Basis Report (DBR), including related calculations, supporting documents and SLD in accordance with the relevant electricity/IS Codes.

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 (Fire Alarm 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

As per the above proposed scheme, the contractor has to prepare and submit a detailed Design Basis Report (DBR), including related calculations, supporting documents and SLD in accordance with the relevant electricity/IS Codes.

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.) 2023, Part-II (Ext.) 2023, 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 additionalspecifications 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, terminationlugs 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.

- **Guarantee**

All equipment shall be guaranteed for a period of 36 months, from the date of taking over the installation by the department, against unsatisfactory performance and/or break down due to defective design, workmanship or material. The equipment or components, or any part thereof, so found defective during guarantee period shall be forthwith repaired or replaced free of cost, to the satisfaction of the Engineer-in-Charge. In case it is felt by the department that undue delay is being caused bythe contractor in doing this, the same will be got done by department at the risk and cost of contractor. The decision of the Engineer-in-Charge in this regard shall be final & binding on the contractor.

- **The tender shall guarantee among other things, the following:**

(a) Quality, strength and performance of the materials used as per manufacturer's standards.

(b) Safe mechanical and electrical stress on all part under all specified conditions of operation.

(c) Satisfactory operation during the maintenance period.

- **ACCEPTABLE MAKES OF VARIOUS EQUIPMANTS:**

The acceptable makes of various equipment / components/ accessories have been indicated in "Acceptable Makes" indicated in the list attached. The tenderer shall work out the cost of the offer on this basis. Alternatemakes are not acceptable.

- **After award of work:**

The successful tenderer would be required to submit the following drawings within 15 days of award of workfor approval before commencement of installation.

(a) General arrangement drawing of the equipment like detectors, R.I., LT Panel etc. in the building withcomplete 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 beexecuted by the tenderer as this is a turnkey job –

(a) Minor building works necessary for installation of equipment, foundation making of opening in walls orin 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, necessaryfees 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-Change and consignee.

COMPLIANCE WITH REGULATIONS AND INDIAN STANDARDS:

All works shall be carried out in accordance with relevant regulation both statutory and those specified by theIndian Standards related to the works covered by this specification. In particular, the equipment and installation will comply with the following:

(i) Factories Act.
(ii) Indian Electricity Rules.
(iii) B.I.S. & other standards as applicable.
(iv) Workmen's compensation Act.
(v) Statutory norms prescribed by local bodies like CEA, Power Supply Co.etc.

Nothing in this specification shall be construed to relieve the successful tenderer of his responsibility forthe design, manufacture and installation of the equipment with all accessories in accordance with currently applicable statutory regulations and safety codes.

- Successful tenderer shall arrange for compliance with statutory provisions of safety regulations and departmental requirements of safety codes in respect of labour employed on the work by the tenderer. Failure to provide such safety requirements would make the tenderer liable for penalty of **Rs. 2000/- for each default**. In addition, the department will be at liberty to make arrangement for safety requirements at the cost of tenderer and recover the cost thereof from him.

- **COMERCIAL CONDITIONS**

The tenderers are advised not to deviate from the technical specifications / items, commercial terms and conditions of NIT like terms of payment, guarantee, arbitration clause, escalation etc.

- **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

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.

Director's Residence cum Integrated Office Ancillary Buildings:

For this building below mentioned Firefighting system has been considered:

- Fire Extinguishers

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.

1.Hand Appliances /Fire Extinguishers:
(i). Supply and installation of fully charged and tested fire extinguishers hand appliances water CO2, foam, dry chemical powder type, ABC stored pressure type, CO2 gas cartridge type as required as per by these specification and drawings.

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.

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) Electrical Rooms.
(b) 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.

Scope of work shall be as under:

I. To get the firefighting scheme approved first from Telangana Fire service before taking up execution of work.
II. To execute the work as per approval of Telangana service.
III. Agency shall obtain clearance certificate from Telangana fire service, Telangana Govt. for installations of Fire Fighting system.
IV. 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.
V. 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).
VI. 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.
VII. 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

VIII. 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.
IX. Three copies of all test results shall be submitted to the Engineer in A4 size sheet paper in 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-2023); Part-II (External)-2023; Part-V (Wet Riser and Sprinkler System for Fire Fighting Installation)-2020, Part-VI (Fire Alarm System)-2018, 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.

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 all 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 shallbe carried out by the Contractor prior to the issue of Completion Certificate to the acceptance of the Authorities.

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.

Scope of work and Technical specification for LAN and Networking system, Telephone wiring:

CONDITIONS AND SPECIFICATIONS FOR Networking (LAN) 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 from the Electrical part of the tender documents.

1. The ELV system works shall comprise of but not limited to the following:
2. Information & Communication Technology (ICT) Infrastructure – (Data/LAN & Telecom) – Passive Components
3. Fire Detection, Alarm and Control System (FAS) – Complete System Works
4. 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.
    - **Director's Residence cum Integrated Office Ancillary Buildings -01No.**
        - Supplying, Installation, Testing & commissioning of suitable Active Components (Manageable switches/ Distribution Switches/ POE Switches) are included in scope of work.

- Supply, laying of Main OFC cable(input) from existing nearest Tap-off point to Directors Residence with required civil works(excavation for burying cable/laying through existing RCC Hume pipe /laying new RCC Hume 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) WiFi
  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: 200 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	Inch/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
	Following common specifications shall apply to all F/UTP CAT6A standards based structured cabling components, i.e., Cable, Patch Panel, IOs& Patch Cords. 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.	
i.	Standards Compliance	F/UTP cabling system, conforming to ANSI/TIA/EIA 568-C.2 CAT6A Cabling system, ISO/IEC 11801-13rd edition, EN-50173-1as amended to date.

		The cabling system components must be UL listed
ii.	OEM Performance Certification	Performance characteristics shall be provided after installation at site and actual tests conducted at site after installation and commissioning for the following parameters: Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT, Return Loss, ACR and PS ACR for 4-connector channel. 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 cable shall be tested for minimum guaranteed performance as per standards at 500MHzoperation minimum.
iii.	OEM Requirement	All passive cabling must be from same OEM (UTP, F/UTP and Fibre)
	F/UTPCAT6A	
	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
	F/UTPCAT6A I/O Jack	
	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
	F/UTPCAT6A PATCH PANEL	
	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
	F/UTPCAT6A PATCH CORDS	
	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
	FACEPLATES	
	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	Fiber channel compliance to ANSI/TIA568 -C.0 forOS2
	OEM Performance Certification	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
	Adapters	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

SPECIFICATIONS FOR EXTERNAL FIBER OPTIC ENCLOSURE:		
	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	a) IP68 Rated b) No. of Splice trays: 6 nos. c) Splice Tray Capacity: 24 Fibers

	d) No. of cable entry ports: 4 round ports and 1 oval port.
Closure	a) The closure should have the capability to accommodate loop cables (un cut loose tube cables) b) The cables should be secured to the closure using hose clamps and a cable attachment device. c) The closure should have a basket for storing loose tubes.

48/24/12 Sliding Fiber Shelf

Specifications & Standard Compliance	
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

Specifications & Standard Compliance	
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 (1.6mm) 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 radiuses. 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 confirming 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
b. providing LAN in new Upcoming buildings of IIT Hyderabad.
c. The solution includes

i. Supply, installation, including necessary cabling, testing, commissioning, and documentation.
ii. Integration with the existing environment and
iii. Three years warranty.

d. Network operational centre (NOC) is in Academic block A. OFC connectivity from NOC to these building should be in star topology.
e. Solution should include a distribution switch
f. Connectivity between distribution switch to access switches should be in star topology for all buildings.
g. All access switches Non-PoE should support stacking.
h. Building to Building connectivity should be with single mode (SM) OFC
i. 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 bidder should submit and follow the Detailed Project report (DPR) for 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 bidder 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 successful bidder (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 successful Bidder 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 successful bidder should ensure that during installation of LAN, day-to-day functioning of official work should not get disrupted.
- The bidder's 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.
- Bidders are required to submit the make and model of proposed equipment with detail data sheets.
- All equipment should be latest models with no End of Life for at least five years from date of commissioning.
- Successful bidder 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 successful bidder 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:

	Specifications
	Architecture
	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
	8GB SDRAM, 16 GB of Flash Memory and 8 MB Packet buffer size
	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"
	Features
	The switch should support HTTP redirect function
	Should Support Network Visibility and Analytical Capability
	Quality of Service (QoS)
	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
	IPv6 Feature
	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.
	Security
	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
	Convergence
	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
	Resiliency and high availability
	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
	Management
	Should support Configuration validation and config check capability as part of a solution.
	The switch should support SNMPv1, v2, and v3
	Layer 2 switching
	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
	Layer 3 services
	The switch should support DHCP server
	The switch should support DHCP relay agent
	Layer 3 routing
	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
	Security
	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
	Environmental Features
	Operating temperature of 0°C to 40°C
	Safety and Emission standards including EN 60950; IEC 60950; VCCI Class A; FCC Class A
	Warranty and Support
	The below Warranty shall be offered directly from the switch OEM.
	Vendor should provide 3 years warranty which will provide NBD advance hardware replacement and24x7x365 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.
	OEM Criteria
	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

	Specifications
	Architecture
	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
	Features
	The switch should support HTTP redirect function
	Solution should Support Network Visibility and Analytical Capability
	Quality of Service (QoS)
	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
	IPv6 Feature
	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
	Security
	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
	Convergence
	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
	Resiliency and high availability
	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
	Management
	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
	Layer 2 switching
	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
	Security
	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 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 or equivalent The switch should support Per-port broadcast throttling The switch should support Private VLAN or equivalent All above mentioned features should be available from day 1. Any license required to be factored from day 1
	Environmental Features
	Shall support IEEE 802.3az Energy-efficient Ethernet (EEE) to reduce power consumption Operating temperature of 0°C to 45°C Safety and Emission standards including EN 60950; IEC 60950; VCCI Class A; FCC Class A
	OEM Criteria
	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 EAL 2/NDPP or above under Common Criteria Certification.

24 Port Access Switch

	Specifications
	Architecture
	24 RJ-45 autosensing 12/120/1200 ports and fixed 4 SFP+. Shall be 19" Rack Mountable The switch should have RJ45 out of band management port and RJ-45/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 128 Gbps or more Shall have up to 95million 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.
	Features
	The switch should support HTTP redirect function

	Solution should Support Network Visibility and Analytical Capability
	Quality of Service (QoS)
	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
	IPv6 Feature
	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
	Security
	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
	Convergence
	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
	Resiliency and high availability
	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
	Management
	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
	Layer 2 switching
	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 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
	Layer 3 services
	The switch should support DHCP server
	Layer 3 routing
	The Switch should support VXLAN The switch should support OSPFv2, OSPFv3 protocols for routing between access and the next layer on the LAN.
	Security

	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 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
	Environmental Features
	Shall support IEEE 802.3az Energy-efficient Ethernet (EEE) to reduce power consumption Operating temperature of 0°C to 45°C Safety and Emission standards including EN 60950; IEC 60950; VCCI Class A; FCC Class A
	Warranty and Support
	The below Warranty shall be offered directly from the switch OEM. Vendor should provide 3 years warranty which will provide NBD advance hardware replacement and24x7x365 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 The Proposed Switches, transceivers, wireless, equipment's and NMS shall be from the same OEM. All above mentioned features should be available from day 1. Any license required to be factored from day 1
	OEM Criteria
	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 EAL 2/NDPP or above under Common Criteria Certification.

SMF 12 Transceiver

Specification	
Speed	**12Gbps**
Type	**Single mode**
Connection	LC
OEM	Same as Switch OEM
Distance	12 KM

MMF 12G Transceiver

Specification	
Speed	**12Gbps**
Type	**Multimode**
Connection	LC
OEM	Same as Switch OEM
Distance	550 meters

SMF 1G Transceiver

Specification	
Speed	**1Gbps**
Type	**Single mode**
Connection	LC
OEM	Same as Switch OEM
Distance	12 KM

Scope of work and Technical specifications for Water Supply Pumping System:

WATER PUMPING SYSTEMS:

Sl. No.	Name of the Building	No. of Floors	No.of Blocks / Buildings	Domestic and Flush Water Pumping System.	Domestic and Flush Water Pumping Pneumatic System.
1	**Director's Residence cum Integrated Office Ancillary Buildings**	G + 1	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 smooth operation drive based, Surface Monoblock/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 One (1) 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 30 min. 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 requirement of pumping shall be described as below:

(i) For **Director's Residence cum Integrated Office Ancillary Buildings**, the new UG sump near BLDG. shall be constructed of appropriate capacity. That UG sump shall be having 2 Nos (1W+1S) pump-sets responsible for feeding the OH water tank of individual bldg. From OH Tank water shall be feed to each discharge point through Pneumatic System. Pumps shall be designed to fill the OH tank in one hour duration. Accordingly, each pump shall fill the OH tank in one hrs.

(ii) STP treat water tank shall be having 2 Nos (1W+1S) for pump-sets responsible for feeding the water to flush tank of individual block. Capacity shall be sufficient to feed all the flush tanks in 30 min.

(iii) The pump sets of 2 nos (1W+1S) of appropriate capacity to fill the overhead tank. The overhead tanks of capacity as prescribed already in Part A & Part B shall be filled up completely in maximum 1 hour of pump operation. The head and discharge rate of pumps shall be selected accordingly.

(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 at as specified in NIT. 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 water requirement of the Campus shall be calculated based on the discharge rate of each outlet of the building shall be as per the NBC requirements subjective to GRIHA norms as applicable. The water requirement of the building shall be derived separately based on the requirement of Hot water, 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.

- **PUMP - MOTOR SET**

DESIGN & CONSTRUCTION FEATURES

Two types of pumps i.e. inline vertical multistage or horizontal type centrifugal pump shall be provided. Variable frequency drive shall be provided with all the pumps, with potential free contacts to monitor on/off status & trip status. The pump motor set and shall be suitable for 1Ph or 3 Ph., 230 or 415 V, 50 Hz. AC power supply and having 1450/ 2900 RPM speed. The packaged variable speed water pressure booster station shall be complete with vertical multi stage centrifugal pumps connected in parallel, with high efficiency IE 5 motors, an air-cooled external variable frequency drive, intelligent multi-pump controller, the controller shall be mounted in a control cabinet with an IP 41 enclosure of suitable rating having potential free contacts to monitor On/Off & Trip status with necessary sensors/switches; hot Dipped Galvanised suction and delivery manifolds; isolation ball valves on suction and discharge of each pump; non return valve on discharge side of each pump; hot dip galvanised common base frame; and diaphragm pressure vessel. A dedicated intelligent multi-pump logic controller for control and monitoring of pumps shall be from the pump manufacturer with easy interface graphical 320 X 240 Pixels colour display unit with key function. controller should able to monitor multiple operating parameters (flow, inlet pressure, outlet pressure, instant flow estimation, cumulative flow and speed etc) to calculate best operating algorithm to pump sequence optimally. Mentioned features should be available, automatic pump alternations for run time equalization, programmable number of starts/stops per hour to prevent pump hunting, Stand by pump selection, pump test run, friction loss compensation, redundant primary sensor for pressure monitoring, soft pressure built-up, log graph display for key parameters, clock program for multiple set point for scheduled system operation. Multi pump controller should have on-board Ethernet facility for BMS. Complete (Skid mounted / wall mounted / floor

mounted) electrical control panel comprising of all accessories such as PLCs, pressure switches, pressure transducers, control wiring and any other necessary imports etc. (list to be provided by the vendor). All installations such as electrical wiring from Electrical Panel to Pump panel, civil foundations, etc is included in this scope. The pump shall be installed with isolation gate/ butterfly valve, non-return valve, etc. The detailed specification for pump & motor is as below:
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. The pump shall can develop required total head at rated capacity. Impeller shall be closed type and shall be dynamically balanced. The pump shall have non-overloading characteristics. The casing shall be of rigid construction and shall have side suction and side delivery in case of vertical multistage pump and side suction and central delivery in case of horizontal centrifugal pump.

The pump shall have very small length suction and delivery pipe connections which will result in minimum friction loss. Impeller shall be of one piece and shall be of SS CF8 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. Pump shall be mounted on a concrete foundation, projecting at least 15 CM above finished floor level. The pumps base shall be set on an anti-vibration pad.
All the parts of the pumps that are in contact with water e.g. shaft, impeller etc. shall be hot dip galvanized or of stainless-steel construction. Pumps shall be so selected that the design duty point is within 5% of the maximum efficiency point. Shut off head shall be 120% of duty point head. All pumps and motors shall be of minimum vibration and noise level during operation. Vibration isolators shall be provided for all pump sets. Facilities shall be provided to prevent starting of pumps when the water tank is at low water level. An indicator for this low water level alarm shall be provided. Facilities to select which pump to be duty pump and standby pump shall be provided and be interchangeable. Leakage from pump gland shall be drained to the nearest floor waste. Pump shall be driven by directly coupled squirrel cage induction motor having TEFC enclosure, IP 67 protection & shall be of Class F insulation. Pump motors above 7.5 kW shall be equipped with a spacer coupling which allows changing of shaft seals without removing the motor. All poly-phase motors of (capacity >0.375 kW and operating hours >1500 hours/year) shall follow minimum efficiency level as per IS 12615 for energy efficient motors. Pressure vessel of non-corrosive FRP composite construction lined with NSF and/or FDA listed material, like high density polyethylene with fully replaceable polyurethane. Air cell burst pressure of minimum of 5 times the vessel operating pressure and cycle tested for 80,000 cycles with charging connections to discharge pipe line with necessary flanges, gaskets, isolating valves, nuts/bolts etc complete.

- **INSPECTION & TESTING**

The pump shall be offered for visual inspection before dispatch.
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.
Material test certificates for the various pump components shall be furnished for Engineer's approval.

- **SYSTEM DESCRIPTION**

The system operation will be such that the initial small water demand shall be met by the charged diaphragm pressure vessel. When the water demand continues, the system pressure will dip to a pre-set pump cut-in point when the lead pump starts to operate at reduced speed through the variable speed drive. However, if the system pressure be still below the pre-set value, the controller continuously increases pump speed to meet the system demand. When

the lead pump is notable to meet the system pressure at full speed, the second pump also starts to operate.

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

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

The system shall be under the control of a microprocessor-based control panel.

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

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

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

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

Under decreasing hydraulic demand, the reverse sequence to the above description shall apply. Alternatively, pumping system shall be with fixed speed drive motor. By getting the signal from microprocessor-based control panel through pressure transmitter, pumps will operate in sequence & vice a versa.

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

- **CONTROL PANEL**

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

Flexibility and simplicity in allowing the necessary re-adjustment of the pumping system pre-set delivery pressure to operate the pumps within the specified maximum and minimum delivery ranges.

Automatic changeover of the pumps to be controlled by the microprocessor which dictates the

duty and standby pumps.

When the system has not been operated for more than 24 hours, it shall automatically start the pumps for a few seconds / day to ensure the pumps readiness always. The standby pumps shall be activated upon failure of duty pump(s).

In event of control failure, the pumps shall be able to be start/stopped manually at the local panel by means of pressure switches.

The microprocessor control panel shall be able to cut-off the pumping system when excess pressure is registered in the discharge common manifold.

The system shall have the capability of receiving input signal concerning reduced water level in suction tanks and shall have control mechanisms to prevent the pumps from running dry.

Automatically starting the pumps when the water level is back to normal.

In case of pump failure due to motor overload, the standby pump is switched on automatically. Alarm signal is displayed on the LCD Display unit and alarm lights are activated.

Functions to limit the no. of start/stop of pumps per hour.

The system control panel shall incorporate LCD Display.

The system control panel shall be IBMS compatible, with potential free contacts having RS 485 ports for monitoring the on/off status.

- **OPERATION OF CONTROL PANEL**

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

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

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

IBMS Compatibility:
The control panel shall be mounted on wall / floor, 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.

- **ELECTRICAL COMPONENT**

. Electrical supply to the pump controller shall be protected using an isolating circuit breaker.

- **METHOD OF STARTING**

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

- **PUMP PRESSURE VESSEL**

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

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

- **ACCESSORIES**

The system shall be provided with all accessories such as base plate, mounting pads, foundation bolts, foot valves, pressure gauge, pressure switches, pressure transmitter, level indicator, isolation valve for pressure vessel, etc. all accessories required for proper and safe operation shall be furnished with the pumps.

- **SUCTION AND DELIVERY PIPE, FITTINGS, FLANGES & VALVES**

All suction, delivery and header pipe shall be GI & shall conform to IS: 1239, medium/heavy duty. Fittings shall be as per the pipe thickness. All pipes shall have flanges connection & pipe shall conform to BS 12, Table - D. All hardware shall be zinc plated. The system shall be equipped with suction & delivery valves flanged valves. On suction side ball/gate valve shall be provided while on delivery side ball/butterfly valves shall be provided. Also, spring operated check valves shall be provided on delivery side of each pump & on delivery header. In case of negative suction foot valve shall be provided for each pump suction or suction header as specified in data sheet. Flexible bellows shall be provided on suction &delivery side of each pump.

- **TESTING**

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:

a) Overall dimensional drawing.
b) Pump performance curves.
c) Cross-sectional drawings.
d) Panel GA drawing.
e) Bill of Material and Material of Construction.

- **HORIZONTAL CENTRIFUGAL SUBMERSIBLE PUMP**

- **SCOPE**

The scope includes supply, installation, testing and commissioning of open well horizontal mono block (submersible) pump set with cast iron body.
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.

ENERGY CONSERVATION

Energy is very costly. Guidelines for energy conservation:

(a) Lighting and Controls

(b) Lighting Design

Lighting design to be done in such a way that it achieves the required visual comfort at working plane and is energy efficient. Visual comfort can be defined in terms of lux level at the working plane and energy efficiency can be defined in terms of lighting power density (Watt/m2). The recommended lux levels and lighting power densities have been specified in Chapter 2 Section 2.9.
Wherever possible, a combination of task lighting and general lighting shall be provided to get desired lighting levels. In addition to general lighting, local task luminaires shall be provided for adequate lighting level and quality in the task areas.

For general lighting, lux levels required for circulation and other non-critical applications should be maintained.

(c) Efficient Lamp Selection

Selection of lamp is the most important criterion for lighting design. The lamp selection should be on the basis of efficacy and good colour rendering index (CRI).

Lamps used for general lighting scheme should comply to the following:

(d) Point Light Source – All the point light sources installed in the building for general lighting should be CFL or LED based with minimum lamp efficacy of 50 lm/W.

(e) Linear Light Source – All the linear light sources installed in the building for general lighting should be T-5 or at least 5 Star BEE rated TFLs.

Table 9 lists the Wattage, luminous flux, efficacy and CRI of different types of lamps. Incandescent lamps should not be used at all.
New high frequency electronic ballasts should be used instead of traditional magnetic ballasts.

(f) Lighting Controls

(g) Automatic Lighting Shutoff

Interior lighting systems in buildings larger than 500 m2 (5000 ft2) shall be equipped with an automatic control device. Within these buildings, all office areas less than 30 m2 (300 ft2) enclosed by walls or ceiling-height partitions, all meeting and conference rooms, all school classrooms, and all storage spaces shall be equipped with occupancy sensors.
For other spaces, this automatic control device shall function on either :

(h) A scheduled basis at specific programmed times. An independent program schedule shall be
provided for areas of no more than 2500 m2 (25000 ft2) and not more than one floor, Or

(i) Occupancy sensor that shall turn the lighting off within 3 minutes of an occupant leaving the space. Light fixtures controlled by occupancy sensors shall have a wall mounted, manual switch capable to turning off lights when the space is occupied.

Exception to above: Lighting systems designed for 24-hour use.

(j) Space Control
Each space enclosed by ceiling-height partitions shall have at least one control device to independently control the general lighting within the space. Each control device shall be activated either manually by an occupant or automatically by sensing an occupant. The maximum coverage area for each control device is given in the table below:

(k) Space Area and Lighting Control

(l) Sl. No.	(m) Space Area (m2)	Maximum Coverage Area for each Control Device (m2)
1	< 1000	250
2	> 1000	1000

Each control device shall be capable of overriding the required shut off control for no more than 2 hours. It should be readily accessible and located such that the occupant can see the control.

Exception to above: The required control device may be remotely installed if required for reasons of safety or security. A remotely located device shall have a pilot light indicator as part of or next to the control device and shall be clearly labeled to identify the controlled lighting.

(n) Day-lighting Controls
Luminaires in day lighted areas greater than 25 m2 (250 ft2) shall be equipped with either a manual or automatic lighting control device that is capable of reducing lighting output of the luminaires in the day lighted areas by at least 50% and controls only the luminaires located entirely within the day lighted area.

(o) Exterior Lighting Control

Lighting for exterior applications shall be controlled by a photo sensor or astronomical time switch that is capable of automatically turning off the exterior lighting when daylight is available or the lighting is not required.

(p) Lighting Control Devices

Following is a description of different types of control devices available for controlling the lighting:

Timers: These are the simplest type of controls and are most popular. Some areas in buildings may require lighting for specific durations like security lighting, landscape lighting or building floodlighting. Timers allow this type of control by switching 'on' and 'off' as per preset times. These can have one setting (same time) for the whole year or several (seasonal/ weekly/daily) settings to take care of the changing sunset times.

Photocell Lighting Control: These measure the amount of natural light available and suitable for both indoor and outdoor applications. When available light falls below a specified level, a control unit switches the lights on (or adjusts a driver to provide more light). Photocells can be programmed so that lights do not flip on and off on partially cloudy days.

Occupancy Sensors : These devices – also known as 'motion detectors' – turn lights off and on in response to human presence. Once sensitivity and coverage area is established, sensors are selected from two predominant technology types.

Passive Infrared Sensors : These detect the motion or heat between vertical and horizontal detection zones. This technology requires a direct line of sight and is more sensitive to lateral motion, but it requires layer motion as distance from the sensor increases. The coverage pattern and field of view can also be precisely controlled. It typically finds its best application in smaller spaces with a direct line of sight, such as restrooms.

Ultrasonic Sensors : These detect movement by sensing disturbances in high-frequency ultrasonic patterns. Because this technology emits ultrasonic waves that are reflected around the room surfaces, it does not require a direct line of sight. It is more sensitive to motion towards and away from the sensor and its sensitivity decreases relative to its distances from the sensor. It also does not have a definable coverage pattern or field of view. These characteristics make it suitable for use in layer-enclosed areas that may have cabinets, shelving, partitions, or other obstructions. If necessary, these technologies can also be combined into one product to improve detection and reduce the likelihood of triggering a false on or off mode.

(q) Efficient Motors

Motors shall comply with the following:

(r) All permanently wired poly-phase motors of 0.375 kW or more serving the building and expected to operate more than 1500 hours per year and all permanently wired polyphase motors of 50 kW or more serving the building and expected to operate more than 500 hours per year shall have a minimum acceptable nominal full load motor efficiency not less than IS 12615 for Energy Efficient motors.

(s) Motors of horsepower differing from those listed in the table shall have efficiency

greater than that of the listed kW motor. See Table 14.

(t) Motor horsepower ratings shall not exceed 20% of the calculated maximum load.

(u) Motor nameplates shall list the nominal full load motor efficiencies and the full load power factor.

(v) Motor users should insist on proper rewinding practices for rewound motors. If the proper rewinding practices cannot be assured, the damaged motor should be replaced with a new, efficient one rather than suffer the significant efficiency penalty associated with typical rewind practices.

(w) Certificates shall be obtained and kept on record indicating the motor efficiency. Whenever a motor is rewound, appropriate measures shall be taken so that the core characteristics ofthe motor is not lost due to thermal and mechanical stress during removal of damaged parts. After rewinding, a new efficiency test shall be performed and similar records shall be maintained.

(x) Motors should be installed with soft start energy savers and Variable Speed drives based on the application required.

(y) Metering

(z) Services exceeding 1000 KVA shall have permanently installed electrical metering to record demand (kVA), energy (kWh), and total power factor. The metering shall also display current (in each phase and the neutral), voltage (between phases and between each phase and neutral), and total harmonic distortion (THD) as a percentage of total current.

(aa) Services not exceeding 100 kVA but over 65 kVA shall have permanently installed electric metering to record demand (kW), energy (kWh), and total power factor (or kVARh).

(bb) Services not exceeding 65 kVAshall have permanently installed electrical metering to record energy (kWh).

(cc) Electrical meters shall be installed to measure the energy units generated on site through DG/ GG sets.

(dd) Separate electrical sub-meters shall be installed to measure energy consumption by HVAC plant, AHU fans and indoor lighting.

(ee) BTU meters* shall be installed for each chiller at the entry and leaving points to measure the cooling generated by chillers.

(ff) BTU meter* shall be installed on the chilled water loop to measure the building's total cooling demand.

(gg) ***BTU Meter:** BTU is the acronym for British Thermal Unit, which is a traditional unit of energy. BTU meters are used for thermometric billing as they measure heat in terms of BTU. These meters are used for measuring energy consumption of heating and cooling systems. By installing BTU meters at individual chillers, cooling generated by individual chillers can be measured and by installing the BTU meter on the chilled water loop, building's total cooling demand can be measured.

Scope of work and Technical specifications for Split AC Installation

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.

The proposed Split ACs Supply, Installation, Testing and Commissioning in IIT Hyderabad campus is for the following buildings:

SCOPE OF WORK AND BASIS OF DESIGN

The scope consists of design, supply, installation, testing and commissioning of Split ACs not less than 1.5 TR in Hall & ELV room. 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)-2024 amended up to date.

The Split ACs should be installed in the designated rooms, if required as instructed by Engineer-In-Charge.

PIPING WORKS:

- **Scope**
  The scope of this section comprises the supply and installing of Design, Supply and Installation of Split AC with 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.

  - **The Inverter type units having one indoor unit and one outdoor unit comprising of INVERTER rotary compressor functioning with environment friendly refrigerant like R32 or equivalent. The refrigerator used should be ozone non-depleting.**
  - **The unit should have full function battery operated cordless remote control.**
  - **The drain pipe should be as per schedule with suitable length and well insulated to avoid condensation. The refrigerant pipe should be well insulated to avoid condensation. The unit shall be suitable to operate on 230 +/- 10%, 50Hz AC Supply for 1.5/2.0 TR units.**
  - **The Unit shall be of min. BEE-5 star rating.**
  - **Only copper material condenser units and cooling unit will be accepted.**
  - **The Split ACs should be designed to operate at high ambient conditions, cools even at 55°C. Backed by the efficient compressor, High-resistance components and**

intelligent controller.

- **The indoor Fan motor should be of BLDC.**

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

Scope of work and Technical specifications for HVAC WORK

1. 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 410- 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
- Aluminum 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 101 Life Safety Code.
- AMCA 210 Laboratory Method of Testing Fans for rating
- Rock wool, IS: 8183
- HI-WALL type split system: BEE, ECBC

SCOPE OF WORK AND BASIS OF DESIGN

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 remaining electrical items to be considered from the electrical part of the tender documents. The scope of work include complete ventilation and air conditioning system as specified in documents and drawings and also as specified but not limited to followings:

a) Air-cooled split Units
b) Insulated condensate drain piping inclusive of all valves & fittings.
c) Insulated refrigerant piping, fittings, accessories etc.
d) Mechanical ventilation system.
e) Air-distribution System comprising of:
- Sheet metal ducts inclusive of external insulation, acoustic lining, canvas connections, silencers, volume control dampers and fire/ smoke dampers as required.
- Supply and return air grilles/ registers and diffusers.

f) Vibration isolators for all HVAC equipment.
g) Automatic controls and instruments including control cabling.
h) Electrical work (starters, power cabling, control cabling, wiring, earthing, cable tray, Conduiting),
i) Wiring and earthing from MCC panels to various refrigeration, air conditioning and mechanical ventilation equipment, control wiring and interlocking.
j) All sub frame required for mounting grills/louvers in masonry works is deemed to be included in HVAC contractor scope.
k) Cutting all openings/ cutouts, chases in walls or slab for duct/pipe crossings, including sealing, frame work, fire proofing, providing sleeves, cover plates, making good structure and finishes to an approved standard.
l) Provide larger size sleeve for crossing of pipe, conduits & cables through fire rated wall/partition. The sleeve shall be sealed with fiberglass and fire sealant.
m) Balancing, testing and commissioning, demonstrating, guaranteed performance parameters and handing over the systems of the entire Air-Conditioning and mechanical ventilation system.

n) Test Certificate/ Reports, list of recommended spares, as-installed drawings, operation and maintenance manual for the entire HVAC installation.
o) Training of Employer's Staff
p) First charge of consumables (like Refrigerant, oil, grease etc.) after completion of commissioning period.
q) Grouting and finishing of foundation.
r) Paint and painting of equipment, supports, flow direction indicators etc.
s) Shop inspection and testing of equipment.
t) Providing isolation valves & drain valves at suitable location as per requirement.

BASIS OF DESIGN

1. The outside weather conditions for Vishakhapatnam are considered on 1% for summer & monsoon and 0.4% for winter as per the latest weather data published by ISHRAE:

SUMMER	MONSOON	WINTER
106.0 OF DB	85.0 OF DB	55.0 OF DB
78.0 OF WB	81.0 OF WB	48.0 OF WB

INSIDE CONDITIONS:

2. All AC areas - 23+1 OC with <60% RH
3. Heat gain from lighting and equipments considered as per electrical design.
4. Occupancy shall be considered as per furniture layout. wherever furniture layout not given, it shall be considered as per NBC.
5. Toilet & pantry ventilation shall be designed @ 15 ACPH.
6. Residential kitchen vent using domestic chimney shall be provided.
7. Lift lobby pressurization @ 50 Pa positive pressure.

The details of Ventilation and Air-Conditioning (VAC) system for various areas are given below:

AIR CONDITIONING SYSTEM

- VRV (VRF) based system is proposed for air-conditioning.
- Wall mounted split AC units N+1(Standby) with sequence controller shall be provided for air conditioning of UPS/ IT/ ELV rooms.

VENTILATION SYSTEM

- Wall mounted toilet exhaust fan shall be provided for toilet exhaust.
- Exhaust chimney over cooking area shall be part of kitchen appliances.
- Propeller fan shall be provided for electrical rooms ventilation.
- Propeller fan shall be provided for pantry ventilation.
- Axial fan including ducting, starter panel, cabling, earthing etc. for lift well pressurization.

PIPING WORKS

A. SCOPE

The scope of this section comprises the supply and installing of pipes, pipe fittings and valves, testing and balancing of all drainage 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.

B. DRAIN PIPING

i. All pipes to be used for drain from CSU and FCU drains pans and hi wall drain and fittings shall be uPVC pipe (4 Kg /cm2 pressure or G.I Class B type).

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

iii. All pipes support shall be mild steel, thoroughly cleaned and given one primary coat of red oxide paint before being installed.

iv. Fittings shall be same material of pipe and pressure rating suitable for the piping system. Flanges shall be of approved make. Supply of flanges shall include bolts, nuts, gaskets as required. Sufficient number of flanges and unions shall be provided for future cleaning and servicing of piping. Tee-off connection shall be through equal or reducing tees. All equipment and valve connections, or connections to any other mating pipes shall be through flanges required for the mating connections. Fittings & flanges shall form part of piping and are not separately identified in Schedule of Quantities.

v. For proper drainage of AHU and FCU Condensate, 'U' trap shall be provided in the drain piping.

vi. All condensate drain piping shall be insulated and painted as per the section "Insulation" as indicated in Schedule of Quantities.

REFRIGERANT PIPING

i. All refrigerant pipes and fittings shall be hard drawn copper tubes and wrought copper / brass fittings suitable for connection with silver solder / phos-copper.

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

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

iv. Horizontal suction line shall be pitched towards the compressor and no reducers shall be provided for proper oil return.

v. After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using Freon mixed with nitrogen / carbon dioxide at a pressure of 20 kg per sq. cm (high side) and 8 kg per sq. cm (low side). Pressure shall be maintained in the system for a minimum of 12 hours. The system shall then be evacuated to a minimum vacuum of 70 cm of mercury and held for 24 hours. Vacuum shall be checked with a vacuum gauge.

vi. All refrigeration piping shall be installed strictly as per the instructions and recommendations of air conditioning equipment manufacturer.
vii. The copper thickness of wall shall be 20G/22G(0.7 to 1 mm).

PIPING INSTALLATION

- 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.
- 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.
- All pipes shall be supported with pipes and channels with necessary PUF pipe supports.
- 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

- 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.
- Bull heading in water/refrigerant piping shall be avoided.
- 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.
- Wherever pipes pass through the brick or masonry / slab openings, the gaps shall be sealed with fire sealant such as fire barrier caulks.
- 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.
- 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.

- 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 cutouts shown in the Drawings do not meet with the requirements.
- 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.
- All pipes shall be accurately cut to the required size in accordance with relevant BIS Codes, edges beveled 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.
- 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.
- 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.
- 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".
- Expansion loops or joints shall be provided to take care of expansion or contraction of pipes due to temperature changes.
- 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.
- 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.
- Open ends of piping shall be blocked as soon as the pipe is installed to avoid entrance of foreign matter.
- 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.
- 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.
- 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.
- 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.
- Extra supports shall be provided at the bends and at heavy fittings like valves to avoid undue stress on the pipes. Pipe hangers shall be fixed on walls and ceiling by means

of metallic or rawl plugs or approved shear fasteners.

- Riser shall have suitable supports at the lowest point.
- All pipes and their steel supports shall be thoroughly cleaned and given one primer coat of Zinc chromate before being installed.
- 3mm gasket shall be used for flanged joints.
-

E. INSULATION

Chilled water piping, condensate drain piping etc., shall be insulated as per the specification enumerated under the specification "Insulation".

F. 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 test, minimum test pressure shall be 10 Kg/sq. cm. The defects in joints and leaks obserest 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 equipments in the system. If proper circulation is not achieved due to air-bound connections the contractor shall rectify the defective connections. He shall bear all the expenses for carrying out the above rectification including the tearing up and refinishing of floors, walls etc. as required. 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, equipments, Instruments, services and labour required to perform the tests and to remove water resulting from cleaning after testing.

G. 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.

H. 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 100 DFT each coat.

5. DUCTING

a. Scope

The scope of this section comprises supply fabrication, installation and testing of all sheet metal / aluminum ducts, supply, installations, testing and balancing of all grilles, registers and diffusers. All to be in accordance with these specifications and the general arrangement shown on the Drawings

b. Raw Materials

Galvanizing shall be Class VIII – light coating of zinc, nominal 120gm/sq.m surface area (conforming to IS 277) and Lock Forming Quality prime material along with mill test certificates. In addition, if deemed necessary, samples of raw material, selected at random by owner's site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

c. SWGs by Size Of Rectangular Ducts

All ducts shall be fabricated from galvanized steel of the following thickness conforming to IS 655 as indicated below:

I. Rectangular Duct

a) For Low Pressure System (Internal pressure of the duct i.e, ± 500Pa).

S.N.	Longest side (mm)	Minimum sheet thickness (GSS)
1	750 mm and below	0.63
2	751 mm to 1500 mm	0.80
3	1501 mm to 2250 mm	1.00
4	1501 mm to 2250 mm	1.25

Table 4 Thickness of Sheet for Galvanized Steel Sheet Duct

(*Clause* 6.2.1)

Classification of Duct by Pressure	Low Pressure Duct	Medium Pressure Duct and High Pressure Duct	Thickness of Sheet, *Min* mm
(1)	(2)	(3)	(4)
Long side of duct	$l \leq 450$	—	0.5
	$450 < l \leq 750$	—	0.6
	$750 < l \leq 1\,500$	$l \leq 450$	0.8
	$1\,500 < l \leq 2\,200$	$450 < l \leq 1\,200$	1.0
	$2\,200 < l$	$1\,200 < l$	1.2

Table 5 Thickness of Sheet for Stainless Steel Sheet Duct

(*Clause* 6.2.1)

Classification of Duct by Pressure	Low Pressure Duct	Medium Pressure Duct and High Pressure Duct	Thickness of Sheet, *Min* mm
(1)	(2)	(3)	(4)
Long side of duct	$l \leq 750$	—	0.5
	$750 < l \leq 1\,500$	—	0.6
	$1\,500 < l \leq 2\,200$	$l \leq 450$	0.8
	$2\,200 < l$	$450 < l \leq 1\,200$	1.0
	—	$1\,200 < l$	1.2

Table 7 Thickness of Sheet for Galvanized Steel Sheet Duct and Stainless Steel Sheet Duct

(*Clause* 6.2.2)

Classification of Duct by Pressure	Low Pressure Duct	Medium Pressure Duct and High Pressure Duct	Thickness of Sheet, *Min* mm
(1)	(2)	(3)	(4)
Internal diameter of duct (d), mm	$d \leq 500$	—	0.5
	$500 < d \leq 630$	—	0.6
	—	$d \leq 450$	0.8
	—	$450 < d \leq 630$	1.0

ii. Circular Duct iii. Spiral Duct

Table 8 Thickness of Sheet for Circular Spiral Galvanized Steel Sheet Duct

(*Clause* 6.2.3)

Classification of Duct by Pressure	Low Pressure Duct	Medium Pressure Duct and High Pressure Duct	Thickness of Sheet, *Min* mm
(1)	(2)	(3)	(4)
Internal diameter of duct (d), mm	$d \leq 450$	$d \leq 200$	0.5
	$450 < d \leq 710$	$200 < d \leq 560$	0.6
	$710 < d \leq 1\,000$	$560 < d \leq 1\,000$	0.8
	$1\,000 < d$	$800 < d \leq 1\,000$	1.0
	—	$1\,000 < d$	1.2

b) Longitudinal seams shall be Pittsburgh lock type at corners. Longitudinal joints shall not be provided for rectangular ducting at locations other than corners, except where larger side of duct exceeds 2500mm. longitudinal joints of ducting having side larger than 2500mm other than corner shall be grooved or standing seam as shown.
c) Flanges used for transverse joints shall be joined with each other with Galvanized Steel (GS) bolts, washers and nuts. The bolts shall be of minimum M8 size and the spacing between bolts shall be maximum 150 mm for low pressure system and 100 mm for high pressure system.

d) For transverse angle flanged joints, neoprene gasket (3mm uncompressed thickness and width equal to flange face) adhered to the flange face shall be used. The bolt holes in gasket shall be the same as bolt diameter and shall be punched prior to insertion of gaskets.
e) All flanges shall be applied with two coats of each minimum 80 micron DFT zinc-chromate, silver or zinc paint. (Red oxide is prohibited)
f) All un-insulated exposed ducts shall be applied with minimum 275 GSM Anti corrosive zinc chromate coating as per IS-277.
g) Angles shall have welded corners and shall be riveted to the ducts at 300mm centers. (Maximum).
h) Ducts shall be pre fabricated at factory or by using lock forming machine.
i) Plenums, collars and irregular shape duct pieces shall be site fabricated as per requirement.

e. Duct Supports & Hangers

- Rectangular duct shall be supported from ceiling using trapeze hangers. Ducts shall rest on supporting angle or channel and this supporting angle or channel shall be supported by CS rods or angles or channels on both sides of ducts with weld or bolts. All the supports shall be coated with 2 layers of epoxy of 80DFT each layer.
- Supporting details for low-pressure system shall be as given below.
- Zinc coated anchor fasteners or embedded plates shall be provided for upper attachments to the building. Anchor fasteners shall be provided by contractor. Embedded plates shall be provided by contractor. Contractor shall provide duct supports from angle cleats welded to the embedded plates. Anchor fasteners shall be loaded to maximum 20% of the maximum rated capacity specified by the manufacturer. Site Engineer IN Charge shall approve all anchor fasteners used for supporting duct.
- Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards -Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- In case of insulated duct, anchor fasteners shall be selected based on actual total load.

e. Fabrication Standards & Equipment

All duct construction and installation shall be in accordance with SMACNA standards. In addition, ducts shall be factory fabricated utilizing the following machines to provide the

requisite quality of ducts.

- Coil (Sheet metal in Roll Form) lines to facilitate location of longitudinal seams at corners/folded edges only, for required duct rigidity and leakage free characteristics. No longitudinal seams permitted along any face side of the duct.
- All ducts, transformation pieces and fittings to be made on CNC profile cutter for requisite accuracy of dimensions, location and dimensions of notches at the folding lines.
- All edges to be machine treated using lock formers, flangers and rollers for turning up edges.

f. Duct Construction

All ducts shall be fabricated and installed in workmanlike manner, conforming to relevant SMACNA codes.

i. Ducts so identified on the Drawings shall be acoustically lined and insulated from outside as described in the section "Insulation" and as indicated in schedule of Quantities. Duct dimensions shown on drawings, are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in Schedule of quantities. The fabricated duct dimensions should be as per approved drawings and care should be taken to ensure that all connecting sections are dimensionally matched to avoid any gaps.

ii. Ducts shall be straight and smooth on the inside with longitudinal seams shall be airtight and at corners only which shall be either Pittsburgh or snap button as per SMACNA practice, to ensure air tightness.

iii. All ducts up to 75cms width within conditioned spaces shall have slip and drive (C & S/SS) joints. The internal ends of slip joints shall be in the direction of airflow. Care should be taken to ensure that S/SS Cleats are mounted on the longer side of the duct and Cleats on the shorter side. Ducts and accessories within ceiling spaces, visible from air-conditioned areas shall be provided with two 2 layers of 80DFT each layer mat black finish paint.

iv. Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Air-turns (vanes) shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.

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

vi. All sheet metal connection, partitions and plenums, required to confine the flow of air to and through the filters and fans, shall be constructed of 18 SWG GSS / 16 SWG aluminum, thoroughly stiffened with 25mm x 25mm x 3mm galvanized steel angle braces and fitted with all necessary access doors as required, to give access to all parts of the apparatus. Access doors shall be not less than 45cm x 45cm in size.

vii. Plenums shall be shop/factory fabricated panel type and assembled at site. Fixing of galvanized angle flanges on duct pieces shall be with rivets heads inside i.e. towards GS sheet and riveting shall be done from outside.

viii. Self adhesive Neoprene rubber / UV resistant PVC foam lining 5mm nominal thickness instead of felt, shall be used between duct flanges and between duct supports in all ducting installation.

g. Installation Practice

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

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

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

iii. If a duct cannot be run as shown on the drawings, the contractor shall install the duct between the required points by any path available in accordance with other services and as per approval of owner's site representative.

iv. All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with trapeze hangers formed of galvanized steel rods and galvanized steel angle/channel or a pair of brackets, connected by galvanized steel rod under ducts. The spacing between supports should be not greater than 2.0 meter. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the hanger rods shall be welded to the plates. Trapeze hanger formed of galvanized steel rods shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash/anchor fastener driven into the concrete slab by electrically operated gun. Hanger rods shall then hang through the cleats or fully threaded galvanized rods can be screwed into the anchor fasteners.

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

vi. Where ducts pass through brick or masonry openings, it shall be provided with 25mm thick TF quality expanded polystyrene around the duct and totally covered with fire barrier mortar for complete sealing.

vii. All ducts shall be totally free from vibration under all conditions of operation. Whenever ductwork is connected to fans, air handling units or blower coil units that may cause vibration in the ducts, ducts shall be provided with a flexible connection, located at the unit discharge. Flexible connections shall be constructed of fire retarding flexible heavy canvas sleeve at least 10cm long securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting ductwork rigidly held by independent supports on both sides of the flexible connection. The flexible connection shall be suitable for pressure at the point of installation.

viii. Duct shall not rest on false ceiling and shall be in level from bottom. Taper pieces shall taper from top.

ix. The contractor shall upon the award of work prepare detailed shop drawings of ducting for approval by Engineer-in-charge. The drawings shall indicate the exact route of ducting, ducting dimensions, details of splitters, vanes, dampers, fire dampers, heaters, filters etc. as specified and required. The drawings shall also incorporate cross section

indicating beams, obstruction, piping, cables etc. The ducting shall be suitably designed to avoid all obstructions and at the same time utilizing a minimum number of bends / transformations
/divisions etc. Every duct layout drawing shall clearly indicate the location and spacing of supports and hangers.

x. All the ducts shall be rigid and shall be adequately supported and braced wherever required with Tees, angles or adequate size to prevent buckling vibration or breathing. The contractor should mention the total quantity of various sizes ducting sheet along with each floor drawing of duct layout.

h. Elbows, Vanes etc

Simple elbows, transformation sections shall be formed with Pittsburgh corner seams. Complicated fittings shall be constructed with double corners. Elbows, bends and offset pieces shall have a center line radius of not less than 1.5 times the radial of width of the duct. Turning vanes should be provided at required spacing such that the aspect ratio of each individual elbow formed by vanes shall not be more.

i. Transformation:

Duct transformation shall be made with a side slope of 10mm to 70mm. Gradual changes shall be used so as to maintain uniform velocities accompanied by decreased turbulence, lower resistance & minimum noise.

j. Obstructions:

Where ducting has to avoid building structural members, piping, electrical pipes and cables, ducts shall be transformed, divided or curved to one side and a stream lined collar shall be used in all such cases (the reduction in area shall not exceed 20% of the original area) subject to approval of Engineer in charge. Factory fabricated ducts are also acceptable subject to meeting above specification.

k. Take offs:

All branch take-offs and collars shall be provided with turning vanes. Straightening vanes shall be provided in the collars wherever practicable.

l. Dampers & Splitters

Dampers shall be provided in the duct work for proper control and balancing of air distribution. Dampers shall have easily accessible operating mechanism of opposed blade type. The operating mechanism shall consist of links, levers and quadrants as required for proper control and setting in a desired position. The position of the handle of Damper operating mechanism shall be clearly visible and it shall indicate the position of the damper in duct. Dampers, splitters and their operating mechanism shall be fabricated of GS sheets of 16 SWG and shall be easily accessible through suitable access doors in the ducts.
Dampers shall be installed in duct at all required locations such as chutes, branches etc.

m. Back draft damper

Back draft damper shall be measured by their cross-sectional area perpendicular to air flow based on the approved drawing I as built drawing and paid per unit area. Quoted rates shall include necessary collars and flanges for mounting etc. No special allowance shall be payable for extension of cross-section outside the air stream.

n. Louvers

Louvers complete with bird screen etc., shall be measured from the approved drawings / as

built drawing on the basis of core area (excluding margin flanges) and paid per unit area. Louvers in supply and exhaust fan units are part of fan units and no separate payment will be made for the same. The louvers shall be made of extruded aluminium power coated, min. 2mm thick frame & min. 1.5mm thick fins within it.

- Any supports, nuts, bolts, anchors, fasteners, gasket, tools, gadgets etc. required for successful operation and acceptance shall be provided at no extra cost to the client.
- Fresh air intake grills shall be made of extruded aluminum sections and shall have washable synthetic type air filter having 90% efficiency down to 10 microns (MERV 8)
- A flanged frame using RS sections shall be provided on front face to conceal the gap between the louvers and the adjoining wall face. Corners of frame shall be welded. The frame shall be made structurally rigid.
- Louvers made from extruded aluminum section shall be in modular panel form for ease of handling. These shall be free from waves and buckles. Vertical blades shall be truly vertical and horizontal blades shall be truly horizontal. Butt joints in blades shall not be accepted.
- Additional intermediate equally spaced supports and stiffeners shall be provided to prevent sagging/vibrating of the louvers, at not more than 750mm centers where the louver's length is longer than 750rnm.
- A bird wire screen made of 12 mm mesh in 1.6 mm steel wire held in angle or channel frame shall be fixed to the rear face of the louver frame by screens.

o. Fresh Air Intakes

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

p. Apparatus and Equipment Connections

Equipments such as air handling units shall be connected to the duct by means of double canvas sleeve of 15 ounce, woven asbestos cloth connection of at least 150mm long.

Duct sleeves made of 20 SWG thick galvanized sheet shall be used for ducts passing through load bearing walls or partitions. Sleeves shall provide 25 mm clearance all around as per duct or insulated duct. The space between sleeve and duct shall be packed with twisted asbestos.

All the sheet metal plenums required to confine the flow of air through filters and fans, shall be fabricated out of 18 SWG galvanized sheet steel, and suitably braced as required. Suitable access doors shall be provided for plenums.

q. Diffusers & Grilles

All side wall supply grills shall be double deflection type with both horizontal and vertical vanes being adjustable. Grilles shall be provided with multi-louver damper for volume control with adjustable handle. All return air and exhaust grilles shall have only horizontal louvers. The supply air grills and return air grills shall be on same face and continuous

.Supply air ceiling diffuser shall be provided with volume control dampers which can be

operated from below.

All the diffusers and grilles shall be of powder coated aluminium. Diffusers and grilles shall be provided with sponge rubber gasket between flanges and wall or ceiling. Samples of grills/ diffusers shall be approved by Engineer-in charge before installation. The shade of Grills and Diffuser shall match the Building finish and got approved by Engineer –in-charge.

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

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

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

- Circular ceiling outlets/intakes shall have either flush or anti smudge outer cone as specified in the tender specifications. Flush outer cones shall have the lower edge of the cone not more than 5 mm below the underside of the finished ceiling into which it is fitted. Anti-smudge cones shall have the outer cone profile designed to reduce dirt deposit on the ceiling adjacent to the air outlet. The metal sheet used for construction of these shall be minimum 1.6 mm thick extruded aluminum sheet.

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

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

- All supply air outlets shall be fitted with a volume control device, made of extruded aluminum gate section. The blades of the device shall be mill finish/ block shade pivoted on nylon brushes to avoid rusting & rattling noise, which shall be located immediately behind the outlet and shall be fully adjustable from within the occupied space without removing any

access panel. The volume control device for circular outlets shall be opposed blade radial/shutter type dampers, or two or more butterfly dampers in conjunction with equalizing grid. Opposed blade dampers shall be used for square and rectangular ceiling/ wall outlets and intakes.

- All the products supplied by contractor should supplement 'in performance by selection curves of product ratings from the manufacturer.
- Laminar supply air diffusers shall be made of 2mm thick powder coated aluminum sheet duly insulated with 5mm thick dosed cell polyethylene foam insulation having factory laminated aluminum foil and joints covered with self-adhesive aluminum tape and having holes 2/3 mm dia including frame work.

r. Testing

After completion of ducting, the entire system shall be tested for air leakages. The maximum allowable air leakage shall be 10%. On commissioning of the plant, the entire air distribution system shall be balanced to supply the required air quantities to various regions and rooms to maintain the specified inside conditions. The readings of air quantities after final balancing of the system through each diffuser or grill shall be recorded and submitted to the Engineer-in-Charge.

After duct installation, total duct work (Air-conditioning and Mechanical Ventilation Ducts) should be tested for leakage. The procedure for leak testing should be followed as per SMACNA – "HVAC Air Duct Leakage Test Manual" (First Edition)

- This section of the specification describes the ductwork leakage testing procedure.
- All ductwork shall be pressure tested for leakage, smoke test is not acceptable. The contractor shall provide the necessary test equipment and skilled labour to carry out the tests satisfactorily.
- Testes shall be witnessed and certified by the Engineer-in-Charge. Prior to witness of final tests, the contractor shall carry out preliminary tests to ensure the test results are within specified limits.
- All duct work shall be tested for leakage without duct insulation or duct enclosure at the joints.
- Accuracy of the test apparatus shall be within:
- ±5%of the indicated flow rate or 0.5 l/s, whichever is greater, and
- 5% of the indicated static pressure in duct under test.

- The test apparatus shall have a calibration certificate, chart of graph dated not earlier than one year before the test for which it is used.
- The entire air distribution system shall be balanced with the help of an anemometer. The measured air quantities at fan discharge and at the various outlets shall be within ±5 percent of those specified/ quoted. Branch duct adjustments shall be permanently marked after the air balancing is completed so that these can be restored to their correct position if disturbed at any time.

6. INSULATION

a. Scope

The scope of this section comprises the supply and application of acoustic and thermal insulation for ducting, piping, etc. conforming to these specifications. The insulation material shall be applied only after the satisfactory testing of the equipments, piping, ducting and accessories etc. The surface of the material to be insulated shall be measured properly and insulation material shall be cut to proper size accordingly with sufficient allowance in dimension. Material shall be fitted under compression and no stretching of material shall be permitted. A thin film of adhesive shall be applied on the back of the insulating material sheet and then on to the metal surface. When adhesive is tack dry, insulating material sheet shall be placed in position and pressed firmly to achieve a good bond. All longitudinal and transverse joints shall be sealed as per manufacturer recommendations. The adhesive shall be strictly as recommended by the manufacturer.The insulation work shall be done by the workers trained by the manufacturer representative. The manufacturer representative shall visit the site at regular intervals (as required by Engineer-in charge) and shall inspect and certify the insulation work quality as per their standard. No insulation work shall be covered or handed over without the inspection and certification by the manufacturer's representative.

b. Material

S.N.	Material of insulation	Conductivity (k value in W/m-°k) @ 20°C	Density (Kg/ Cum)	Fire properties	Water vapor permeability (μ)	Operating Temperature range (°C)
1.	Closed cell nitrile rubber	0.037	40-60	Class 0 as per BS 476 Part 6, for fire propagation test and Class 1 as per BS 476 Part 7, for surface spread of flame test.	More than 7000	-40 to 105
2.	Open cell nitrile rubber	0.045	140-180	Class 1 as per BS 476 Part 7, for surface spread of flame test.		-40 to 105
3.	Rock wool	0.035	64	Class 0 as per BS 476 Part 6, for fire propagation test and Class 1 as per BS 476 Part 7, for surface spread of flame test.		0 to 600

4.	Expanded Polystyrene	0.035	20	Fire retardant, self-extinguish, TF quality		-200 to 80
5.	EPDM	0.037	40-60	Class 0 as per BS 476 Part 6, for fire propagation test and Class 1 as per BS 476 Part 7, for surface spread of flame test.		-40 to 105

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's test certificate for thermal conductivity values, density, water vapour permeability and fire properties. Samples of insulation material from each lot delivered at site may be selected by Engineer-in-Charge and gotten tested for thermal conductivity and density at Contractor's cost. Adhesive used for sealing the insulation shall be non-flammable, vapour proof adhesive strictly as per manufacturer's recommendations.

c. Refrigerant/ Drain pipe Insulation using closed cell nitrile rubber

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.
ii. Good quality adhesive as per manufacturer recommendation should be used for pasting 100% 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. The longitudinal & radial joints should have overlapping 2" strip of same material with min 3mm thickness.
iii. The insulation material shall be closed cell nitrile rubber covered with 6-7 mil minimum thickness and 200 gram/sqmt ±10% interwoven glass fabric for UV and mechanical protection and the thickness of insulation shall be as identified in the schedule of quantity. All valves, fittings 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 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.

7. VRV (VRF) AND SPLIT AC SYSTEM

A. SCOPE

The scope of this section comprise the supply, installation, testing and commissioning of BEE 5 star rated air cooled Hi-wall or cassette type split units (Cooling application) conforming to these specifications and in accordance with the requirements of Drawings and Schedule of Quantities:

- Outdoor Units
- Indoor Units
- Refrigerant Piping & Insulation
- Drain Piping & Insulation
- Control Cabling
- Stabilizer.

B. OUTDOOR UNIT

i. The outdoor unit shall be factory assembled, weather proof casing (Material of construction of casing shall be vendor's standard design), constructed from heavy SWG GI sheets steel panels and coated with baked enamel finish minimum 40 microns thick. The outdoor unit shall be completely factory wired, tested with all necessary controls & filled with first charge of refrigerant before delivering at site. The outdoor unit shall be provided with hydrophilic coating.

ii. The outdoor units should have anti corrosion paint free plate for easy mounting of unit.

iii. The outdoor unit shall be provided with epoxy painted MS angle supports suspend from Wall/ ceiling for mounting the outdoor unit or floor mounted epoxy painted MS angle frame for mounting outdoor unit with vibration isolators. All the supports/angles shall be coated with hop dip galvanized of minimum 80micron DFT.

iv. The outdoor unit should be fitted with low noise level and should not be more than 65db
(A) at normal operation when measured at 1.5m distance from the equipment.

v. The outdoor unit should be fitted with low noise aero spiral design fan with aero fitting grill for spiral discharge airflow to reduce pressure loss and should be fixed with DC/ AC fan motor for better efficiency.

vi. Refrigerant Circuit: The refrigerant (R-410a) circuit shall include liquid and gas shut-off valves at condenser end. All necessary safety devices shall be provided to ensure the safe operation of the system including high pressure switch, fuse, fan drive overload protector, fusible plug, crankcase heater, over load relay.

C. INDOOR UNIT

The unit shall be high wall mounted type or cassette type for cooling application. The unit shall include pre-filters, fan section and DX- coil section. The housing of the unit shall be powder coated/ heat treated galvanized steel. The body shall be light in weight and shall be able to suspend from four comers. The fan shall be aerodynamically designed diffuser turbo fan type. Unit shall have an external attractive panel for supply and return air.

i. The fan shall be dual suction, aerodynamically designed, Turbo, multi blade type, statically & dynamically balanced to ensure low noise and vibration free operation of the system. The fan shall be direct driven type, mounted directly on motor shaft having support

from housing.

ii. The cooling coil shall be made out of seamless copper tubes and have continuous aluminum fins. The fins shall be spaced by collars forming an integral part. The tubes shall be staggered in the direction of airflow. The tubes shall be hydraulically/

mechanically expanded for minimum thermal contact resistance with fins. Each coil shall be factory tested at 21 kg/sq.m .air pressure under water.

iii. Indoor unit shall have cleanable type filter fixed to an integrally molded plastic frame. The filter shall be with inbuilt ionizer; UV filter and germi control filters and shall be slide in and neatly insert able type. It shall be possible to clean the filters either with compressed air or water.

iv. Each unit shall have PID control for maintaining designed room temperature. Each unit shall be provided with microprocessor thermostat for cooling.

v. Each indoor high wall unit shall be with cordless infrared remote controller as standard features. Cordless remote shall have standard features as per standard design of manufacturers.

vi. The units shall have PLC for auto sequencing of split units with microprocessor based controller along with enclosure / accessories having facility for configuration as per the requirement for sequenced start/stop.

D. REFRIGERANT PIPING

Refrigerant piping for the split air-conditioning system shall be of soft seamless copper tubes. Forged copper fittings shall be used for the refrigerant piping. The refrigerant piping arrangements shall be in accordance with good engineering practices as applicable to the air-conditioning industry, and shall include charging connections, suction line insulation and all other items normally forming part of proper refrigerant circuits.

i. Before joining any copper pipe or fittings, its internals shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. Subsequently it shall be thoroughly blown out using nitrogen gas.

ii. After completion of installation of the refrigerant piping, the refrigerant piping system shall be pressure tested using nitrogen gas at a suitable pressure as specified by OEM (Original Equipment Manufacturer).

iii. The supplier of air-conditioning system shall choose sizes as designed and erect proper interconnections of the complete refrigerant circuit. The thickness of copper piping shall not be less than 20 SWG.

iv. The suction line pipe size and the liquid line pipe sizes shall be selected according to the manufacturer's specified diameter. All refrigerant pipes shall be properly supported and anchored to the building/structure using steel hangers, fasteners, brackets and supports which shall be fixed to the building/structure by means of inserts or expansion shields or anchor fasteners of adequate size and number to support the load imposed thereon.

v. The refrigerant piping should be laid in such a way that it should not distort the interior of the room, wherever the refrigerant pipe has to be laid across the room, it should be laid in a concealed manner by making appropriate boxing arrangement matching with the interior of the room. All associated minor Civil Engineering works (like chasing on wall, ceiling & re-plastering & repainting etc.) related with the above items are included in the scope of work. The above scope does not include false ceiling wherever required.

vi. Entire liquid and suction refrigerant pipe lines including all fittings, valves and strainer bodies, etc. shall be insulated with 13mm thick elastomeric Nitrile rubber with mechanical and UV protection as specified in BOQ.

vii. Piping work shall be recessed in wall/floor wherever required as per direction of Engineer-in-charge without any extra cost.

E. DRAIN PIPING

i. The drain pipe connection of each indoor unit should be 25 mm dia. The drain-pipe should be 4 Kg /cm2 pressure or G.I Class B type. uPVC pipe ISI marked and conforming to relevant IS complete with fitting as required whereas the connection of the indoor unit to the uPVC pipe should be with flexible braided pipe. The drain piping should be insulated with thick tubular Nitrile rubber Elastomeric insulation as specified in BOQ.

ii. For proper drainage of condensate U trap shall be provided in the drain piping wherever required. The condensate drain pipe arrangement for disposal of condensate water be made in such a way that there should not be any leakages of condensate water inside rooms as well in the route of drain water pipe line & water should be discharged at the location jointly decided with Engineer in charge. All associated Civil Engineering works as per requirement at site in above connection like making chase in the wall & restoring it original shape by re-plastering & repainting, etc. are included in the scope of work. The arrangement of drain-pipe shall be made in such a way that it should not affect the aesthetic of the building as well as maintenance friendly & easily accessible.

F. VARIABLE REFRIGERANT VOLUME AIR CONDITIONERS

The contractor shall supply and install VRV system air conditioners wherever indicated. The system shall be complete in all respects and comply with the specifications as given. The system shall operate on cooling as well as heating system as per requirement.

j) Condensing Units:

Each condensing unit shall be complete unit with hermetic compressor/s, air cooled condenser, condenser fans with motors, internal piping, switches and internal wiring and shall be enclosed in a corrosion resistant, epoxy coated weather proof outdoor type housing.

The compressor shall be VRV with Twin/Triple compressor control. The compressors shall be suitable for R-410a. The optimum capacity control shall be of multiple compressors in accordance with load.

The condenser coil shall be air cooled type with aluminium fins and copper tubes and necessary refrigerant connections. The copper tubes shall not be less than 1/2" O.D.

The condenser air fans shall be propeller type direct driven, each complete with motor. The air quantity and area of the condenser shall be adequate for working in the specified outdoor conditions.

The casing shall be fabricated from galvanized steel zinc phosphate and finished with epoxy coating. The casing shall make the whole unit fully weather proof, suitable for outdoor installation on the sea side.

The unit shall include a remote control assembly with thermostat and starting and speed switches.

The necessary charge of refrigerant gas and lubricated oil shall be provided to run the system.

ii) **Indoor Unit:**

The cooling unit shall be matched to condensing units and shall consist of cooling coil, blower, filters, outer casing, drain pan, accessories etc.

The cooling coil shall have copper tubes of not less than 3/8" O.D. and continuous aluminium plate fins with integral collars. The tubes shall be staggered in the direction of air flow.

The fan section shall comprise of 1 no. Aluminium /industrial plastic centrifugal blower, statically and dynamically balanced motor, drive package, mounting arrangement etc.

The unit shall include a cordless remote control assembly with thermostat and starter and 3 speed switches.

iii) **Refrigerant Piping:**

The condensing unit and evaporator units shall be interconnected by type 'l' seamless copper refrigerant liquid and suction lines using flared or brazed fittings. Necessary accessories shall be incorporated in the circuit.

The insulation of suction line shall be as per manufacturer standard.

8. VENTILATION FANS

A. SCOPE

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

B. TYPE

Centrifugal, tube axial, in-line propeller fans and roof mounted units shall be of the type as indicated on Drawings and identified in Schedule of Quantities. As required / usage fans should be suitable for chemical & corrosive fume exhaust.

C. CAPACITY

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

D. AXIAL FLOW FAN

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

- Casing: Casing shall be constructed of heavy gage sheet steel. Fan casing, motor mount and straightening vane shall be of welded steel construction. Motor mounting plate shall be minimum 15 mm thick and machined to receive motor flange. An inspection door with handle and neoprene gasket shall be provided. Casing shall have flanged connection on both ends for ducted applications. Support brackets for ceiling suspension shall be

welded to the casing for connection to hanger bolts. Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. Casing shall be bondorized, primed and finish coated with enamel paint.

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

- Drive: Drive to fan shall be provided through belt drive with adjustable motor sheave and standard sheet steel belt guard with vented front for heat dissipation. Belts shall be of oil-resistant type.
- Vibration Isolation: The assembly of fan and motor shall be suspended from the slab by vibration isolation suspension of rubber-in-shear type.
- Accessories : The following accessories shall be provided with all fans :

- Outlet cone for static pressure regain.
- Inlet cone
- Fan silencers may be provided where specifically called for in Schedule of Quantities. Fans shall be factory assembled and shipped with all accessories factory-mounted.
- For smoke extraction application as specified in the bill of quantities the fan shall be suitable for operation at 250deg C for 2hrs. The Test certificate according to EN 12101-3 certifying the same needs to be provided.

E. PROPELLER FAN

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

- Mounting Plate shall be of steel construction, square with streamlined venturi inlet (reversed for supply applications) coated with baked enamel paint. Mounting plate shall be of standard size, constructed of 12 to 16 SWG sheet steel depending upon the fan size. Orifice ring shall be correctly formed by spinning or stamping to provide easy passage of air without turbulence and to direct the air stream.
- Fan Blades shall be constructed of aluminium. Fan hub shall be of heavy welded steel construction with blades bolted to the hub. Fan blades and hub assembly shall be statically and dynamically balanced at the manufacturer's works.
- Shaft shall be of steel, accurately ground and shall be of ample size for the load transmitted and shall not pass through first critical speed through the full range of specified fan speeds.
- Fan motor shall be as per the Technical specifications of Electrical items.

Accessories : The following accessories shall be provided with propeller fans :

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

- Fixed or gravity louvers built into a steel frame at the outlet.
- Regulator for controlling fan speed for single phase fan motor.
- Single phase preventers for 3 phase fans.

F. PERFORMANCE DATA

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

G. TESTING

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

9. CONTROLS AND INSTRUMENTATION

a. Scope:

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

b. EQUIPMENT SAFETY CONTROLS

1. Compressor:

Compressor shall be provided with the following safety controls:-

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

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

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

2. Condenser

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

3. Chiller

- An antifreeze shall be provided with water chiller, set at a few degrees above the freezing point. This shall operate, when the temperature of water in the chiller

falls below the set point to trip the compressor motor. The reset provided for the safety shall be manual.

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

4. Refrigeration Plant

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

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

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

iii) The compressor motor shall also be interlocked electrically with,

- Condenser water pump in case of water cooled condenser, and condenser fan with air cooled condensers,
- Chilled water pumps in case of chilled water system and evaporator fan in case of direct expansion system, and
- Antifreeze thermostat in case of chillers.

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

5. REFRIGERANT FLOW CONTROLS

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

5.1 Solenoid Valve

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

b) Discharge gas valves shall be provided in the following applications as required: Hot gas defrosting: normally this solenoid valve shall remain closed, but it shall open up to feed the evaporator with hot gas for defrosting when required, especially in cold storage applications.

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

5.2 Thermostatic Expansion Valve

Thermostatic expansion valve shall be provided in DX type refrigeration plant to modulate the flow rate of liquid refrigerant entering the evaporator in response to the extent of superheat of refrigerant gas leaving the evaporator, so that only a metered flow is ensured matching the load. The number of expansion valve shall be such that the specified accuracy of temperature control of the system can be achieved and that no valve is expected to operate below 35% of its rated capacity. The sizes shall be selected suitably so as to avoid hunting. Adjustable super heat control and external equalizer port shall be provided for each valve. Each expansion valve shall be easily removable for cleaning and adjusting.

5.3 Float Valve

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

5.4 Compressor Capacity Control

The capacity control arrangement shall be in accordance with 2.2A.7 for centrifugal type compressors and 2.2B.8 for screw compressors.

10. ELECTRICAL FOR HVAC EQUIPMENTS

All Electrical items & BMS Specification for HVAC to be considered from electrical & BMS services specifications respectively.

11. 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.

Colour scheme for the plant and equipment

a) Colour scheme for equipment like chilling unit, pumps, AHUs etc shall be as per manufacturer's standard Colour scheme,

b) 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:

c) 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 100 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		
Cable Trays & Duct Support	Black		

12. MODE OF MEASUREMENT

Representatives from the CONTRACTOR and Engineer shall conduct a joint inspection of the Equipment's. All the discrepancies observed either incomplete works or defective work shall be clearly indicated in the joint inspection report. The mode of measurements given below is for the purpose of measurement and payment and the scope of works shall be as specified elsewhere in the specification.

The following measurement code shall apply to this contract:-

a. Ducting

- All sheet metal ducting work shall be measured in terms of final sheet area installed in Sq. m.
- Eg:- Measurement of 600 mm x 300 mm duct of 1 m length = [(600+300)x2x1] = 1.80 Sq.m.
- Duct fittings such as bends, elbows, tap-offs, collars, transformation pieces etc. shall

be treated as ordinary duct pieces with their length measured along their center line as mentioned in point (i).

- Vanes, splitters, duct dampers, deflectors, access doors, etc. which are required to be installed in the duct work shall not be measured separately as it shall form part of the duct work.
- Duct supports, stiffening members, etc. shall not be measured separately. All such supports/hangers shall form part of duct work.
- Equipment connections such as canvas/asbestos/rexine shall be deemed to be part of the duct work, and no separate measurement shall be allowed.
- No separate special measurement shall be made for bends, transformation pieces, tap offset, elbows, etc.
- Fire dampers - shall be measured by their cross sectional area perpendicular to the direction of air flow. Quoted rates shall include the necessary collars and flanges for mounting, inspection pieces with access door, electrical actuators and panel. No special allowance shall be payable for extension of cross section outside the air stream.
- Control panel for Fire/Smoke dampers shall be measured by numbers which shall include FRLS cable for interconnection of control panel, actuator & AHU panel. No additional payment on account of FRLS cable shall be made.
- For each drawing, all supply of ductwork must be accompanied by computer generated detailed bill of materials indicating all relevant duct sizes, dimensions and quantities. In addition, summary sheets are also to be provided showing duct area by SWG and duct size range as applicable.
- Measurement sheet covering each fabricated duct showing dimensions and external surface area along with summary of external surface area of duct SWG-wise
- All duct pieces to have a part number, which should correspond to the serial number, assigned to it in the measurement sheet. The above system will ensure speedy and proper site measurement, verification and approvals.
- Duct measurements (for insulated ducts) shall be taken before application of insulation.
- Duct work shall be measured section wise on the basis of external surface area by multiplying the axial length from flange face to flange face for each section by the corresponding duct perimeter in the center of that section length.
- Uniformly tapering straight sections shall also be measured as in (ii) above. However, for special pieces like tees, bends etc. area computations for surface areas shall be done as per the shape of such pieces.

- The quoted unit rate for external surfaces of ducts shall include all wastage allowances, flanges, gaskets for joints, vibration isolators, bracings, hangers and supports, inspection chambers/access panels, splitter dampers with quadrants and levers for position indication, turning vanes, straightening vanes, and all other accessories required to complete the duct installation as per the specifications. These accessories shall not be separately measured.
- Grilles and diffusers (except linear diffusers) shall be measured by the cross sectional areas, perpendicular to the airflow, and excluding the flanges. Volume control dampers, where provided shall not be separately accounted for.
- Linear diffusers shall be measured by linear measurements only, and not by cross sectional areas, and shall exclude flanges for mounting of the linear diffusers. The supply air plenum for linear diffusers shall be measured as described above for ducting.

b. Grilles/ Diffuser/ Louver/ Damper:

All grills, diffusers, louvers and dampers will be measured in terms of effective area in Sq.m perpendicular to the direction of air flow.

c. Ducting Insulation

Ducting insulation will be measured on the basis of centerline of insulation and not the outer line of insulation.

i. Eg:- Measurement of 25mm thick insulation on 600 mmx300mm duct of 1m length = [(600+25)+(300+25)]x2x1] =1.9 Sq.m

ii. No separate special measurement shall be made for insulation of bends, transformation pieces, tap offs, elbows, etc. All such insulation shall be treated as standard duct insulation.

iii. Insulation item shall include all accessories and finishes as specified. No separate measurement will be made for such items.

iv. Duct insulation and acoustic lining shall be measured on the basis of surface area along the outer surface (Ref IS 14164) of insulation thickness. Thus the surface area of externally thermal insulated or acoustically lined duct shall be based on the perimeter at the centre of thickness of insulation, multiplied by the centre-line length of ducting including tapered pieces, bends, tees, branches etc. as measured for bare ducting. In the case of tapering pieces, their average perimeter shall be considered.

d. Piping with/without insulation

i. Piping with insulation shall be measured in running length (meters) for each size of pipe.

ii. The length of piping including accessories and fittings shall be measured along the center line of piping.

iii. No separate measurement of flanges, bends, elbows, reducer, expanders, tees, cross pipe supports, hangers, anchors, sockets for thermometer, pressure gauge, gaskets, sealants etc. shall be made. All such fittings / accessories shall be treated as normal piping.

iv. All accessories and finishes connected with insulation work shall be deemed to form part of insulation, and no separate measurement shall be made for such items.

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

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

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

viii. Pipe insulation shall be measured in units of length along the centre line of the insulated pipe. The linear measurements shall be taken before the application of the insulation. For piping measurements, all valves, orifice plates and strainers shall be considered strictly by linear measurement along the centre line of the pipes, and no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.

e. Pipe fitting, valves etc.

i. No separate measurement of insulation shall be made for valves, fittings such as bends, elbows, reducers, expanders, tees, crosses, flanges, etc. All such insulation shall be linear in meters measured along the center line of piping.

ii. All accessories and finishes connected with insulation work shall be deemed to form part of insulation, and no separate measurement will be made for such items.

iii. No separate measurement of insulation on valves will be made.

f. Equipment Insulation:

No separate measurement for insulation of any equipment shall be made. Insulation of equipment shall be deemed to form part of the equipment. Insulation on equipment shall be done as per specs provided.

13. NOISE CRITERION AND VIBRATION ISOLATION

All air conditioning equipment and materials (like chillers, pumps, 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.

14. PERFORMANCE FOR TEST RESULTS & NOTES ON TEST INSTRUMENTS AND CAPACITY COMPUTATIONS

Sl.No.	Item	Test Results	
1.	Ambient conditions	D.B. Temp W.B.Temp %RH	- deg C - deg C
2.	Compressors	R.P.M Suction pressure Discharge pressure Oil pressure	 - Kg/sq.cm -Kg/sq.cm -Kg/sq.cm
3.	Compressor Motors	R.P.M. Voltage Current (i)at 100% load (ii) at partial load (a) (b) (c)	 - Volts - amps - amps - amps - amps
4.	Water Chillers	Water flow rate Water temperature Entering Leaving Water pressure Entering Leaving	- LPM - deg C - deg C -Kg/sq.cm -Kg/sq.cm
5.	Condensers	Water flow rate Water temperature Entering Leaving Water pressure Entering Leaving	- LPM - deg C - deg C -Kg/sq.cm -Kg/sq.cm
6.	Pumps	R.P.M. Motor current Discharge pressure Suction pressure	 -amps -Kg/sq.cm -Kg/sq.cm
7.	Cooling Towers	Water temperature Entering Leaving Wet bulb approach Fan motor current Fan motor voltage Fan motor R.P.M	 - deg C - deg C - deg C - amps - volts

NOTES

A. Test Instruments

- All instruments for testing shall be provided by the air conditioning contractor.
- Thermometers used for measurement of temperature of water I 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.

Air handling units and fancoil units	Monthly inspection	1. Inspect all air handling and fan coil units. 2. Check all air filters and clean or change filters as necessary. 3. Check all water coils, seals and pipelines for leaks and rectify as necessary. 4. Check and re-calibrate modulating valves and controls. Adjust and rectify as necessary to ensure compliance to the original specifications. 5. Purge air from all water coils. 6. Check all fan bearings and lubricate with grease as necessary. 7. Check the tension of all belt drives and adjust as necessary. 8. Check and clean all the condensate pans, trays and drains. 9. Check measure and re-calibrate all sensors if necessary. 10. Check, clean and service smoke detectors. Carry out a system test to ensure that the smoke detector will trip the AHU's. 11. Check spring vibration isolators for abnormal vibration. Rectify if necessary. 12. Coil to be cleaned by (a) spray of high-pressure clean water (not exceeding 30 psi (b) with chemical spray, if necessary.
Air handling units and fan coil units	Annual inspection prior to expiry of warranty period	1. Perform all functions for monthly checks. 2. Tighten motor terminals 3. Check starter contacts. 4. Test and calibrate overload settings.
Air cooled packaged units and precision-computer air-condition equipment	Monthly check	1. Check condenser fan motor load ampere. 2. Check fan and motor mounting brackets. 3. Check shafts and bearings. Lubricate with grease as necessary. 4. Check the tension of all belt drives and adjust as necessary. 5. Check for refrigerant leaks with electronic leak detector. 6. Check electrical terminals and contactors operation and connections for tightness. 7. Check compressor motor current. 8. Check refrigerant line driers and moisture indicators.
Air cooled packaged units and precision-ac equipment	Annual inspection prior to expiry of warranty period.	Perform all functions listed in the monthly checks.
Air distribution system	Monthly and annual inspection prior to expiry of warranty period	1. Check operation of all modulating and fixed dampers controlling air flow through unit. Lubricate all damper bearings and linkages as necessary. 2. Carry out space temperature checks on air-conditioned areas with thermo hydrograph. Balance air flow as necessary to compliance with requirements of original specifications. These checks include the calibration of sensors, thermostat, etc. 3. Check noise level of discharged air from diffusers.

Ventilation	Monthly check and annual inspection prior to expiry of warranty period	1. Check adjust as necessary the air flow of all fans are in compliance with the original specifications. 2. Check the tension of all belt drives and adjust as necessary. 3. Check and lubricate all fan bearings. 4. Tighten motor terminals. 5. Check starter contacts. 6. Test and calibrate overload settings. 7. A system check shall be carried out for all Mechanical ventilation (MV), Pressurisation and Exhaust system to verify the performance of the systems.
Switch board	Six-monthly and annual inspection prior to the expiry of the warranty period	1. Clean and adjust all switch gear, contactors, relays and associated electrical equipment at intervals not exceeding six months. 2. Check and prove operation of thermal over load and protection devices. 3. Check and ensure tightness of all equipment fastenings and cable terminations within switch boards. 4. Vacuum clean all switch board cubicles.
Piping system	Monthly and annual inspection prior to expiry of warranty period	1. Check all piping system for leaks and repair these where they have occurred. 2. Check for damage & deterioration of insulation or sheathings. Rectify as necessary
	Consumable materials	The department shall supply the following consumable materials as and when required :- 1. All oils and greases required for lubrication of compressors, fan bearings, motors bearings, pivots and other moving parts. 2. All refrigerant required for topping up. Refrigerant loss if due to manufacturing defect or due to negligence shall be made good by the contractor. 3. All consumable filter elements/ rolls. 4. All chemicals for the correct chemical treatment of the cooling tower and chilled water system. 5. All carbon brushes required to replace worn brushes in electric motors. 6. All electric contact points required to replace worn electric contact points in switchgears, motor starter gears, electronic control gears and electric relays. 7. All electric fuses required to replace blown fuses. Just before the expiry of the warranty of the contract, the contractor shall carry out a complete system operability test on all the systems or sub-systems as called for in the contract. The purpose of the test is to verify that the performance of all the systems or sub-systems in the contract is in accordance to the specifications. All test shall be carried out in the presence of the Engineer-in-Charge or his representative. The warranty period is deemed to be over if the department or his representative is completely satisfied with the system performance during the test.

16. INSPECTION, TESTING AND COMMISSIONING

a. Scope

This covers initial inspection and testing of equipments/ materials on receipt at site, final inspection testing and commissioning of all equipment at site and description of testing requirements and procedure.

b. Initial Inspection & testing at Manufacturer's Works

i) Initial inspection of materials &equipments 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 equipments 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. Equipments 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

I. Ducting

a) The sheet used for ducting shall be checked for physical test at site. The physical test should include the sheet thickness and bend test as per relevant IS specifications.

b) Zinc coating of GSS Sheet as mentioned in the tender documents may be got tested from a laboratory to verify that same meets the contract requirements.

ii. Switch Gear, Control Gear, and Measuring Instruments

These should be of specified make. For air circuit breaker manufacturer's test certificate shall be furnished by contractor and the same shall be verified as per contract requirements.

iii. Electric motors

Electric motors should be of specified make, manufacturer's test certificate for electric motor shall be furnished.

iv. 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.

v. 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.

c. Final Inspection & Testing

Final Inspection & testing will be done 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 equipments 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.
iii. The equipment capacity computations shall be carried out.
iv. The input kW of the unit/ TR at full load shall also be checked against contract requirements, if any
v. Pressure drops across chiller and condenser at specified flow rates shall be checked against the contract requirements.
vi. All instruments for testing shall be provided by the contractor. The accuracy of the instruments shall be as follows:
a) Temperature: Liquid in glass thermometer having accuracy ± 1 deg. C as per IS: 4825.
b) Wet bulb Temperature: Sling psychrometer confirming to IS: 6017. Scale Error: For less than 0 deg. C: 0.3 deg.C ± 0.2 deg.C
For over 0 deg. C: 0.2 deg.C ± 0.1 deg.C
c) Pressure Gauge: With the accuracy of ± 1% for maximum scale value from 10 to 90% and ± 1.9% for maximum scale value for rest of the scale conforming to IS: 3695.
d) Water flow meter: Water flow shall be measured using the arrangement installed as per schedule of work.

d. Safety measures

All equipments 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.

The contractor shall operate, test and adjust the air-conditioning system units, fan, motors, all air handling appliances including adjustment of regulators, dampers, etc. All testing equipments, labour, operating personnel, oil, refrigerant or any other item required for these tests shall be provided by the contractor to enable the plant to be put in a continuous running test.

TEST PROCEDURE:
a. 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.

b. Capacity of the Plant:

The following aspects shall be checked before conducting the performance tests:

- The outside conditions shall be as close to the design values as possible.
- 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.
- The plant shall be fully loaded and the temperature stabilized.
- Hourly readings of water flow shall be recorded.
- Hourly readings of pressure, temperature, electrical current, voltage and power factor shall be recorded.

c. Cooling coils of air-handling units:

The flow of air over the cooling coil shall be measured by recording the velocity of air across each filter placed before the cooling coil. The velocity shall be measured by means of an anemometer.

Air quantity across the filters = Velocity of air across the filter in FPM x Net filter area in Sq.ft.

The wet bulb temperature of air entering the coil and that leaving the coil shall be measured. The enthalpy of entering and leaving air shall be noted from psychometric chart,

Corresponding to the WB temperature recorded. Say, He = Enthalpy of entering air in btu/lb.

Hl = Enthalpy of leaving air in btu/lb.

Capacity of AHU in TR = (cfm of AHU x dh x 4.5) / 12000

(Where dh is the difference of temp. air entering and leaving across the coils)

d. Compressor

The following readings shall be recorded:

- Suction gas pressure
- Discharge gas pressure
- Suction gas temperature
- Discharge gas temperature
- 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.

$$\text{KW/Ton of the compressor} = \frac{\text{(Power Input in KW)}}{\text{Compressor capacity in TR}}$$

e. Air Balancing

Systems are to be balanced by first adjusting the total flow at the fan, then by adjusting main dampers and branch dampers. Only final minor adjustments are to be made with register and diffuser dampers. Balancing of the air system shall be accomplished without causing objectionable air noise. Baffles and orifice plates required for proper air balance shall be furnished and installed by the contractor. Basically the following tests and adjustments are required.

- Test all the fan systems to provide proper cfm/ cmh.
- Adjust fresh air, return air and exhaust dampers to provide proper air quantities in all modes of control.
- Test and record fresh air, return air and mixed air temperature at all air handling units. Test and record data at all coils after air and hydronic systems are balanced. Measure wet and dry bulb temperature on cooling coils.
- Make point tube transverse at all main supply and return ducts to set proper air quantities. Adjust all zone and branch dampers to proper cfm/ cmh.
- Test and adjust each register, grills, diffuser or other terminals equipment to within 5% of design air quantity. Each opening shall be defined on the test report by size, manufacturer's model, room location, design cfm and actual cfm. Outlets shall be adjusted to minimize objectionable drafts.
- Test and record static pressure drop across all filters and major coils.
- High velocity duct systems shall be tested for leakage. If excessive or audible leakage is detected, the defect shall be repaired by the contractor. Sufficient static pressure readings shall be taken from the air handling units to the terminal units to establish system static pressure.

After the desired inside conditions are achieved the quantity of air through every outlet shall be measured:
Air Qty (CFM) = Air velocity at the outlet in FPM x Effective area of the outlet in Sft.

f. 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.

g. Balancing Tolerance:

Systems shall be balanced within the following tolerances:

i) Duct leakage Rates (at operating pressures) 5% of full flow
Low pressure ducts

	(0 to 0.5 kPa) Medium Pressure ducts (0.5 to 3 kPa) High Pressure (Greater than 3 kPa)	 1% of full flow 1% of full flow
ii)	Air flow rates Under 70 l/s Over/ at 70 l/s	 10% of flow 5% of flow
iii)	Water flow rates Chilled Water Other	 2% of flow 5% of flow
iv)	Head flow rates Heat exchangers	 5% of design capacity

h. Performance Testing At Various Loading Conditions:

The performance tests shall be conducted for various loads such as 100%, 75%, 50%, and 25% of the capacity of the plant.

i. Functional Tests Electrical Equipment:

1) 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.

2) Motors:

a) Insulation Resistance of all motors shall be tested with megger and the value shall not be less than 1 Meg-ohm.

b) Starting current shall be recorded.

c) Starter operation shall be checked for single phasing by removing one of the phases.

d) Overload protection shall be checked by altering the starter thermal overload setting.

j. Safety Devices & Controls:

a) Interlocks for compressor motor with that of chilled water pumps shall be checked.

b) Flow switches in chilled water lines shall be checked.

c) High pressure-stat shall be checked by varying the setting of the cutout.

d) Low pressure stat shall be tested by closing the pilot solenoid valve.

e) Anti-freeze thermostat shall be tested by varying the setting.

f) Oil failure switch shall only be tested by varying the setting.

g) 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 manufacturers may be adopted with prior permission.

The following readings shall be recorded hourly during the tests and capacity of the plant shall be computed.

a. Compressor

i) Suction pressure - kg/cm2 (psi)
ii) Suction temperature - oC (oF)
iii) Discharge pressure - kg/cm2 (psi)
iv) Condensing Tempr. - oC (oF)
v) Oil pressure - kg/cm2 (psi)
vi) Compressor Speed - RPM

b. Compressor motor:

i) Rated capacity - HP
ii) Rated volts - Volts
iii) Rated current - Amps
iv) Starting current - Amps

c. Power consumption for 100%, 75%, 50% & 25% loads

i) Motor current in amps. - Amps
ii) Voltage - Volts
iii) Starting current. - Amps

d. Condenser

i) Refrigerant condensing pressure - kg/cm2 (psi)
ii) Refrigerant condensing Temp. - oC (oF)
iii) Temp. of water entering - oC (oF)
iv) Temp. of water leaving - oC (oF)
v) Water flow rate - lit/sec. (gpm)

e. Evaporator

i) Réfrigérant evaporating pressure - kg/cm2 (psi)
ii) Réfrigérant evaporating Temp. - oC (oF)
iii) Water flow rate - lit/sec. (gpm)
iv) Entering water temp. - oC (oF)
v) Leaving water temp. - oC (oF)
vi) Pressure drop through chiller - kg/cm2

f. Air Grilles

i) Area of Grilles - m2 (sq. ft)
ii) Velocity - m/s (FPM)
iii) Air flow rate - m3 (FPM)
iv) Temperature DB - oC (oF)
v) Temperature WB - oC (oF)

17. 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 complete HVAC system with plant including low side equipments 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 HVAC system 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 HVAC

system 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 HVAC system. Record of inside conditions will be made during this period to check the same are as per NIT requirements. The HVAC system 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 HVAC system plant will be made available for beneficial use. After the HVAC system has operated without any major break down/ trouble and inside conditions are maintained as per NIT 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 HVAC system 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 equipments shall be carried out as and when conditions become stabilized.

d. Seasonal testing shall be carried out as & when outside conditions become suitable.

18. GUARANTEE

a. The contractor shall guarantee that the air-conditioning system shall maintain the desired inside temperature within ± 1 °C and relative humidity within ± 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 equipments 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.

19. TENDER DRAWINGS, 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 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.

a. Tender Drawings

The drawings appended with the tender documents are intended to show the areas to be conditioned, space allotted for various equipments, tentative ducts, cable and pipe routes. The equipments offered shall be suitable for installation in the spaces shown in these drawings.

b. Drawings for approval on award of the work

The contractor shall prepare & submit 6 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 equipments/ materials as per agreement, if there is any contradiction between the approved drawings and agreement.

- Layout drawings of the equipments to be installed at various locations.
- Drawings including section, showing the details of erection of entire equipments including their foundations/ supports.
- Plumbing drawings showing the layout of entire piping, dia & length of pipes, valves and isometric drawings showing connections to various equipment.
- Electrical wiring diagrams for all electrical equipments and controls including the sizes and capacities of the various cables and equipments.
- Dimensioned drawings of all electrical and control panels,
- Drawings showing the details of all insulations and vapour barrier works,
- Drawings showing details of supports for pipes, cable trays etc.
- Any other drawings relevant to the work.

c. Completion Drawings

3 sets of the following laminated drawings shall be submitted by the contractor while handing over the installation to the Department. In addition, one set will be given on compact disc.

- Installation drawings giving complete details of all the equipments, including their supports, foundations etc.
- 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 section drawings for the entire piping including the pipe connections to the various equipments and insulation details wherever required.
- Ducting layout drawings include insulation giving sizes and lengths of all the ducts and the sizes and locations of all types of dampers, grilles, diffusers, louvers, mentioning air quantities and including section drawings for the entire ducting including the duct connections to the various equipments and insulation details wherever required.
- Line diagram and layout of all electrical control panels giving switchgear ratings and their disposition, cable feeder sizes and their layout.
- Control wiring drawings with all control components and sequence of operations to explain the operation of control circuits.

20. 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 26.0.

b. 3 sets of manufacturer's technical catalogues of all equipments and accessories.

c. Operation and maintenance manual of all major equipments, detailing all Adjustments, operation and maintenance procedure, Mandatory & Recommended spares list for each equipment for 5years.

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.

21. TECHNICAL DATA:
FOLLOWING DATA TO BE FURNISHED BY CONTRACTOR:

COMPRESSOR:
1. Manufacturer
2. Model
3. Type
4. (a) Refrigerant
(b) Weight of refrigerant per unit
5. Operating speed (RPM)
6. Type of drive and speed ratio
7. No. of impellers/ No. of stages
8. Out put in TR and input power consumption in KW, at the selected operating conditions % of Load Input KW at 0.0002 (FPS) fouling factor for chiller.

100% load
75% load
60% load
50% load
40% load
25% load
10% load

9. Type of capacity control
10. Capacity control range
11. Type of lubrication
12. Material of bearing
13. Operating weight (Kg.)
14. Overall dimensions of the machine
15. Compressor motor
i) Make
ii) Rated output
iii) Working voltage range
iv) Type of enclosure
v) Class of insulation
vi) Speed
vii) Full load current
viii) Starting current
ix) Efficiency
x) Power factor
xi) Temperature rise over ambient of 45 deg C

16. List of Safeties/protection provided in the chiller unit (Whether provided)
i) Motor over current
ii) Over voltage
iii) Under voltage

iv) Single cycle dropout/ intermittent power loss
v) Baring oil high temperature
vi) Low evaporator refrigerant temperature
vii) High condenser refrigerant pressure

viii) High motor temperature (For sealed/ semi hermetic chiller units only)
ix) Prolonged surge in compressor
x) Compressor starter faults
xi) Star-to-start and stop-to-stop timers for motor protection against rapid recycling
xii) Low lubricating oil pressure

17. Details of all the functions of Microprocessor control system are to be enclosed. Whether enclosed- Yes/No.

REFRIGERANT PIPING

1. Material for pipes
2. Pipe wall thickness (mm)
3. Material of fittings
4. Material of valves
5. Make of TX valve if provided
6. Make of refrigerant float if provided

ELECTRICAL

1. Motors (Give separate particulars for each application)
(i) Manufacturer
(ii) Type and frame reference
(iii) Rated output (KW)
(iv) Range of working voltage (V)
(v) No. of phases
(vi) Rated frequency
(vii) Rated speed (RPM)
(viii) Full load current (amps)
(ix) Class of insulation
(x) Efficiency and power factor at the following loadings 100%, 75%, 50% 25% of Rated full load
(xi) Type of bearings

2. Motor starters (Give separate particulars for each application):
(i) Manufacturer
(ii) Type
(iii) Rating
(iv) Whether the following protections are provided
(a) Over load
(b) Under voltage
(c) Single phase prevention (for 3phase motor starters)
3. Switch board:
(i) Manufacturer
(ii) Type

4. Circuit Breaker
(i) Manufacturer
(ii) Type
(iii) Rated normal current (amps)
(iv) Short circuit rating (MVA)
(v) Whether following are provided
(a) O/L trip

(b) E/F trip
(c) Under voltage trip

5. Measuring Instruments:
(i) Manufacturer
(ii) Range
(iii) Dial size
(iv) Glass Index

6. Iron clad switch gears:
(i) Manufacturer
(ii) Make of HRC fuse provided

S. No. Description Unit Condition of Services

1.0 VRV type Air-conditioning Units:

1.1 **General:**
Manufacturer
Overall Dimensions (mm)
Weight (Kg)

1.2 Compressor:
Refrigerant
No. of Cylinders
Bore of Stroke
Swept Volume (mm)
Speed (R.P.M.)
Capacity K. Cal/Hr at
7°C Sat. Suction Temp. and 43.3°C Cond. Temp.

1.3 Cooling Coil:
Refrig. Temp. (oC)
Type of Tube
Tube Material
Tube Dia (mm)

1.4 Condenser:
Cond. Temp. (oC)
Type of Tube

Tube Material
Tube Dia (mm)

CONTROLS:

1. Make and type of thermostats
2. Make and type of humidistat
3. Make and type of damper motor
4. Make and type of other control components

INSULATION (For each application)

1. Manufacturer
2. Material and density
3. 'K' value at 10 deg C mean temperature Thickness

LOW SIDE:

A. DATASHEET FOR ALL VENTILATION FANS

- DATA SHEET - A- Technical Requirements

Sl. no.	Description	Requirements
1	Numbers and minimum capacity	Refer BILL OF QUANTITIES
2	Air flow rate	Refer schedule
3	Type of fan motor	415 V, 3 PH, 50 Hz TEFC Sq. Cage,IE-3 energy efficient IP55
4	Type of starter	Star-Delta / DOL / VFD
5	Pre-Filters (cleanable type)	Pre filters (panel type) of 90% efficiency down to 10 microns as per BS EN 779. Maximum face velocity 2.5 m/s

- **DATA SHEET – B**

DATA TO BE FURNISHED BY CONTRACTOR		
(for each size / capacity of Fan separately)		
Sl. No.	**Description**	**Requirement**
1.	Fan No.	
2.	Type	
3.	Model / Make	
4.	Minimum Supply Air Quantity (S/A – CMH)	
5.	Total Fan Static Pressure (Pascals)	
6.	External Static Pressure (Pascals)	
7.	Type of Fan	

8.	Type of Fan Control	
9.	Maximum fan rpm	
10.	Maximum outlet velocity	
11.	Type of Filters	
	Prefilters	
	Numbers	
	Dimension	
	Efficiency	
	Face velocity	
12	Type of Starter	
13	Motor Voltage	
14	Type of Vibration isolator	
15	Controls	
16	Dimensions L x W x H	

17	Operating weight kg	
18	Fan motor kW rating	

- **DATA SHEET – C**

Data to be furnished by the contractor after the award of contractor and before installation

1. Schedule of drawings and documents to be submitted for review, approval and information with submission dates.
2. Quality Assurance Plan (QAP).
3. Dimensioned general arrangement drawing showing all equipment with accessories, mounting details, etc.
4. Overall space and head room requirement with details of handling during erection, operation and maintenance.
5. Foundation drawing with static and dynamic loading data, pocket details, foundation outline, etc, for all items.
6. Cross-sectional drawings of all items with part list and materials of construction.
7. Performance curves and selection charts for fan, filters, etc. Selection charts and calculation.
8. Operation and maintenance manual.
9. Catalogues furnishing detailed technical data for fan etc.

DG Set Specification :-

- CPWD General Specifications for Electrical Works Part VII D.G. Sets – 2013, Amended (05.11.2024)

GENERAL

1.1 INTRODUCTION

1.1.1 Scope

1.1.1.1 These specifications cover the general specifications pertaining to diesel engine driven generating sets & their installation.

1.1.1.2. These General Specifications cover the equipments and materials for the DG Sets, their testing and/ or inspection as may be necessary before their dispatch from their respective works, their delivery at site, all preparatory works, assembling, installation and adjustments, commissioning, final testing, putting into operation and handing over of the complete system.

I. These General Specifications are subject to revision from time to time.

II. Each DG Set installation work has its own particular requirements. These General Specifications shall be supplemented with tender specifications as may be required for a particular work. The tender specifications, wherever they differ from these 'General Specifications', shall have over-riding value and shall be followed for that particular work. A specimen NIT for DG Set works is appended at Appendix 'IV' for general guidance.

1.1.2 Related Documents

These General Specifications shall be read in conjunction with the General conditions of contract. These General Specifications shall also be read in conjunction with the tender specifications, schedule of work, drawings and other documents connected with the work.

1.1.3 Site Information

The tenderer should, in his own interest, visit the site and familiarise himself with the site conditions before tendering. For any clarification, tenderer may discuss with the Engineer-in-Charge.

1.2 CONFORMITY WITH STATUTORY ACTS, RULES, STANDARDS AND CODES

(i) All components shall conform to relevant Indian Standard Specifications, wherever existing, amended to date. A list of such standards is appended in Appendix 'V'.

(ii) All electrical works shall be carried out in accordance with the provisions of Indian Electricity Act, 2003 and Indian Electricity Rules, 1956 as amended up to date. They shall also conform to CPWD General Specifications for Electrical Works, Part-I (Internal), 2013 and Part-II (External), 1994 and Part IV (Substation), 2013, as amended up to date.

1.3 SAFETY CODES AND LABOUR REGULATIONS

In respect of all labour employed directly or indirectly on the work for the performance of the contractor's part of work, the contractor at his own expense, will arrange for the safety provisions as per the statutory provisions, B.I.S recommendations, factory act, workman's compensation act, CPWD code and instructions issued from time to time. Failure to provide such safety requirements would make the tenderer liable for penalty for Rs. 200/- for each violation. In addition the Engineer-in-charge, shall be at liberty to make arrangements and provide facilities as aforesaid and recover the cost from the contractor.

The contractor shall provide necessary barriers, warning signals and other safety measures while executing the work of DG Set installation, cables etc. or wherever necessary so as to avoid accident. He shall also indemnify CPWD against claims for compensation arising out of negligence in this respect. Contractor shall be liable, in accordance with the Indian Law and Regulations for any accident occurring due to any cause. The department shall not be responsible for any accident occurred or damage incurred or claims arising there from during the execution of work. The contractor shall also provide all insurance including third party insurance as may be necessary to cover the risk. No extra payment would be made to the contractor due to the above provisions thereof.

1.4 WORKS TO BE ARRANGED BY THE DEPARTMENT

Unless otherwise specified in the tender documents, the following works shall be arranged by the Department:

I. Space for accommodating all the equipments and components involved in the work. However, watch and ward shall be responsibility of the contractor.

II. Power supply (Single/three phase).

1.5 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: -

I. Foundations for equipments including vibration isolation springs/ pads.

II. Making good all damages caused to the structure during installation and restoring the same to their original finish.

III. Minor building works necessary for installation of equipments, foundation trench for fuel line & cable, making of opening in walls or in floors and restoring them to their original condition/ finish and necessary grouting etc. as required.

IV. All supports for exhaust & water pipes, chimney, bus trunking (if included in scope of contract), cables, anti-vibration pads etc. as are necessary.

V. All electrical work and neutral earthing, body earthing, required for engine & alternator, main board/ control panels, and control wiring including loop earthing, if specified in Schedule of Work.

VI. All pipes, bus trunking and/ or cable connections.

VII. POL i.e. HSD oil and lub. oil for diesel engine for testing & commissioning for 12 hours i/c 1hr of 10% overloading at OEA/ OEM works shall be arranged by the contractor. POL i.e. HSD oil and lub. oil for trial run of 4 Hrs. at site at available load shall be arranged by the department.

VIII. Painting of all expcsed metal surfaces of equipments and components with appropriate colour.

IX. Clearance/ Approval of the complete installation from CPCB/ State Pollution Control Board, Central Electricity Authority (CEA)/ Local Bodies and other licensing authorities, wherever required.

1.6 RATES

I. The rates quoted by the tenderer, shall be firm and inclusive of all taxes (including works contract tax), duties and levies and all charges for packing, forwarding, insurance, freight and delivery, installation, testing, commissioning etc. at site including temporary constructional storage, risks, overhead charges, general liabilities/ obligations etc. but exclusive of Service Tax, which shall be reimbursed on production of documentary proof of actual payment against this contract/ work.

II. Octroi exemption certificate will be issued by the department if required by the contractor. However, the department is not liable to reimburse the octroi duty in case exemption certificates are not honoured by the concerned authorities.

III. The contractor has to carry out routine and preventive maintenance as per manufacturer's standards for a period of 12 months from the date of handing over. However, all consumables (fuel/ lube oil etc.) including filters will be supplied by the department.

1.7 POWER SUPPLY AND WATER SUPPLY

Power Supply

I. Unless otherwise specified, 3 phase, 415 volts, 50 Hz power supply shall be provided by the department free of charge to the contractor at one point for installation at site suitable for 10 KW load. Termination switchgear however, shall be provided by the contractor. Further extension if required shall be done by the contractor.

II. The contractor shall not use the power supply for any other purpose than that for which it is intended for. No major fabrication work shall be done at site. Power shall be used only for welding/ cutting works. The power supply shall be disconnected in case of such default and the contractor shall then have to arrange the required power supply at his cost.

Water Supply

Water supply shall be made available to the contractor by the Department free of charge at one point.

1.8 MACHINERY FOR ERECTION

All tools and tackles required for unloading / handling of equipments and materials at site, their assembly, erection, testing and commissioning shall be the responsibility of the contractor.

1.9 COMPLETENESS OF THE TENDER, SUBMISSION OF PROGRAMME, APPROVAL OF DRAWINGS AND COMMENCEMENT OF WORK

I. Completeness of the tender

All sundry equipments, fittings, assemblies, accessories, hardware items, foundation bolts, supports, termination lugs for electrical connections, cable glands, junction boxes and all other sundry items for proper assembly and installation of the various equipments and components of the work shall be deemed to have been included in the tender, irrespective of the fact that whether such items are specifically mentioned in tender documents or not.

II. Submission of programme

Within fifteen days from the date of receipt of the letter of acceptance, the successful tenderer shall submit his programme for submission of drawings, supply of equipment, installation, testing, commissioning and handing over of the installation to the Engineer-in-Charge. This programme shall be framed keeping in view the building progress.

III. Submission of Drawings

The contractor shall submit the drawings to the Engineer-in-Charge as per clause 1.19 of this specification for approval before start of work.

IV.Commencement of Work

The contractor shall commence work as soon as the drawings submitted by him are approved. The drawings are to be submitted by the contractor within 15 days of stipulated date of start, and shall be approved by the Engineer-in-Charge within 10 days of receipt in his office.

1.10 DISPATCH OF MATERIALS TO SITE AND THEIR SAFE CUSTODY

The contractor shall dispatch materials to site in consultation with the Engineer-in-Charge. Suitable lockable storage accommodation shall be made available free of charge temporarily. Watch & ward however, shall be the responsibility of contractor.

Programme of dispatch of material shall be framed keeping in view the building progress. Safe custody of all equipment/ items supplied by the contractor shall be the responsibility of the contractor till final taking over by the department.

1.11 CO-ORDINATION WITH OTHER AGENCIES

The contractor shall co-ordinate with all other agencies involved in the work so that the work of other agencies is not hampered due to delay in his work.

1.12 INDEMNITY

The successful tenderer shall at all times indemnify the department, consequent on this works contract. The successful tenderer shall be liable, in accordance with the Indian Law and Regulations for any accident occurring due to any cause and the contractor shall be responsible for any accident or damage incurred or claims arising there from on the department during the period of erection, construction and putting into operation the equipments and ancillary equipment under the supervision of the successful tenderer in so far as the latter is responsible. The successful tenderer shall also provide all insurance including third party insurance as may be necessary to cover the risk. No extra payment would be made to the successful tenderer on account of the above.

1.13 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. The entire installation shall be such as to cause minimum transmission of noise and vibration to the building structure.

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.

1.14 CARE OF THE BUILDING

Care shall be taken by the contractor during execution of the work to avoid damage to the building. He shall be responsible for repairing all such damages and restoring the same to the original finish at his cost. He shall also remove all unwanted and waste materials arising out of the installation from the site of work from time to time.

1.15 INSPECTION AND TESTING

I. The successful tenderer will arrange staff/fuel/POL for test run at his cost.

Inspection and Testing of DG sets of capacity more than 200 KVA

I. For DG sets of capacity more than 200 KVA, testing shall necessarily be carried out at factory/ manufacturer premises in presence of representative of the Department.

II. For testing, following procedure will be followed: All major items/ equipments i.e. engine & alternator in assembled condition, associated electrical control panels etc. shall be offered for inspection and testing

at factory/ manufacturers works. The successful tenderer shall give a notice of minimum two weeks for carrying out such tests. The Engineer-in-charge/ or his authorized representative shall witness such inspection & testing at mutually agreed date. The cost of the representative's visit to the factory will be borne by the Department.

III. The department also reserves the right to inspect the fabrication job at factory and the successful tenderer has to make arrangements for the same.

IV. DG set will be tested on load of unity power factor for the rated KW rating. During testing, each of the D.G. sets covered under scope of work, shall be operated for a period of 12 hours on the rated KW at DG set's KW rating including one hour on 10% overload after continuous run of the 12 Hours. During testing all controls/ operations safeties will be checked and proper record will be maintained. Any defect/ abnormality noticed during testing shall be rectified. The testing will be declared successful only when no abnormality/ failure is noticed during the testing. The DG set will be cleared for dispatch to site only when the testing is declared successful by authorised representative/ Engineer-in-Charge.

Inspection and Testing of DG sets of capacity equal to or less than 200 KVA

I. For DG sets of capacity equal to or less than 200 KVA, testing shall necessarily be carried out at site. However, initial inspection can be done at factory/manufacturer works before dispatch at site of work at the discretion of Engineer-in-Charge as per details given at 1.15.2.2 above. All major items/ equipment i.e. engine & alternator in assembled condition, Electrical control panel etc. shall be offered for initial inspection at factory/ manufacturers works. The cost of the Engineer's visit to the factory will be borne by the Department. After initial inspection, DG Set and associated Electrical panel equipments shall be cleared for dispatch at site.

II. Copies of all documents of routine and type test certificates of the equipment, carried out at the manufacturers premises shall be furnished to the Engineer-in-charge and consignee.

III. After completion of the installation work in all respects, the contractor shall offer the DG Sets for testing. Testing shall be carried out exactly as per Clause 1.15.2.4 mentioned above.

IV. The requirement of testing of DG Set at manufacturer's premises, in presence of representative of the Department, can be dispensed with/ waived off, keeping in view the exigency of works, with the prior approval of the Chief Engineer. However, test certificates of the particular DG Set on full load, as mentioned in Clause 1.15.2.4 above, shall be submitted at the time of delivery of DG Set at site.

Trial Run/ Running-in-Period

After successful testing of the DG Set, a trial run at available load will be carried out for 120 Hours or 15 Days whichever is earlier. 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 successful tenderer. However, diesel shall be provided by Department. 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 abnormal/ unsatisfactory operation of any component of the entire installation included in the scope of work of the contract, occurs during this period. After this the DG Set 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 department subject to guarantee clause of the contract. This date of taking over of the DG Set, after trouble free operation during the trial run/ running-in period, shall be the date of acceptance/ taking over.

Safety measures

All equipments shall incorporate suitable safety provisions to ensure safety of the operating personnel as per manufacturers' standard practice.

1.16 STATUTORY CLEARANCE(S)

Approval/ clearance of the complete installation shall be obtained by the contractor from CPCB/ State Pollution Control Boards/ Local Bodies/ Central Electricity Authority (CEA)/ other licensing authorities wherever required. However, application shall be made by Department and any statutory fee, as

applicable, shall be paid by Department directly to the govt. authorities concerned.

1.17 GUARANTEE

All equipments shall be guaranteed, against unsatisfactory performance and/ or break down due to defective design, workmanship or material, for a period of 12 months from the date of taking over the installation by the department. The equipments or components, or any part thereof, so found defective during guarantee period shall be forthwith repaired or replaced free of cost, to the satisfaction of the Engineer-in-Charge. In case it is felt by the department that undue delay is being caused by the contractor in attending the defect/ fault removed, the same will be got done by the department at the risk and cost of the contractor. The decision of the Engineer-in-charge in this regard shall be final.

1.18 PAYMENT TERMS

The following percentage of contract rates shall be payable against the stages of work shown herein:

Stage of Work	*Engine-Alternator Set & AMF Panel*	*All other items*
I After initial inspection (wherever specified) & delivery at site in good condition on pro-rata basis	85%	75%
II On completion of pro-rata installation	10 %	20%
III On commissioning and completion of successful running in period & taking over of the DG set by the department.	5 %	5 %

Deduction of Security Deposit shall be governed by standard/ relevant clauses of CPWD-7/8.

1.19 **TENDER DRAWINGS, DRAWINGS FOR APPROVAL & COMPLETION DRAWINGS**

Tender Drawings

The drawings appended with the tender documents are intended to show space allotted for various equipments. The equipments offered shall be suitable for installation in the spaces shown in these 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 equipments/ materials as per agreement, if there is any contradiction between the approved drawings and agreement.

I. Lay out drawings of the equipments to be installed including control cables, fuel/ lube oil pipes and supports/ structure for exhaust piping, Chimney and bus ducts/ cable trays.

II. Drawings including section, showing the details of erection of entire equipments.

III. Electrical wiring diagrams from engine-alternator set to Electrical control panel, Electrical control panel to essential LT board including the sizes and capacities of the various electrical/ control cables and equipment.

IV. Dimensioned drawings of Acoustic enclosure/ Engine-Alternator set and Electrical control panel.

V. Drawings showing details of supports for pipes, chimney cable trays, ducts etc.

VI. Any other drawings relevant to the work.

Drawings/Documents to be furnished on completion of installation

Two sets of the following laminated drawings shall be submitted by the contractor while handing over the installation to the Department. One set shall be laminated on a hard base for display in the DG set room/room where AMF panel is installed and another set shall be displayed in Junior Engineer's room. In addition, drawings will be given on Compact Disc (CD).

I. DG set installation drawings giving complete details of all the equipments, including their foundations.

II. Line diagram and layout of all electrical control/AMF panels giving switchgear ratings and their disposition, cable feeder sizes and their layout.

III. Control wiring drawings with all control components and sequence of operations to explain the operation of control circuits in AMF panel/PCC.

IV.(i) Manufacturer's technical catalogues of all equipments and accessories.

V.(ii) Operation and maintenance manual of all major equipments, detailing all adjustments, operation and maintenance procedure.

1.20 AFTER SALES SERVICES

VI. The contractor shall ensure adequate and prompt after sales service free of cost during guarantee period, and against payment after the guarantee period is over, in the form of maintenance, spares and personnel as and when required during normal life span of the equipments 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 DG Set installation is taken over.

TECHNICAL

2.1 SCOPE

This section deal with unloading procedures, location, standard capacities and climatic conditions for DG set installation.

Unloading

Gensets without Acoustic Enclosure

I. Genset should not be lifted from engine and alternator hooks. These are designed for lifting individual items only. Normally, provision for Genset lifting is provided on base-rails. The Genset should be unloaded from base rail by lifting with proper Genset lifting tackle or nylon sling/steel rope of suitable capacity and crane so as to ensure no damage to oil sump, air cleaner, radiator pipes etc.

II. Genset should be covered with polyethylene or tarpaulin during installation to ensure that water does not enter inside.

III. Spreader bar/ spacer plate of suitable size may be required to avoid damages to Genset components.

IV. DG set with Acoustic enclosures are provided with lifting hooks.

V.

Location

I. DG Sets with Acoustic Enclosure

In case DG sets up to 1000 KVA capacity are required to be supplied with acoustic enclosure as per CPCB norms. DG Set with acoustic enclosure shall preferably be installed outside the building

(including terrace subject to structural feasibility) & location should be finalized in consultation with the Architect. However, DG set should be as near to the substation as possible i.e. as near to Essential LT Panel as possible. Associated AMF panel/ Electrical panel of the DG Set can be located inside the acoustic enclosure or outside the acoustic enclosure as per manufacturer standard. In case, AMF/ Electrical panel has to be installed outside the acoustic enclosure, location of room to house AMF/ Electrical panel should be decided in consultation with the Architect so that it shall be as near to the acoustic enclosure as possible. Specially, in case of connection through bus trunking, care should be taken for aesthetics.

II.DG Sets without Acoustic Enclosure

I. In case of DG Sets beyond 1000 KVA capacity i.e. when DG set is supplied without acoustic enclosure, room of appropriate size should be provided to house the DG Set. The DG set room should be as near to the substation as possible (i.e. as near to Essential LT Panel as possible). While deciding the room layout, typical 2-meters free space around Genset is recommended for proper heat dissipation and ease of service. However, to avoid hot air re-circulation, radiator cooled engines should have maximum possible space in the front. Minimum 1.5 meter free space is must. A typical Genset room is shown in Figure 1.

II. As far as possible, installation of DG Set should be avoided in basement. In cases where installation of D.G. Set in basement is unavoidable, due care of supply of adequate amount of air required for proper operation of D.G. Set shall be taken.

III.Nominal ratings of DG Sets

DG Sets are normally available in following standard capacities:

(Ratings in KVA)

7.5	10	12.5	15	17.5	25	30	35	40	50	62.5
75	82.5	110	125	140	200	225	250	320	350	380
415	450	500	550	600	625	700	750	1010	1250	1500

Capacity output of DG Set should be specified in tender in terms of "Prime Power Rating at 0.85 load factor" as per Clause 13.3.2 of ISO-8528 (Part-1), titled 'Reciprocating internal combustion engine driven alternating current generating sets: Part-1: Application, ratings and performance' (See Appendix 'I'). However, depending upon the particular application & use, 'Continuous' or 'Standby' rating can be specified.

IV.Climatic Conditions

The output of DG Set shall be specified in tender documents under actual site conditions. The tenderer has to certify that the engine & alternator meets the capacity requirement after de-ration as per IS/ BIS.

V.DG Set upto 1000 KVA capacity should be type tested for Noise and Emission norms/standards as per CPCB as per Appendix 'II' and Appendix 'III'.

2.2DIESEL ENGINE

Scope: This section covers engine rating, standard components of a diesel engine including exhaust piping.

I. Diesel Engine

II.Engine Rating

The engine shall be of standard design of the original manufacturers. It should be 4 stroke cycles, water cooled, naturally aspirated/ turbo charged (as per manufacturer standard), diesel engine developing suitable BHP for giving a power rating as per ISO 8528- Part-1 in KVA at the load terminals

of alternator at 1500 rpm at actual site conditions.

The engine shall be capable for delivering specified Prime Power rating at variable loads for PF of 0.8 lag with 10% overload available in excess of specified output for one hour in every 12 hours. The average load factor of the engine over period of 24 hours shall be 0.85 (85%) for prime power output.

The testing procedure shall be as mentioned in para 1.15.

The engine shall conform to IS.10000/ ISO 3046/ BS:649/ BS 5514 amended up to date.

I. Necessary certificate indicating the compliance of the above capacity requirement for the engine model so selected along with compliance of Noise and Emission norms as per latest CPCB guidelines for DG set capacity up to 1000 KVA, should be furnished from the manufacturers along with the technical bid. (Refer Appendix 'II' for noise norms and Appendix 'III' for emission norms). However above 1000 KVA DG set, manufacturers shall furnish certificate that the Engine for the DG set complies with the CPCB Emission norms.

II. The engine shall be fitted with following accessories subject to the design of the manufacturer:

1. Dynamically balanced Fly wheel
2. Necessary flexible coupling and guard for alternator and engine (applicable only for double bearing alternator)
3. Air cleaner (dry/ oil bath type) as per manufacturer standard,
4. A mechanical/ electronic governor to maintain engine speed at all conditions of load. (see Clause 2.2.1.4)

III. Daily fuel service tank of minimum capacity as per Table below, fabricated from M.S. sheet with inlet, outlet connections air vent tap, drain plug and level indicator (gauge) M.S. fuel piping from tank to engine with valves, unions, reducers, flexible hose connection and floor mounting pedestals, twin fuel filters and fuel injectors. The location of the tank shall depend on standard manufacturers design.

Table I : Recommended Minimum Capacity of Daily Fuel Service Tank

S.No.	Capacity of DG set	Minimum Fuel Tank Capacity
(i)	Upto 25 KVA	100 Litres
(ii)	Above 25 to 62.5 KVA	120 Litres
(iii)	Above 62.5 KVA to 125 KVA	226 Litres
(iv)	Above 125 KVA to 200 KVA	285 Litres
(v)	Above 200 KVA to 380 KVA	500 Litres
(vi)	Above 380 KVA to 500 KVA	700 Litres
(vii)	Above 500 KVA to 750 KVA	900 Litres

Dry exhaust manifold with suitable exhaust residential grade silencer to reduce the noise level.

VI. V.Suitable self-starter for 12 V/ 24 V DC.

VII. Battery charging alternator unit and voltage regulator, suitable for starting batteries, battery racks with interconnecting leads and terminals.

VIII. Necessary gear driven oil pump for lubricating oil, priming of engine bearing as well as fuel

systems as per manufacturer recommendations.

IX. Naturally aspirated/ turbo charger (as per manufacturer standard)

X. Lubrication oil cooler

XI. Lubrication oil filters with replaceable elements

XII. Crank case heater as per manufacturer recommendations

XIII. Fuel injection: Engine should have suitable fuel injection system in order to achieve low fuel consumption

XIV. Fuel control solenoid

XV. Fuel pump with engine speed adjustment

XVI. Engine Control Panel: fitted and having digital display for following:

a) Start/stop key switch. (f) Battery charging indication

b) Lube oil pressure indication (g) Low lub. Oil trip indication

c)Water temp. indication (h) High water temp. indication

d) RPM indication (i) Over speed indication.

e) Engine Hours indications

XVII. All moving parts of the engine shall be mechanically guarded in such a manner that a human finger cannot touch any moving part.

XVIII. Radiator/ Heat Exchanger System/ Remote Radiator(delete whichever is not applicable)

XIX. Any other item not included/ specified but is a standard design of the manufacturer

Governor

Mechanical governor of class A2 for up to and including 200 KVA capacity and Electronic governor of class A1 for capacity above 200 KVA, as per ISO 3046/ BS 5514 with actuator shall be provided as per standard design of manufacturer. Governor shall be a self contained unit capable of monitoring speed.

Frequency Variation

The engine speed shall be so maintained that frequency variation at constant load including no load shall remain within a band of 1% of rated frequency.

Fuel System

It shall be fed through engine driven fuel pump. A replaceable element of fuel filter shall be suitably located to permit easy servicing. The daily service tank shall be complete with necessary supports, gauges, connecting pipe work etc. In case of Top Mounted tanks, non return valves are must in fuel supply and return line of specified value. Pipe sealant should be used for sealing for all connections. No Teflon tape to be used. If piping length is more than 10 meters, detail engineering is required in consultation with OEM/ Manufacturers.

Lubricating Oil System

It shall be so designed that when the engine starts after a long shut down lubrication failure does not occur. Necessary priming pump for the lub. oil circuit as per recommendation of manufacturer shall be installed, to keep bearings primed. This pump shall be normally automatically operative on AC/ DC supply available with the set.

Starting System

This shall comprise of necessary set of heavy duty batteries 12V/ 24V DC (as per manufacturer standard), and suitable starter motors, axial type gear to match with the toothed ring on the fly wheel. A timer in the control panel to protect the starter motor from excessively long cranking runs shall be suitably integrated with the engine protection system and shall be included within the scope of the work. Battery capacity shall be suitable for meeting the needs of starting system (as three attempt starting), as well as the requirements of control panel, indications and auxiliaries such as priming pump as applicable etc. The scope shall cover all cabling, terminals, including initial charging etc. The system shall be capable of starting the DG set within 20-30 sec., even in winter condition with an ambient temperature down to 0°C.

Battery Charger

The battery charger shall be suitable to charge required numbers of batteries at 12V/ 24 volts complete with, transformer, rectifier, charge rate selector switch, indicating ammeter & voltmeter etc. Connections between the battery charger & batteries shall be provided with suitable copper leads with lugs etc.

Piping Work

All pipe lines and fittings and accessories requirement inside the room/ enclosure and outside for exhaust piping shall be provided by the contractor. This shall include necessary flexible pieces in the exhaust, fuel, lub. oil and water lines as are necessary in view of the vibration isolation requirement in the installation. Piping of adequate size shall be used for lub. oil of the material as per manufacturer standard. However, only M.S. pipes for the exhaust shall be used. For fuel lines within the acoustic enclosure, PVC braided pipe as per manufacturer recommendations can be used. However, for fuel lines outside the acoustics enclosure only MS pipe be used.

The pipe work shall be inclusive of all fittings and accessories required such as bends, reducers, elbows, flanges, flexible connections, necessary hardware etc. The installation shall cover clamps, supports, hangers etc. as are necessary for completing the work. However, the work shall be sectionalized with flanged connections as are necessary for easy isolation for purposes for maintenance of unit as approved by Engineer-in-charge.

Common Bed Plate

Engine and alternator shall be directly coupled or coupled by means of flexoplate/ flexible coupling as per manufacturer standard design and both units shall be mounted on a common bed plate together with all auxiliaries to ensure perfect alignment of engine and alternator with minimum vibrations. The bed plate shall be suitable for installation on suitable anti-vibration mounting system.

Exhaust System: (wherever applicable)

Exhaust Piping: All M.S. Pipes for exhaust lines shall be conforming to relevant IS. The runs forming part of factory assembly on the engine flexible connections up to exhaust silencer shall be exclusive of exhaust piping item. The work include necessary cladding of exhaust pipe work using 50 mm thick Loosely bound resin (LBR) mattress/ mineral wool/ Rockwool, density not less than 120 kg/m3 and aluminium cladding (0.6 mm thick) for the complete portion. The exhaust pipe work includes necessary supports, foundation etc. to avoid any load & stress on turbo charger / exhaust piping.The exhaust pipe shall be *run along the existing wall of the building duly clamped/*supported on independent structure for which, the design and Drawing for such structure shall be got approved from the Engineer-in-charge.

I. (a) Exhaust system should create minimum back pressure.

II. Number of bends should be kept minimum and smooth bends should be used to minimize back pressure.

III. Pipe sleeve of larger dia. should be used while passing the pipe through concrete wall & gap should be filled with felt lining.

IV. Exhaust piping inside the Acoustic Enclosure/ Genset room should be lagged with asbestos rope along

with aluminium sheet cladding / insulated as per clause 2.2.1.12.1 to avoid heat input to the room.

V. Exhaust flexible shall have it's free length when it is installed. For bigger engines, 2 flexible bellows can be used.

VI. For engines up to 500 KVA, only one bellow is required. However, if exhaust pipe length is more than 7 m then additional bellow/ provision for expansion should be provided.

VII. 'Schedule B' MS pipes and long bend/elbows should be used.

VIII. The exhaust outlet should be in the direction of prevailing winds and should not allow exhaust gases to enter air inlet/ windows etc.

IX. When tail end is horizontal, 45 Degree downward cut should be given at the end of the pipe to avoid rain water entry into exhaust piping.

X. When tail end is vertical, there should be rain trap to avoid rain water entry. If rain cap is used, the distance between exhaust pipe and rain cap should be higher than diameter of pipe. Horizontal run of exhaust piping should slope downwards away from engine to the condensate trap. Silencer should be installed with drain plug at bottom.

Optimum Silencer Location: Location of the silencer in exhaust system has very definite influence on both reduction of noise and back pressure imposed on the system. The preferred silencer locations are given in the Table below, where L is length of the total exhaust system measured from exhaust manifold in meters. Please note that locating the silencer as per optimum silencer location is not mandatory. For high rise buildings, suitable arrangements may have to be provided in consultation with acoustics engineer.

Optimum Location of Silencer (In meters)		
	In-line Engine	'V' Engine
Best	2L/5	(4L – 1.5) / 5
Second best	4L/5	(2L – 4.5) / 5
Worst Location of Silencer	L/5 or 3L/5 or at tail end of Exhaust piping	(3L - 10)/ 5 or at the tail end of Exhaust piping

Exhaust Stack Height: In order to dispose exhaust above building height, minimum exhaust stack height should be as follows:-

For DG set up to 1000 KVA :-

$H = h + 0.2 \times \sqrt{KVA}$

Where H = height of exhaust stack h = height of building

For DG set above 1000 KVA :-

30 m High or 3 m above the building height, which ever is higher.

Care should be taken to ensure that no carbon particles emitted due to exhaust leakage enters and deposits on alternator windings and on open connections.

Support to Exhaust Piping: Exhaust piping should be supported in such manner that load of exhaust piping is not exerted to turbocharger.

Air System

It is preferable to provide vacuum indicator with all engines to indicate choked filter. Maximum air intake restrictions with clean and choked filters should be within prescribed limit as per OEM/

manufacturer recommendation for the particular model of the engine. Gensets should be supplied with medium duty/ heavy duty air cleaners (specify one only). (Heavy duty air cleaner should be used for installations in dusty or polluted surroundings.)

Cooling System

I. System should be designed for ambient temperature of 40 Deg.C.

II. Water softening/ demineralizing plants should be used, if raw water quality is not acceptable.

III. Coolant should be used mixed with additive (in suitable proportion) as per recommendation of OEM /Manufacturer for various engine models.

IV. Radiator fan flow should be free from any obstruction.

V. For radiator cooled DG Set, proper room ventilation should be planned at the time of construction of DG room.

VI. Remote Radiator can be used in case of basement installation where fresh air may not be available. The proper location of remote radiator is very essential for the successful and efficient operation of remote radiator. In this the cooling media is ambient air. So in order to obtain maximum efficiency from remote radiator, it is necessary to get fresh air in its surrounding. The horizontal distance of remote radiator from engine should not exceed 10 Meter.

VII. For the dusty or polluted surroundings (as radiator gets clogged) and/ or bigger capacity Gensets (say 1000 KVA and above), installation of Cooling System with Heat Exchanger system may be used.

VIII. Optional items as under may be included as per site requirement at the discretion of Technical Sanctioning authority:

Cooling System

a) Remote Radiator

b) Jacket Water Heater

c) Crankcase Oil Heater

d) After cooler jacket turbo charger electrical pre heat systems.

Fuel System

e) Fuel Water Separator

f) Auxiliary Fuel Pump

IX. Exhaust System

g) Industrial Grade Muffler

h) Residential Grade Muffler

i) Critical Grade Muffler

j) Super Critical Grade Muffler

Start System

k) Battery Warmer Plate

l) Battery Charger

Automatic Float Equalizing

Trickle

2.3ALTERNATOR

Scope : This section covers technical requirement of the alternator.

I. Synchronous Alternator

Self excited, screen protected, self regulated, brush less alternator, Horizontal foot mounted in Single/Double bearing construction (specify one only) suitable for the following:

Rated PF. : 0.8 (lag)

Rated voltage : 415 volts

Rated frequency : 50 Hz

No. of Phases : 3

Enclosure : SPDP

Degree of protection : IP-23

Ventilation : Self ventilated air cooled

Ambient Temperature : 40° C Maximum

Insulation Class : F/H

Temperature Rise : Within class F/H limits at rated load Voltage Regulation : +/- 1%

Voltage variation : +/- 5%

Overload duration/capacity : 10% for one hour in every 12 hours of continuous use.

Frequency variation : As defined by the Engine Governor (+/- 1%)

Excitation : Self / separately excited (Self excitation upto 750 KVA and separately excited system above 750 KVA)

Type of AVR: Electronic

Type of Bearing and arrangement : Anti-friction bearings with Grease lubrication Lubrication

Standard : IS 4722 & IEC:34 as amended upto date.

II. Alternator should be able to deliver output rating at actual site conditions.

III. The alternator above 500 KVA capacity shall be fitted with suitable Nos. Resistance Temperature Device (RTD) & Bearing Temperature Device (BTD) alongwith space heaters. The terminal of space heaters will be wired to terminal box and the temperature scanner shall be provided in control panel for scaling the winding and bearing temperature.

IV. Excitation

The alternator shall be brushless type and shall be self/ separately excited, self-regulated having static excitation facility. The exciter unit be mounted on the control panel or on the alternator assembly. The rectifier shall be suitable for operation at high ambient temperature at site.

V. Automatic Voltage Regulators (AVR)

In order to maintain output terminal voltage constant within the regulation limits i.e.

+/- 1%, Automatic voltage regulator unit shall be provided as per standard practice of manufacturer.

VI. Fault tripping

In the event of any fault e.g. over voltage/ high bearing temperature/ high winding temperature or an external fault, the AVR shall remove the excitation voltage to the alternator. An emergency trip shall also be provided.

VII. Standards

The alternator shall be in accordance with the following standards as are applicable.

I. IS 4722/ BS 2613 : 1970. The performance of rotating electrical machine.

II. IS 4889/ BS 269 rules for method of declaring efficiency of electrical machine.

VIII. Performance

III. Voltage dip shall not exceed 20% of the rated voltage for any step load or transient load as per ISO 8528 (Part-1). The winding shall not develop hot spots exceeding safe limits due to imbalance of 20% between any two phases from no load to full load.

The generator shall preferably be capable of withstanding a current equal to 1.5 times the rated current for a period of not more than 15 seconds as required vide clause 14.1.1 of IS 4722:1992.

IV. The performance characteristics of the alternator shall be as below:

Efficiency at full load 0.8 P.F. (i) 1. Upto 25 KVA – not less than 82%

2. Above 25 KVA and upto 62.5 KVA –not less than 86%

3. Above 62.5 KVA & upto 250 KVA –not less than 90%

4. Above 250 KVA – not less than 93.5%

b) Total distortion factor Less than 3 %

a) (i) 10% overload One hour in every 12 hrs of continuous use.

- 50% overload 15 seconds.

IX. Terminal Boxes

Terminal boxes shall be suitable for U.G. cables/ Bus Trunking. The terminal box shall be suitable to withstand the mechanical and thermal stresses developed due to any short circuit at the terminals.

X. Earth Terminals

2 Nos. earth terminals on opposite side with vibration proof connections, non-ferrous hardware etc. with galvanized plate and passivated washer of minimum size 12 mm dia. hole shall be provided.

XI. Space Heaters

Alternators of capacity more than 500 KVA shall be provided with suitable space heaters to maintain the winding temperature automatically such that it does not absorb moisture during long idle periods. The heater terminals shall be brought to a separate terminal box suitable for 230 V AC supply and a permanent caution notice shall be displayed.

2.4 MANUAL/ AMF PANEL, BATTERIES AND ELECTRICAL SYSTEM

Scope: This section covers technical and functional requirements of Manual/ AMF Panel, Battery/ Electrical System.

- **Location of Panel**

- **DG Set with Acoustic Enclosure**

Associated AMF panel/ Manual panel of the DG Set can be located inside the acoustic enclosure or outside the acoustic enclosure as per manufacturer's standard. In case, AMF/ Manual panel has to be installed outside the acoustic panel, location of room to house AMF/ Manual panel should be decided in consultation with the Architect as near to the acoustic enclosure as possible. In case of connection through bus trunking, care should be taken for aesthetics vis-à-vis surrounding.

- **DG Set without Acoustic Enclosure**

In case of DG Set is supplied without acoustic enclosure, Manual/AMF electrical control panel should be located inside the sub station building.

- **Type of Control Panel**

Control panel shall be either manual type or AMF type as per the requirement of work to be decided by NIT approving authority.

- **Manual Control Panel**

The control panel shall be fabricated out of 1.6 mm sheet steel, totally enclosed, dust, damp and vermin proof wall mounted/ free standing floor mounted type with IP-53 degree of protection & front operated.

The Standard control panel shall consist the following instruments:

I. Composite meter for digital display of :

- Voltage
- Current
- Power factor (for 15 KVA and above)
- Frequency (for 15 KVA & above)
- Energy Meter (for 15 KVA & above)

II. HRC fuses of suitable rating.

III. One MCB of suitable rating for DG sets up to 45 KVA rating or Switch Disconnector Fuse Unit (SDFU) for higher ratings.

IV. Push button-switch or ON/ OFF Switch for ON and OFF operation

V. Pilot lamps one No. in case of single phase DG sets and 3 numbers in case of three phase DG sets.

VI. Battery charger complete with voltage regulator, Voltmeter and Ammeter for charging the battery from external mains. This will be in addition to the battery charging alternator or dynamo fitted on the engine.

VII. Instrument fuses.

All the components in the control panel shall be properly mounted, duly wired and labeled. Suitable terminals are to be provided for panel incoming and outgoing connections.

AMF Control Panel

I. General Features: The control panel shall be fabricated out of 1.6 mm thick sheet steel, totally enclosed, dust, damp and vermin proof free standing floor mounted type & front operated. It shall be made into sections such that as far as feasible, there is no mixing of control, power, DC & AC functions in the same section and they are sufficiently segregated except where their bunching is

necessary. Hinged doors shall be provided preferably double leaf for access for routine inspection from the rear. There is no objection to have single leaf hinged door in the front, all indication lamps, instruments meter etc. shall be flushed in the front. The degree of protection required will be IP-42 conforming to IS 2147.

II. Terminal Blocks and Wiring: Terminal blocks of robust type and generally not less than 15 Amps capacity, 250/500 V grade for DC upto 100 V and 660/ 1100 volts grade for AC and rest of the junction shall be employed in such a manner so that they are freely accessible for maintenance. All control and small wiring from unit to unit inside the panel shall also be done with not less than 2.5 sqmm copper conductor PVC insulated and 660/ 1100 volts grade. Suitable colour coding can be adopted. Wiring system shall be neatly formed and run preferably, function wise and as far as feasible segregated voltage wise. All ends shall be identified with ferrules at the ends.

III. Labeling: All internal components shall be provided with suitable identification labels suitably engraved. Labels shall be fixed on buttons, indication lamps etc.

IV. Painting: The entire panel shall be given primer coat after proper treatment and powder coating with 7 tanks process before assembly of various items.

V. Equipment requirements: The control cubical shall incorporate into assembly general equipment and systems as under:

- Control system equipments and components such as relays, contactors, timers, etc. both for automatic operation on main failure and as well as for manual operation.
- Equipment and components necessary for testing generating set's healthiness with test mode and with load on mains.
- Necessary instruments and accessories such as voltmeter, power factor meter, KW meter, KWH meter, Ammeter, Frequency meter etc. in one energy analyzer unit with selector switch to obtain the reading of desired parameters.
- Necessary indication lamps, fuses, terminal blocks, push buttons, control switches etc. as required.
- Necessary engine/ generating set shut down devices due to faults /abnormalities.
- Necessary visual audio alarm indication and annunciation facility as specified.
- Necessary battery charger.
- Necessary excitation control and voltage regulating equipment. (Alternatively provided on the Alternator itself).
- Necessary over head bus trunking terminations all internal wiring, connections etc. as required.
- Breakers as specified in the schedule of work.

System Operation: The above mentioned facilities provided shall afford the following operational requirements.

Auto Mode:

- A line voltage monitor shall monitor supply voltage on each phase. When the mains supply voltage fails completely or falls below set value (variable between 80 to 95% of the normal value) on any phase, the monitor module shall initiate start-up of diesel engine. To avoid initiation due to momentary disturbance, a time delay adjustment between 0 to 5 second shall be incorporated in start-up initiation.
- A three attempt starting facility shall be provided 6 seconds ON, 5 seconds OFF, 6 seconds ON, 5 seconds OFF, 6 seconds ON, if at the end of the thirdattempt, the engine does not

start, it shall be locked out of start, a master timer shall be provided for this function. Suitable adjustment timers be incorporated which will make it feasible to vary independently ON-OFF setting periods from 1-10 seconds. If alternator does not build up voltage after the first or second start as may be, further starting attempt will not be made until the starting facility is reset.

- Once the alternator has built up voltage, the alternator circuit breaker shall close connecting the load to the alternator. The load is now supplied by the alternator.

- When the main supply is restored and is healthy as sensed by the line voltage monitor setting, both for under voltage and unbalance, the system shall be monitored by a suitable timer which can be set between 1 minute to 10 minutes for the load to be transferred automatically to main supply.

- The diesel alternator set reverts to standby for next operation as per (a), (b) and (c) above.

Manual Mode:

- In a manual mode, it shall be feasible to start-up the generator set by the operator on pressing the start push button.

- Three attempt starting facility shall be operative for the start-up function.

- Alternator circuit breakers close and trip operations shall also be through operator only by pressing the appropriate button on the panel and closure shall be feasible only after alternator has built up full voltage. If the load is already on 'mains', pressure on 'close' button shall be ineffective.

- Engine shut down, otherwise due to faults, shall be manual by pressing a 'stop' button.

Test Mode:

- When under 'test' mode pressing of 'test' button shall complete the start up sequence simulation and start the engine. The simulation will be that of mains failure. Sequence 2.4.2.2.6.1(a) and (b) shall be completed.

- Engine shall build up voltage but the set shall not take load by closing of alternator circuit breaker. When the load is on the mains, monitoring of performance for voltage/ frequency etc. shall be feasible without supply to load.

- If during test mode, the power supply has failed, the load shall automatically get transferred to alternator.

- Bringing the mode selector to auto position shall shut down the set as per sequence of 2.4.2.2.6.1(d) provided main supply is ON. If the mains supply is not available at that time, the alternator shall take load as in (c) above.

Engine shut down and alternator protection equipment: Following shut down and protection system shall be integrated in the control panel.

a) Engine:

- Low lubricating oil pressure shut down. This shall be inoperative during start up and acceleration period.

- High coolant (water) temp. shut down.

- Engine over speed shut down.

b) Alternator Protection: Following protection arrangement shall be made:

- Over load

- Short circuit

- Earth fault
- Over voltage .

Monitoring and Metering Facilities:

a) Necessary energy analyzer unit for visual monitoring of mains, alternator and load voltage, current, frequency, KWH, power factor, etc.

b) A set of visual monitoring lamp indication for:

- Load on set
- Load on mains
- Set on test (Alternator on operation duty, Alternator on standby duty).
- Set of lamp for engine shut down for over speed, low lub. oil pressure and high coolant water temperature, overload trip of alternator, earth fault trip of alternator, engine lock out and failure to start etc. All these indications shall have an audio and visual alarm. When operator accepts the alarm, the hooter will be silenced and the fault indication will become steady until reset by operating a reset button.

Operating Devices: A set of operation devices shall be incorporated in the front of panel as under:

a) Master Engine Control Switch: This shall cut off in 'OFF' position DC control to the entire panel, thus preventing start-up of engine due to any cause. However, battery charger, lamp test button for testing the healthiness of indication lamps, DC volt mater / ammeter etc. shall be operative. It shall be feasible to lock the switch in OFF position for maintenance and shut down purposes.

b) Operation selector switch OFF/AUTO/MANUAL/TEST position.

c) Energy analyzer unit for display of various electrical parameters like voltage, current, frequency, KW, power factor, etc.

d) A set of push button as specified.

e) Relays, contactors, timers, circuit breakers as required.

f) Necessary battery charger with boost/ trickle selector, DC voltmeter and DC ammeter.

Compatibility with 'Building Management System'(BMS):

PLC compatibility and required nos. of Input/ Output terminals points should be provided in the AMF control panel.

Battery/ Electrical System

- Batteries supplied with Genset are generally dry and uncharged. First charging of uncharged batteries is very important and should be done from authorized battery charging centre. Initial charging should be done for 72-80 hours.
- Batteries should be placed on stands and relatively at cool place.
- Battery capacity and copper cable sizes for various engine capacity are recommended as indicated in the table below. Cable sizes shown are for maximum length of 2 m. If length is more, cable size should be selected in such a way that voltage drop does not exceed 2 V. However capacity as recommended by manufacturer may be taken.

DG Set Capacity	• Battery	• Cable Size (Material	• lectrical

	Capacity (AH)	Copper) Sq. mm	System (Volts)
Above 500 KVA	• 360	• 70	• 24
Above 125 KVA upto 500 KVA	• 180	• 70	• 12
Above 82.5 KVA upto 125 KVA	• 180	• 50	• 12
Above 62.5 KVA upto 82.5 KVA	• 150	• 50	• 12
Above 25 KVA upto 62.5 KVA	• 120	• 50	• 12
Upto 25 KVA	• 88	• 35	• 12

- For AMF applications, a static battery charger working on mains supply is recommended to keep the batteries charged at all times.
- 1.5 sq.mm copper wire should be used for wiring between junction box and Control Panel.

Cabling

I. Power cabling between alternator and control panel and control panel and change over switch to mains should be done with recommended cable sizes.

II. Typical cable sizes for 415 V application are provided in Appendix VI.

III. As far as possible, for DG Set of capacity 750 KVA & above connection between alternator to AMF panel & AMF Panel to Essential panel shall be through bus-trunking. For exposed/ outdoor bus trunking protection requirement should be IP-55.

IV. If LT panel is part of tender of the DG Set jobs of 500 KVA & above, LT Panel specified, should be one of the reputed brands.

V. Overheating due to loose thimbling / undersize cables causes most of electrical failures, hence correct size of cable and thimbles should always be used, if cable is specified.

VI. While terminating cables, avoid any tension on the bolts/ busbars (if cable is specified). While terminating R, Y& B phase notations should be maintained in the alternator and control panel for easy maintenance.

VII. Crimped cables should be connected to alternator and control panel through cable glands, if cable is specified.

VIII. Multi-core copper cables should be used for inter connecting the engine controls with the switchgear and other equipments.

IX. For AMF application, multicore 1.5 sq.mm flexible stranded copper cable for control cabling should be used.

X. It is recommended to support output cables on separate structure on ground so that weight of cables should not fall on alternator/ base rail.

XI. External wirings, when provided for remote voltage / excitation monitoring/ droop CT etc. shall be

screened sheathed type. Maximum length of such wiring shall not exceed 5 meters.

- **Alternator Termination Links**

I. For proper terminations between links and switchgear terminals, the contact area must be adequate. The following situations should also be avoided as they lead to creation of heat sources at the point of termination:

   a) Point contact arising out of improper position of links with switchgear terminals [Figure 2(i)].

   b) Gaps between busbars / links and terminals being remedied by connecting bolt/stud [Figure 2(ii)]. In such cases the bolt will carry the load current. Normally these bolts / studs are made of MS and hence are not designed to carry currents.

II. Adequate clearance between busbars / links at terminals should be maintained (IS 4232 may be referred to for guidelines).

- Figure 2(iii) indicates the quality of different configurations.

III. Improper termination will lead to local heat generation which may lead to failure.

2.5FOUNDATION

Scope: This section covers details of foundations for DG set with or without acoustic enclosures.

Genset with Acoustic Enclosure

a) For DG Sets installed inside the DG Set Room - A PCC foundation (1:2:4, M-20 grade) of approximate depth 150 mm above the finished Genset Room Floor level is required so as to provide leveled surface for placement of the acoustics enclosure. The length and breadth of foundation should be at least 250 mm more on all sides than the size of the enclosure. Genset should be mounted on AVM's inside the enclosure.

b) For DG Sets installed outside in open area - A PCC (1:2:4, M-20 grade) foundation of weight 2.5 times the operating weight of the Genset with enclosure or as recommended by the Genset manufacturer OEM/OEA, whichever is higher, is required to be provided and is included in scope of work for SITC of Genset. 300 mm of this foundation height should be above the ground level. The length and breadth of foundation should be at least 250 mm more on all sides than the size of enclosure. Genset should be mounted on AVM's inside the enclosure.

- Design of the foundation as recommended by the OEM shall be submitted by the contractor before execution of work along with the drawings as mentioned in section 1.19.

Genset without Acoustic Enclosure

I. Genset should not be installed on loose sand or clay.

II. Foundation should be designed considering safe bearing capacity of soil. Vibration isolators (AVMs) should be provided to reduce vibration transmission to the surrounding structure.

III. Depths of PCC (Plain Cement Concrete) for typical soil condition have been shown in the table below. However structural engineer should be consulted to verify the data depending upon soil condition.

-

DG Set Capacity (KVA)	Typical Depth of PCC Foundation (For soil bearing capacity 5000 kg/sqm)
750-2000	600 mm
625	400 mm

•	320-500	•	400 mm
•	200-320	•	400 mm
•	82.5 -200	•	400 mm
•	Upto 82.5	•	200 mm

IV. Foundation level should be checked diagonally as well as across the length for even flatness. The foundation should be within ± 0.5 Degree (angle) of any horizontal plane.

2.6ACOUSTIC ENCLOSURE

Scope : This section covers technical requirements of the acoustic enclosures.

• As per CPCB norms, restriction has been imposed for new DG sets upto 1000 KVA for noise level (see Appendix 'II'). Therefore, in terms of these norms, acoustic enclosure should be type tested at the climatic conditions specified in para 2.1.4 through one of the authorized laboratory.

• **Installation**

I. Acoustic enclosures are supplied with built in Anti Vibration Mountings (AVMs). As such Genset can be installed directly on the leveled surface.

II. Exhaust piping outlet should not be turned towards window / ventilator of home or occupied building. Provision of rain cap should be ensured.

III. The acoustic enclosure placement should be such that there is no restriction in front of air inlet and outlet from canopy.

• **Service Accessibility**

I. Genset / Engine control panel should be visible from outside the enclosure.Routine / periodical check on engine / alternator (filter replacement and tappet setting etc.) should be possible without dismantling acoustic enclosure.

II. For major repairs / overhaul, it may be required to dismantle the acoustic enclosure.

III. Sufficient space should be available around the Genset for inspection and service.

General Design Guidelines

I. To avoid re-circulation of hot air, durable sealing between radiator and canopy is must.

II. Ventilation fans are must for the Gensets cooled by heat-exchanger/cooling tower system.

III. Exhaust piping inside the enclosure must be lagged (except bellow).

IV. Temperature rise inside the enclosure should not be more than 5°C for maximum ambient above 40°C and it should be below 10°C for ambient below 40°C.

V. There should be provision for oil, coolant drain and fill. Fuel tank should have provision for cleaning.

VI. The enclosure should be designed to meet the total air requirement for the D.G. Set at full load at site conditions as recomended by the engine manufacturer.

Specifications for Acoustic Enclosure

I. The acoustic enclosure shall be designed and manufactured confirming to relevant standards suitable for out door installation exposed to weather conditions, and to limit overall noise level to 75 dB (A) at a distance of 1 mtr. from the enclosure as per CPCB norms under free field conditions.

II. The construction should be such that it prevents entry of rain water splashing into the enclosure

and allows free & quick flow of rain water to the ground in the event of heavy rain. The detailed construction shall conform to the details as under:

III. The enclosure shall be fabricated out the CRCA sheet of thickness not less than

IV. 1.6 mm on the outside cover with inside cover having not less than 0.6 mm thick perforated powder coated CRCA sheet.

V. The hinged doors shall be made from not less than 16 SWG (1.6 mm) thick CRCA sheet and will be made air tight with neoprene rubber gasket and heavy duty locks.

VI. All sheet metal parts should be processed through 7-tank process.

VII. The enclosure should be powder coated.

VIII. The enclosure should accommodate the daily service fuel tank of the D.G. Set to make the system compact. There should be provision of fuel gauge, which should show the level of the fuel even when the DG Set is not running. The gauge should be calibrated. The fuel tank should be filled from the out side as in automobiles and should be with a lockable cap.

IX. The batteries should be accommodated in the enclosure in battery rack.

X. The canopy should be provided with high enclosure temperature safety device.

XI. The acoustic lining should be made up of high quality insulation material i.e. rockwool/ glass/ mineral wool/ PU foam of appropriate thickness & density for sound absorption as per standard design of manufacturer's to reduce the sound level as per CPCB norms. The insulation material shall be covered with fine glass fiber cloth and would be supported by perforated M. S. Sheet duly powder coated / GI sheet/ aluminium sheet.

XII. The enclosure shall be provided with suitable size & No. of hinged type doors along the length of the enclosure on each side for easy access inside the acoustic enclosure for inspection, operation and maintenance purpose. Sufficient space will be provided inside the enclosure on all sides of the D.G. set for inspection, easy maintenance & repairs.

XIII. The canopy should be as compact as possible with good aesthetic look.

XIV. The complete enclosure shall be of modular construction.

XV. The forced ventilation shall be as per manufacturer design using either engine radiator fan or additional blower fan(s). If the acoustic enclosure is to be provided with forced ventilation then suitable size of axial flow fan (with motor and auto-start arrangement) and suitable size axial flow exhaust fan to take the hot air from the enclosure complete with necessary motors and auto start arrangement should be provided. The forced ventilation arrangement should be provided with auto stop arrangement to stop after 5 minutes of the stopping of D.G sets.

XVI. The acoustic enclosure should be suitable for cable connection/connection through bus-trunking. Such arrangements on acoustic enclosure should be water proof & dust-proof conforming to IP-65 protection.

XVII. The inside of enclosure should be provided with at least two nos. LED tube light luminaire controlled by a 5A switch for adequate lighting during servicing etc. of the DG Set. The power supply to this luminaire should be from the load side of the AMF Panel so that it can remain energized under all conditions.

TECHNICAL SPECIFICATION FOR 15KWp ROOFTOP SOLAR PV SYSTEM

Design, Engineering, Supply, Installation, Testing, Commissioning and Three-Year Comprehensive Warranty of a 15 kWp Hybrid Grid-Interactive Rooftop Solar Photovoltaic Power Plant with Standalone (Island Mode) Operation Facility for the Proposed Directors' Bungalow.

1. GENERAL

1.1 Scope

This specification covers the design, engineering, manufacture, factory testing, supply, transportation, insurance, unloading, storage, erection, testing, commissioning, synchronisation, demonstration of performance, statutory approvals, training, documentation and comprehensive warranty of a 15 kWp Hybrid Grid-Interactive Rooftop Solar Photovoltaic Power Plant for the proposed Directors' Bungalow at the Indian Institute of Technology Hyderabad.

The Solar PV system shall be supplied on a complete turnkey basis including all equipment, accessories, hardware, software, wiring, cabling, civil works, structural works, interconnections, earthing, lightning protection, monitoring system and all incidental items necessary for successful commissioning of the plant irrespective of whether specifically mentioned in this specification. The successful bidder shall be fully responsible for the complete performance, safety, reliability and statutory compliance of the installed system.

1.2 Objective

The objective of this specification is to procure a high-quality, reliable, energy-efficient and future-ready Solar PV system capable of operating under both grid-connected and standalone (island) modes while maximizing energy generation and ensuring complete electrical safety. The plant shall be designed for continuous operation under the climatic conditions prevailing at IIT Hyderabad with minimum maintenance requirements and maximum operational availability.

The proposed system shall also be compatible with future Battery Energy Storage System (BESS) integration without replacement of the inverter.

1.3 Scope of Supply

The bidder's scope shall include, but not be limited to, supply of the following:

a) Solar PV Modules
b) Hybrid Grid Interactive Inverter
c) Module Mounting Structure
d) DC Combiner Boxes
e) DC Distribution Board
f) AC Distribution Board
g) AC and DC Cables
h) Solar Connectors
i) Earthing System
j) Lightning Protection System
k) Monitoring System
l) Energy Metering Arrangement
m) Communication System
n) Remote Monitoring Portal
o) Protection Devices
p) Junction Boxes
q) Cable Trays
r) Identification Labels
s) Danger Boards
t) Fire Extinguishers
u) All accessories required for complete installation.

No additional payment shall be made for any item required for successful commissioning of the Solar PV Plant.

1.4 Scope of Services

The Contractor shall perform the following works:

- Site survey
- Detailed engineering
- Shadow analysis
- Structural assessment
- Module layout preparation
- String sizing
- Cable sizing
- Protection coordination study
- Preparation of Single Line Diagram
- Earthing layout
- Lightning protection layout
- Equipment installation
- Cable laying
- Testing
- Commissioning
- Grid synchronization
- Demonstration of guaranteed performance
- Training of IIT personnel
- Submission of complete documentation.

1.5 System Configuration

The Solar PV Plant shall consist of the following major components:

- Solar PV Array
- Hybrid Grid Interactive Inverter
- DC Combiner Box
- DC Distribution Board
- AC Distribution Board
- Module Mounting Structure
- Earthing System
- Lightning Protection System
- Data Acquisition System
- Remote Monitoring System
- Utility Grid Interface
- Standalone Essential Load Panel
- Automatic Islanding Controller
- Communication Gateway

1.6 System Operation Philosophy

The plant shall be capable of operating in the following modes.

Mode-1 : Grid Connected Operation

Solar energy generated shall primarily supply the connected building loads. Any surplus energy shall be exported to the IITs power system grid through the bidirectional energy meter in accordance with existing net metering guidelines.

Mode-2 : Island Mode
Upon failure of utility supply, the inverter shall automatically disconnect from the utility grid. The inverter shall continue supplying designated essential loads from available solar generation. No electrical back-feed into the utility grid shall be permitted.

Mode-3 : Future Battery Mode
The inverter shall be capable of integrating Battery Energy Storage Systems without replacement of the inverter. Battery charging shall have configurable priorities including:

- Solar Priority
- Grid Priority
- Time-of-Day Charging
- Peak Shaving
- Backup Reserve Mode

1.7 Design Life
The complete Solar PV Plant shall be designed for a minimum operational life of 25 years. The Module Mounting Structure shall also have a design life of 25 years without significant corrosion or deterioration. Electronic equipment shall have a minimum expected service life of 10 years.

1.8 Climatic Conditions
The system shall be suitable for continuous outdoor operation under the climatic conditions prevailing at IIT Hyderabad.
The design shall consider:

- Ambient temperature: 0°C to 55°C
- Relative humidity: 10–95%
- Altitude: 529 m above MSL
- Wind velocity: 180 km/h (Max)
- Solar irradiation: Approximately 5.5–6.0 kWh/m²/day
- Dusty environment
- Heavy rainfall
- High UV radiation

All equipment shall be suitable for tropical climatic conditions.

2. APPLICABLE CODES AND STANDARDS
The complete Solar PV Plant shall comply with the latest editions of the following standards.
Indian Standards

- IS 14286
- IS/IEC 61215
- IS/IEC 61730
- IS 3043
- IS 2062
- IS 4759
- IS 7098
- IS 1554
- IS 694
- National Electrical Code of India

International Standards

- IEC 61730

- IEC 61701
- IEC 62804
- IEC 62109
- IEC 62116
- IEC 61683
- IEC 61727
- IEC 61000
- IEC 60364
- IEC 62305
- IEEE 519
- IEEE 1547

Regulatory Requirements
The installation shall comply with:

- MNRE Guidelines
- CEA (Technical Standards for Connectivity of Distributed Generation Resources)
- CEA Safety Regulations
- CEIG Telangana
- TGERC Net Metering Regulations
- National Building Code of India

In case of conflict, the latest applicable Indian statutory regulations shall prevail.

3. DESIGN BASIS

The Solar PV Plant shall be designed based on the following criteria:

Parameter	Requirement
Plant Capacity	15 kWp (DC)
System Voltage	415 V, 3 Phase, 50 Hz
System Type	Hybrid Grid-Interactive
Standalone Operation	Mandatory
Future Battery Integration	Mandatory
Minimum Performance Ratio	≥ 80%
Annual Availability	≥ 99%
Grid Synchronisation	Automatic
Anti-Islanding	Mandatory
Reactive Power Support	Mandatory
Remote Monitoring	Mandatory
Communication	Modbus TCP / RS485 / Ethernet
Design Life	25 Years

The Contractor shall optimise the complete system to achieve the maximum annual energy yield while ensuring compliance with all safety and statutory requirements.

4. SOLAR PHOTOVOLTAIC (SPV) MODULES

4.1 General

The Solar Photovoltaic (SPV) modules shall be of the latest commercially proven **N-Type TOPCon Mono Crystalline** technology and shall be manufactured by an ALMM-approved manufacturer (Approved List of Models and Manufacturers by MNRE). Modules shall be designed for continuous outdoor operation under tropical climatic conditions and shall exhibit high conversion efficiency, low degradation, and excellent thermal performance. Only new, unused and factory-tested modules shall be supplied. Refurbished, repaired or previously installed modules shall not be accepted. The Contractor shall submit manufacturer's catalogues, factory test certificates and IEC/BIS compliance certificates for

approval prior to procurement.

4.2 Technical Requirements

Parameter	Requirement
Technology	N-Type TOPCon Mono Crystalline
Cell Type	Half Cut Cells
Module Rating	580–620 Wp
Module Efficiency	Minimum 22%
Maximum System Voltage	1500 V DC
Power Tolerance	0 to +5 W
Junction Box	IP68
Connectors	MC4 Compatible
Frame	Anodised Aluminium
Front Glass	3.2 mm Tempered Low-Iron Glass
Wind Load	Minimum 5400 Pa
Snow Load	Minimum 2400 Pa
Fire Rating	Class C or Better

4.3 Electrical Characteristics

The Contractor shall ensure that all supplied modules of identical rating have closely matched electrical characteristics. Variation in Maximum Power Current (Imp) among modules connected to the same MPPT shall not exceed ±1%. Variation in Maximum Power Voltage (Vmp) shall not exceed ±2%. All modules shall be flash-tested at the factory, and individual flash test reports shall be submitted.

4.4 Environmental Performance

The modules shall comply with:

- IEC 61215
- IEC 61730
- IEC 61701 (Salt Mist)
- IEC 62716 (Ammonia induced corossion)
- IEC 62804 (PID Resistance)

The modules shall be resistant to:

- High humidity
- Dust
- UV radiation
- Thermal cycling
- Mechanical impact
- Hot spots
- Potential Induced Degradation (PID)

4.5 Identification

Each module shall have a permanently laminated identification label indicating:

- Manufacturer
- Model Number
- Serial Number
- Rated Power
- Voltage

- Current
- Year of Manufacture
- Country of Origin
- IEC Certification

4.6 Warranty

Minimum warranty requirements shall be:
Product Warranty : **25 Years**
Performance Warranty:

- 98% after Year-1
- Maximum degradation 0.40% per year thereafter
- Minimum 87.4% output after 30 years

The Contractor shall submit original warranty certificates during handover.

5. HYBRID GRID-INTERACTIVE SOLAR INVERTER

5.1 General

The inverter shall be a three-phase Hybrid Grid Interactive String Inverter capable of operating under Grid Connected, Standalone (Island), and Future Battery Integrated modes. The inverter shall comply with IEC 62109, IEC 62116, IEEE 1547 and applicable CEA regulations. Transformer-less topology shall be preferred.

5.2 Technical Requirements

Parameter	Requirement
Type	Hybrid String Inverter
Rated Output	15 kW AC
Number of MPPT	Minimum 3
MPPT Efficiency	≥99.5%
Maximum Efficiency	≥98.5%
Output Voltage	415 V ±10%
Frequency	50 Hz
Protection Degree	IP65
Cooling	Intelligent Natural/Forced Cooling
THD	<3%
Power Factor	Adjustable ±0.8
Reactive Power Control	Mandatory

5.3 Functional Requirements

The inverter shall support:

- Maximum Power Point Tracking
- Automatic Grid Synchronization
- Automatic Restart
- Soft Start
- Black Start
- Event Logging
- Fault Recording
- Password Protection
- Remote Firmware Upgrade

- Data Logging
- Zero Export Control
- Reactive Power Compensation
- Volt-VAR Control
- Volt-Watt Control
- Frequency-Watt Control

5.4 Standalone Operation

The inverter shall automatically detect grid failure and disconnect from the utility grid. The inverter shall continue supplying designated essential loads without interruption using available solar energy. No electrical back-feed to the utility grid shall be permitted.

The inverter shall automatically synchronize with the utility before reconnection.

5.5 Battery Readiness

Although battery installation is not included in the present scope, the inverter shall be inherently compatible with future Battery Energy Storage Systems (BESS). The Contractor shall ensure that future battery addition does not require replacement of the inverter.

5.6 Communication

The inverter shall support:

- RS-485
- Ethernet
- Wi-Fi
- Modbus TCP/IP
- Remote Web Portal
- Mobile Application

Provision shall be available for integration with IITH Campus Energy Management System.

5.7 Display Parameters

The inverter display shall indicate:

- DC Voltage
- DC Current
- AC Voltage
- AC Current
- Active Power
- Reactive Power
- Apparent Power
- Frequency
- Daily Energy
- Monthly Energy
- Total Energy
- Fault Codes
- Operating Mode

6. MODULE MOUNTING STRUCTURE (MMS)

6.1 General

The MMS shall be designed considering:

- Dead load of PV modules and supporting members.

- Wind uplift, suction and overturning forces.
- Live load due to maintenance personnel.
- Thermal expansion and contraction.
- Seismic forces applicable to the project location.
- Corrosion due to atmospheric exposure.
- Roof waterproofing requirements.
- Ease of maintenance and future module replacement.

The design shall ensure uniform distribution of loads on the roof slab without causing overstressing of the structural members.

The design shall comply with:

- IS 2062
- IS 875
- IS 800
- IS 4759

The Contractor shall submit detailed structural calculations certified by a Chartered Structural Engineer.

6.2 Material

The Module Mounting Structure shall be fabricated from Hot Dip Galvanised Steel (preferred) or Aluminium Alloy AA6063-T6. The minimum galvanization thickness shall be **80 microns** after fabrication. No red oxide primer shall be permitted.

6.3 Wind Design

The structure shall be designed for:

Maximum Wind Speed : **180 km/h**

Minimum Factor of Safety : **1.5**

No permanent deformation shall occur under design wind loading.

6.4 Fasteners

All nuts, bolts and washers shall be of Stainless Steel SS304. Spring washers shall be provided wherever necessary. No galvanised fasteners shall be permitted for module fixing.

6.5 Roof Installation

The structure shall:

- Maintain roof waterproofing.
- Avoid water stagnation.
- Allow thermal expansion.
- Permit easy replacement of modules.
- Permit cleaning from front and rear.
- Maintain minimum clearance of 300 mm from roof level.

6.6 Module Orientation

Modules shall be installed facing True South unless site conditions dictate otherwise.

Tilt angle shall be optimized using simulation software considering:

- Latitude
- Annual irradiation
- Mutual shading
- Roof constraints

6.7 Structural Analysis

Prior to installation, the Contractor shall submit:

- Roof Load Analysis
- Wind Load Calculation
- Foundation Details
- Structural Stability Certificate

The Contractor shall ensure that the existing roof is not overstressed.

6.8 Corrosion Protection

All fabricated members shall be:

- Degreased
- Pickled
- Hot Dip Galvanised
- Passivated

Cut edges shall be treated with zinc-rich paint.

6.9 Acceptance Criteria

The Module Mounting Structure shall satisfy the following:

- No visible corrosion.
- No sharp edges.
- No deformation.
- Proper drainage.
- Easy accessibility.
- Minimum maintenance.
- Design life of **25 years.**

6.10 Cable Management

Provision shall be made for proper cable routing using:

- Aluminium/GI cable trays.
- UV-resistant cable clips.
- Stainless steel clamps.

Cables shall not rest directly on the roof or on module frames.

6.11 Earthing Continuity

The complete mounting structure shall be electrically bonded. Suitable earthing lugs shall be provided at designated locations to ensure continuity throughout the array.

DC CABLING SYSTEM

7.1 General

The DC cabling system shall interconnect the Solar PV modules, String Combiner Boxes (SCBs), DC Distribution Board (DCDB) and Hybrid Grid Interactive Inverter. The complete DC wiring shall be designed to minimize voltage drop, maximize energy transfer and ensure long-term reliability under outdoor environmental conditions. Only dedicated photovoltaic solar cables shall be used. Under no circumstances shall ordinary PVC building wires be used on the DC side. The Contractor shall prepare complete cable sizing calculations considering current carrying capacity, ambient temperature, grouping factor and voltage drop.

7.1 Technical Requirements

Parameter	Requirement
Conductor	Annealed Tinned Copper
Insulation	XLPO / XLPE
Voltage Rating	1.5 kV DC
Temperature Rating	–40°C to +120°C
UV Resistance	Mandatory
Flame Retardant	Mandatory
Halogen Free	Preferred
Compliance	IEC 62930 / EN 50618

The minimum conductor size shall be **4 sq.mm**, however final sizing shall be based on design calculations.

7.3 Cable Installation

The DC cables shall:

- Be routed through UV-resistant HDPE conduits or hot-dip galvanized cable trays.
- Be neatly clamped at intervals not exceeding 500 mm.
- Avoid sharp bends.
- Avoid water accumulation.
- Be protected against rodents and mechanical damage.
- Maintain minimum bending radius as recommended by the manufacturer.

Positive and negative cables shall be routed together to minimize induced magnetic fields.

7.4 Voltage Drop

Maximum permissible voltage drop shall be:
PV Module to String Combiner Box : **≤1%**
String Combiner Box to Inverter : **≤1%**
Total DC voltage drop : **≤2%**

7.5 Cable Identification

All cables shall carry permanent ferrules indicating:

- String Number
- Cable Number
- From
- To
- Voltage Level

Cable markers shall be UV stabilized.

8. AC CABLING SYSTEM

8.1 General

The AC cabling system shall connect the inverter output to the AC Distribution Board (ACDB), Main LT Distribution Board and utility interconnection point. The complete AC wiring shall comply with IS 7098, IS 1554 and CEA Safety Regulations.

8.2 Technical Requirements

Parameter	Requirement
Conductor	Copper
Insulation	XLPE
Armour	As Required
Voltage Grade	1.1 kV
Temperature	90°C
Compliance	IS 7098

Minimum conductor size shall be determined by design calculations.

8.3 Installation Requirements

AC cables shall:

- Be installed in GI cable trays.
- Be mechanically protected.
- Be adequately supported.
- Be identified by ferrules.
- Be terminated using compression lugs.
- Have colour coding in accordance with IS standards.

8.4 Voltage Drop

Maximum permissible voltage drop:
Inverter to ACDB : ≤1%
ACDB to Main LT Panel : **≤1%**
Total AC voltage drop : **≤2%**

9. DC DISTRIBUTION BOARD (DCDB)

9.1 General

Each inverter shall be provided with a dedicated DC Distribution Board.
The enclosure shall be:

- IP65
- Powder coated
- Outdoor type
- Lockable
- UV resistant

9.2 Minimum Components

The DCDB shall comprise:

- Incoming Terminals
- String Fuses
- DC Isolator
- Type II DC Surge Protection Device
- Busbars
- Terminal Blocks
- Cable Glands
- Danger Labels

9.3 Protection

The DCDB shall provide:

- Reverse Polarity Protection
- Overcurrent Protection
- Surge Protection
- Isolation Facility

10. AC DISTRIBUTION BOARD (ACDB)

10.1 General

A dedicated ACDB shall be installed adjacent to the inverter.

The ACDB shall comply with:

- IEC 61439
- IS 8623

10.2 Minimum Components

The ACDB shall include:

- MCCB
- MCB
- RCCB/ELCB
- Type II SPD
- Selector Switch
- Indicating Lamps
- Multifunction Meter
- Bidirectional energy meter
- Neutral Link
- Earth Bus

11. POWER EVACUATION

The Contractor shall design the power evacuation system from the inverter output to the existing LT Main Distribution Board.

The Contractor shall verify:

- Existing LT Panel Rating
- Short Circuit Level
- Cable Capacity
- Protection Coordination

Power evacuation shall not adversely affect the existing electrical installation.

12. DATA ACQUISITION SYSTEM (DAS)

The complete Solar PV Plant shall be provided with an intelligent Data Acquisition System. The DAS shall continuously record:

- Solar Generation
- Irradiance (Provision)
- Module Temperature (Provision)
- Ambient Temperature
- DC Voltage, DC Current
- AC Voltage, AC Current
- Frequency
- Power Factor

- Active Power, Reactive Power, Energy Generation
- Inverter Status
- Alarm Status

Data logging interval shall not exceed **5 minutes**.
Historical data shall be retained for a minimum period of **5 years**.

13. REMOTE MONITORING SYSTEM

The Contractor shall provide a cloud-based remote monitoring system.
The monitoring portal shall support:

- Desktop Browser
- Mobile Application
- Remote Login
- Password Protection
- Event Logging
- Alarm Notification
- Daily Reports
- Monthly Reports
- Annual Reports
- CSV Export
- PDF Reports

Provision shall be available for integration with the IIT Hyderabad Energy Management System (EMS) through **Modbus TCP/IP**.

14. ANTI-ISLANDING PHILOSOPHY

14.1 General

The Solar Photovoltaic Plant shall be equipped with a certified anti-islanding protection scheme to prevent inadvertent energization of the utility distribution network during grid outages.
The anti-islanding protection shall comply with:

- IEC 62116
- IEEE 1547
- IEC 61727
- CEA (Technical Standards for Connectivity of Distributed Generation Resources)
- Applicable Telangana DISCOM Regulations

The Contractor shall submit manufacturer's type test certificates demonstrating compliance with the above standards.

14.2 Functional Requirements

Upon failure of utility supply, the inverter shall:

a) Continuously monitor utility voltage and frequency.
b) Detect abnormal grid conditions.
c) Disconnect from the utility grid within the prescribed clearing time.
d) Prevent export of electrical power into the utility network.
e) Continue supplying designated essential loads through the Standalone Distribution Board (SDB), provided sufficient solar power is available.
f) Automatically reconnect only after:
   - Grid voltage returns within permissible limits.
   - Grid frequency returns within permissible limits.
   - Synchronization criteria are satisfied.
   - Mandatory reconnection delay has elapsed.

14.3 Protection Settings

The following settings shall be configurable:

Parameter	Requirement
Over Voltage	As per CEA/TGERC
Under Voltage	As per CEA/TGERC
Over Frequency	As per CEA/TGERC
Under Frequency	As per CEA/TGERC
Vector Shift	Adjustable
Reconnection Delay	Adjustable
Voltage Recovery Time	Adjustable

The Contractor shall submit the proposed protection settings for approval before commissioning.

15. PROTECTION PHILOSOPHY

15.1 General

The Solar PV Plant shall incorporate a comprehensive protection system to safeguard personnel, equipment and the utility network. Protection shall be coordinated to ensure selective isolation of faulty sections while maintaining continuity of supply to healthy portions of the installation.

15.2 DC Side Protection

The following protections shall be provided:

- String Fuse Protection
- Reverse Polarity Protection
- DC Isolator
- DC Circuit Breaker
- Type II DC Surge Protection Device
- Insulation Monitoring
- DC Leakage Detection
- Ground Fault Detection

15.3 AC Side Protection

The following protections shall be provided:

- MCCB
- MCB
- RCCB/ELCB
- Short Circuit Protection
- Overcurrent Protection
- Earth Fault Protection
- Overload Protection
- Surge Protection

15.4 Grid Protection

The inverter shall incorporate:

- Over Voltage Protection
- Under Voltage Protection
- Over Frequency Protection
- Under Frequency Protection
- Reverse Power Protection
- Anti-Islanding Protection
- Synchronism Check

- Vector Shift Detection
- ROCOF (Rate of Change of Frequency)
- Automatic Reconnection after Grid Restoration

15.5 Equipment Protection

The inverter shall continuously monitor:

- Internal Temperature
- Fan Failure
- DC Bus Voltage
- Heat Sink Temperature
- Communication Failure
- SPD Health Status
- Arc Fault (where supported)

Automatic shutdown shall occur under abnormal operating conditions, with event logging and alarm indication.

16. EARTHING SYSTEM

16.1 General

The complete Solar PV Plant shall be provided with a dedicated earthing system complying with IS 3043 and CEA Safety Regulations. The earthing system shall ensure personnel safety, equipment protection and reliable operation of protective devices.

16.2 Separate Earthing

Independent earthing shall be provided for:

a) PV Module Mounting Structure
b) Inverter Body
c) DC Distribution Board
d) AC Distribution Board
e) Lightning Protection System
f) Monitoring Equipment
g) Communication Equipment

All earthing points shall be interconnected through an equipotential bonding network.

16.3 Earth Electrodes

Earth electrodes shall preferably be:

- Maintenance Free Copper Bonded Electrodes or Copper Plate Earthing

Earth pits shall include:

- Inspection Chamber
- RCC Cover
- Test Link
- Identification Plate

16.4 Earth Resistance

Maximum allowable resistance:

Application	Maximum Resistance
Equipment Earthing	≤1 Ohm
Lightning Earthing	≤2 Ohm
Communication Earthing	≤1 Ohm

Earth resistance shall be measured before commissioning using a calibrated Earth Tester.

16.5 Equipotential Bonding

The following shall be bonded:

- Module Frames
- MMS
- Cable Trays
- Inverter
- ACDB
- DCDB
- Lightning Down Conductors
- Metallic Conduits

Bonding conductors shall be Green PVC insulated copper.

17. LIGHTNING PROTECTION SYSTEM

17.1 General

The Solar PV Plant shall be protected against direct and indirect lightning strikes. The Lightning Protection System shall comply with IEC 62305 and IS 2309.

17.2 Air Terminals

The Contractor shall carry out a Lightning Risk Assessment. Based on the assessment, suitable Air Terminals shall be installed to provide complete protection to:

- PV Array
- Inverter
- Monitoring Equipment

17.3 Down Conductors

Down conductors shall:

- Be Copper or GI Strip
- Follow shortest practical path
- Be mechanically protected
- Avoid sharp bends

18. FIRE SAFETY

The Contractor shall provide fire protection suitable for electrical installations. The following shall be supplied:

- ABC Fire Extinguishers
- CO_2 Fire Extinguishers
- Sand Buckets
- Danger Boards
- Emergency Contact Details
- Emergency Shutdown Procedure

Fire extinguishers shall comply with BIS requirements.

19. DANGER BOARDS & SIGNAGES

The Contractor shall provide permanent engraved signages indicating:

- Solar PV Array
- DC Danger
- AC Danger
- Inverter Room
- Earthing Points

- Lightning Earthing
- Emergency Shutdown Procedure
- Isolation Switches

Labels shall be UV resistant and permanently fixed.

20. QUALITY ASSURANCE

All equipment supplied under this contract shall be:

- Brand New
- Latest Model
- Free from Manufacturing Defects
- Factory Tested
- Type Tested
- Routine Tested

The Contractor shall maintain a documented Quality Assurance Plan covering procurement, manufacturing, installation, testing and commissioning. All measuring instruments used during testing shall possess valid calibration certificates traceable to NABL or equivalent accredited laboratories.

21. TESTING, INSPECTION AND COMMISSIONING

21.1 General

The Contractor shall be responsible for carrying out all inspections, routine tests, type tests, pre-commissioning tests, commissioning tests and performance demonstration of the complete Solar Photovoltaic Plant. All testing instruments shall possess valid calibration certificates traceable to NABL or equivalent accredited laboratories. Testing shall be carried out in the presence of the IITH authorised representative.

The Contractor shall provide all test equipment, manpower, consumables and accessories required for successful testing and commissioning.

21.2 Factory Acceptance Tests (FAT)

The following factory test certificates shall be submitted before dispatch of equipment.

Solar PV Modules

- Flash Test Report for each module
- Electroluminescence (EL) Test
- Insulation Resistance Test
- Wet Leakage Test
- Mechanical Load Test
- Hail Impact Test
- PID Resistance Test
- IEC Compliance Certificates

Hybrid Inverter

- Routine Test Report
- Efficiency Test
- MPPT Efficiency Test
- Harmonic Measurement
- Anti-Islanding Test
- Functional Test
- Communication Test
- Protection Verification
- Type Test Certificates

Module Mounting Structure

- Material Test Certificate
- Galvanization Thickness Report
- Structural Steel Certificate
- Fastener Test Certificate

21.3 Site Acceptance Tests (SAT)

Following tests shall be carried out after installation.

Mechanical Inspection

The Employer shall verify:

- Alignment of module rows
- Tightness of fasteners
- Structural rigidity
- Roof waterproofing
- Accessibility for maintenance
- Cable routing
- Cable tagging
- Warning labels
- Earthing continuity

Electrical Inspection

The following tests shall be performed.

DC Side

- String Polarity Test
- Open Circuit Voltage
- Short Circuit Current
- Insulation Resistance
- Continuity Test

AC Side

- Phase Sequence
- Voltage Measurement
- Frequency Measurement
- Current Measurement
- Earthing Continuity
- MCCB Operation
- SPD Health Status

21.4 Protection Testing

The Contractor shall demonstrate satisfactory operation of all protection functions.

The following protections shall be individually tested.

- Over Voltage
- Under Voltage
- Over Frequency
- Under Frequency
- Earth Fault
- Reverse Power
- Anti-Islanding

- Reverse Polarity
- DC Isolation
- Surge Protection
- Communication Failure Alarm

Trip values and operating times shall be recorded and submitted.

21.5 Anti-Islanding Demonstration

The Contractor shall demonstrate:

- Automatic disconnection upon grid failure.
- No export of power during island mode.
- Automatic restoration upon grid recovery.
- Synchronization before reconnection.
- Stable operation of essential loads.

IITH reserves the right to repeat the test until satisfactory performance is achieved.

21.6 Standalone Mode Demonstration

The Contractor shall demonstrate uninterrupted operation of designated essential loads during simulated grid outage. The following shall be recorded:

- Transition time
- Voltage variation
- Frequency variation
- Inverter response
- Load stability

22. PERFORMANCE GUARANTEE

The Contractor shall guarantee the satisfactory performance of the complete Solar PV Plant. Failure to achieve guaranteed performance shall constitute a defect under the Contract. Minimum Annual Performance Ratio (PR) shall be **80%** (Performance Ratio shall be calculated in accordance with IEC 61724.

22.1 The Contractor shall submit estimated monthly and annual energy generation based on:

- Meteonorm/PVsyst simulation
- Local meteorological data
- Actual module specifications
- Actual inverter specifications
- Site coordinates
- Roof orientation
- Shadow analysis

22.2 Voltage Quality

The inverter output shall satisfy:

Parameter	Requirement
THD	<3%
Power Factor	Adjustable ±0.8
DC Injection	<0.5%
Frequency	50 Hz ± 3%

23. DOCUMENTATION

23.1 Drawings

The Contractor shall submit three hard copies and one soft copy of the following.

- General Arrangement Drawing
- Single Line Diagram
- Module Layout
- Cable Layout
- Earthing Layout
- Lightning Layout
- AC Schematic
- DC Schematic
- Communication Layout

23.2 Design Calculations

The following calculations shall be submitted.

- String Sizing
- Inverter Sizing
- Cable Sizing
- Voltage Drop
- Short Circuit Level
- Earthing Design
- Lightning Risk Assessment
- Structural Design
- Wind Loading Calculation

23.3 Equipment Documentation

The Contractor shall submit:

- Datasheets
- Catalogues
- Test Certificates
- Warranty Certificates
- Calibration Certificates
- Type Test Reports
- Factory Test Reports

23.4 Operation & Maintenance Manual

The O&M Manual shall include:

- System Description
- Operating Instructions
- Emergency Shutdown Procedure
- Safety Precautions
- Preventive Maintenance Schedule
- Troubleshooting Guide
- Spare Parts List
- Contact Details
- Warranty Information

24. OPERATION & MAINTENANCE

27.1 General

The Contractor shall provide comprehensive Operation and Maintenance services for **five (5) years** from the date of successful commissioning. The scope shall include preventive, predictive and corrective maintenance.

24.2 Preventive Maintenance

Preventive maintenance shall be carried out at least once every quarter.

The activities shall include:

- Cleaning of PV Modules
- Tightening of Electrical Connections
- Thermographic Inspection
- Earthing Verification
- Lightning Protection Inspection
- Inverter Cleaning
- Cable Inspection
- Functional Testing
- Monitoring System Verification

Maintenance records shall be maintained and submitted to the Employer.

24.3 Breakdown Maintenance

The Contractor shall attend complaints within the following response times:

Nature of Fault	Response Time	Restoration Time
Critical Fault	4 Hours	24 Hours
Major Fault	8 Hours	48 Hours
Minor Fault	24 Hours	72 Hours

Where replacement parts are required, temporary arrangements shall be made to restore system operation as early as practicable.

24.4 Spares

The Contractor shall maintain adequate stock of essential spare parts throughout the warranty period. Critical components shall remain available for a minimum period of **10 years** after commissioning.

25. WARRANTY

25.1 General

The complete Solar PV Plant shall carry a comprehensive warranty against defects in design, materials, workmanship and performance. Any defect arising during the warranty period shall be rectified by the Contractor at no additional cost to the Employer.

25.2 Minimum Warranty Requirements

Item	Warranty
Solar PV Modules	25 years
Hybrid Inverter	Minimum 10 Years
Module Mounting Structure	25 Years against corrosion and structural failure
DC/AC Cables	10 Years
Surge Protection Devices	5 Years
Monitoring System	5 Years
Workmanship	5 Years

25.3 Warranty Obligations

The Contractor shall:

- Replace defective equipment with new equipment of equal or better specification.

- Bear all costs related to dismantling, transportation, installation and recommissioning.
- Maintain complete service records.
- Provide periodic health reports of the plant during the warranty period.

ANNEXURE – A

BILL OF QUANTITIES (Indicative)

Sl. No	Description	Unit	Qty
1	N-Type TOPCon Solar PV Modules (580–620 Wp)	Nos.	As Required
2	15 kW Three Phase Hybrid Grid Interactive Inverter	No.	1
3	Hot Dip Galvanized Module Mounting Structure	Lot	1
4	DC Combiner Box (IP65)	No.	As Required
5	DC Distribution Board	No.	1
6	AC Distribution Board	No.	1
7	DC Solar Cable 1.5 kV XLPO	m	As Required
8	AC XLPE Copper Cable	m	As Required
9	MC4 Connectors	Set	As Required
10	GI Cable Tray with Accessories	Lot	1
11	HDPE/PVC Conduits	Lot	1
12	Maintenance Free Earthing Set	Set	Minimum 4
13	Lightning Arrestor with Mast	Set	1
14	Type II DC SPD	No.	1
15	Type II AC SPD	No.	1
16	Energy Meter (Generation)	No.	1
17	Communication Gateway	No.	1
18	Remote Monitoring System	Lot	1
19	Danger Boards & Labels	Lot	1
20	Fire Extinguishers	Set	2
21	Civil Works	Lot	1
22	Testing & Commissioning	Lot	1
23	Training	Lot	1
24	Documentation	Lot	1
25	Five Year Comprehensive Warranty & O&M	Lot	1

The Contractor shall quote on a turnkey basis including all accessories, consumables, hardware, software, civil works, labour, transportation, insurance, statutory approvals and any other items required for successful completion of the work.

ANNEXURE – B

GUARANTEED TECHNICAL PARTICULARS (GTP)

The bidder shall furnish the following information.

A. Solar PV Modules

- Manufacturer
- Country of Origin
- ALMM Registration No.
- Technology
- Cell Type
- Watt Peak

- Module Efficiency
- Open Circuit Voltage
- Short Circuit Current
- Maximum Power Voltage
- Maximum Power Current
- Temperature Coefficient
- Mechanical Load
- Wind Load
- Junction Box Rating
- Connector Type
- Product Warranty
- Performance Warranty

B. Hybrid Inverter
- Manufacturer
- Model
- Rated Capacity
- MPPT Quantity
- Maximum Efficiency
- European Efficiency
- THD
- Power Factor
- Reactive Power Capability
- Battery Compatibility
- Grid Synchronization
- Anti-Islanding
- Communication Ports
- Protection Degree
- Cooling Method
- Operating Temperature
- Warranty

C. Module Mounting Structure
- Material
- Steel Grade
- Galvanization Thickness
- Design Wind Speed
- Design Life
- Structural Certification
- Fastener Material
- Roof Fixing Arrangement

D. DC System
- Cable Make
- Cable Size
- Voltage Rating

- Insulation Type
- Connector Make
- Combiner Box Rating
- Fuse Rating
- DC SPD Rating

E. AC System

- Cable Make
- Cable Size
- MCCB Rating
- ACDB Rating
- SPD Rating
- Meter Accuracy
- Meter Make

F. Earthing

- Number of Earth Pits
- Earth Electrode Type
- Earth Strip Size
- Earth Resistance

G. Monitoring System

- Data Logger
- Communication
- Cloud Monitoring
- Mobile App
- Historical Storage
- Alarm Facility

ANNEXURE – C

VENDOR COMPLIANCE SCHEDULE

The bidder shall indicate compliance against every clause.

Clause	Requirement	Bidder Compliance	Remarks
Solar Modules	Comply	Yes/No	
Hybrid Inverter	Comply	Yes/No	
Standalone Operation	Comply	Yes/No	
Reactive Power Control	Comply	Yes/No	
Battery Ready	Comply	Yes/No	
Anti-Islanding	Comply	Yes/No	
Monitoring	Comply	Yes/No	
Earthing	Comply	Yes/No	
Lightning Protection	Comply	Yes/No	
Testing	Comply	Yes/No	
Warranty	Comply	Yes/No	

Any deviation shall be clearly indicated. Silent compliance shall be treated as full compliance.

ANNEXURE – D

PRE-DISPATCH INSPECTION CHECKLIST

The Employer reserves the right to inspect equipment before dispatch.
The inspection shall include verification of:

- Manufacturer's test certificates
- Material certificates
- Module flash test reports
- EL test reports
- Inverter routine test reports
- Inverter type test reports
- Structural steel certificates
- Galvanization certificates
- Calibration certificates
- Packing quality
- Nameplates
- Warranty certificates

ANNEXURE – E

SITE INSTALLATION CHECKLIST

The following shall be verified before commissioning:

- Module orientation
- Module tilt
- Tightness of fasteners
- Waterproofing
- Cable dressing
- Cable ferrules
- Earthing continuity
- Lightning protection
- SPD installation
- MCCB settings
- Meter installation
- Monitoring system
- Danger boards
- Fire extinguishers
- Cleaning access
- Emergency shutdown

ANNEXURE – F

COMMISSIONING CHECKLIST

The Contractor shall demonstrate:

- Open Circuit Voltage
- Short Circuit Current
- String Polarity
- Insulation Resistance
- Earth Resistance
- Synchronization
- Anti-Islanding
- Standalone Mode

- Power Export
- Reactive Power Operation
- Remote Monitoring
- Alarm Operation
- Communication
- Generation Recording

Commissioning shall be considered complete only after successful demonstration of all operating modes.

ANNEXURE – G

APPROVED MAKES

Equivalent approved makes are acceptable.

Solar Modules

- Waaree
- Tata Power Solar
- Vikram Solar
- Adani Solar
- RenewSys

Hybrid Inverters

- Huawei
- Sungrow
- SMA
- FIMER
- Delta
- Fronius

Switchgear

- ABB
- Siemens
- Schneider Electric
- L&T
- Legrand

Cables

- Polycab
- KEI
- RR Kabel
- Havells
- Finolex

Surge Protection Devices

- Phoenix Contact
- OBO Bettermann
- DEHN
- Citel

Lightning Protection

- OBO
- DEHN
- nVent ERICO

Earthing

- JEF

- Axis
- Earthcon
- Eltech

Monitoring System

- Manufacturer's Integrated Monitoring Platform or equivalent SCADA compatible solution supporting Modbus TCP/IP and IEC 61850 gateway integration.

ANNEXURE – H

ACCEPTANCE CRITERIA

The Solar PV Plant shall be accepted only after:

1. Submission of all statutory approvals and test certificates.
2. Successful completion of Factory Acceptance Tests (FAT) and Site Acceptance Tests (SAT).
3. Verification of anti-islanding and standalone operation.
4. Demonstration of grid synchronization and safe reconnection.
5. Compliance with the Guaranteed Technical Particulars (GTP).
6. Successful operation of the remote monitoring and data acquisition system.
7. Submission of complete documentation, including as-built drawings, O&M manuals, warranty certificates, and training records.
8. Issue of the Final Commissioning Certificate by IITH after satisfactory performance demonstration.

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 , Caldyen, Volstat , HBL
Batton 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, PILCO, Elins, Classic, BEC, Slotco, Stealway
BLDC Ceiling Fan	Usha, Orient, Atomberg, Havells, Crompton
Control Cable (ISI Approved)	Finolex, Havells, Polycab, Lapp India
Copper Conductor PVC Insulated Wires/ Stranded Flexible Wires (FRLS)	Finolex, KEC, Havells, Polycab, Lapp India,RR cabel
Current Transformer (Cast Resin Epoxy Coated)	Automatic Electric, Gilbert & Maxwell, Kappa, Pragati, L&T , Pragat
Cable Management System (Wire Trunking) Raceway	OBO, Legrand, MK, ABB, Elins, Schneider
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/Push Button	L&T, Siemens, Schneider, ABB,L & T, BCH,GE,Teknic
LED Lamp (where ever required)	Cree, Osram, Nichia, Philips, Siemens
Light Fixtures (Internal)	Philips, Wipro, Osram, Havells, Halonix
Light Fixtures (External)	Philips, Wipro, Osram, Havells, Bajaj, K-lite, Halonix
Lighting Control	Lutron, Schneider, Crestron, ABB, Philips
Lightning Protection System	Dehn, OBO, ABB, L&T,Cape,Altech,Furse
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, Step type regulator Accessories with moulded Cover Plate.	Schneider, Legrand(Arteor), Honeywell, Havells, ABB, Gold Medal, Philips Note : Equivalent model of Legrand (Arteor) shall be considered for other Approved makes
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 (Non -TTA)	(Project specific Authorized / Approved OEM Vendors only) – CPRI Approved vendor only
Potential Transformer	Automatic Electric, Gilbert & Maxwell, Kappa, Pragati, L&T , Pragati
Push Buttons	ABB, L&T, Schneider , Rishabh
PVC Conduit (FRLS) & Accessories (ISI Approved)	Precision ,BEC, AKG, Polycab
M S Conduit with heavy duty accessories	BEC, AKG,NIC, Rmcon, VIP,Polycab, Universal
Power cables 1100V grade	Universal, Finolex, Polycab, Havells
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	BCH, Industrial Control, L-Mak , Jainson, Schneider, L&T
FRP/Themoplastic Boxes	Hensel, Splesberg, OBO, Syntex, Hager
Timers	Schneider, Siemens, ABB , Theben, Legrand
UPS	APC, Numeric, Legrand, Socomec,
Elevator (LIFTS)	Kone, Schindler, Mitsubishi, OTIS
Exhaust Fan	Crompton, Khaitan, Havells, Orient , Atomberg
HT/ LT Jointing Kit & Termination Kits	Birla-3M, Raychem, RPG
Anti Vibration Mountings	Gerb, Resistoflex , Dunlop
Motors	ABB , Crompton, Siemens
DG Set with AMF panel	Kirloskar, Cummins, Caterpillar, Greaves Cotton
Solar Photovoltaic System (PV Modules)	Vikram Solar /Waree/Renew Power/ TATA Solar/Sova Solar/Premier Technologies other

	Reputed brands approved by MNRE (With Approval of IITH)
Solar Photovoltaic System (Inverters)	SMA/ABB/Seimens/Watt power/Waree/ other Reputed brands approved by MNRE (With Approval of IITH)
Flexible Coupling	Resistoflex , Kanwal
Residential Silencer	Same as Engine make
Semi Rotary type hand fuel filling pump	Rotodel, Kitty Binks
Hybrid Capacitor Panels	Siemens, ABB, Schneider,EPCOS(TDK) ,P2P , Elins
Master Plan & Parking & Plaza Light Fixtures	Bollard Lighting - Preferred make Wipro, Philips, Osram, Halonix
	Street Lighting - Preferred make Wipro, Philips,Osram, Halonix
	Post Top Lighting - Preferred make Wipro, Philips,Osram, Halonix
Geysers	AO Smith, Racold, Jaguar, Havells
Phenolic laminated sheet	Hylam, Formica, Mylam, Greenlam
Timers/ Contactors/Starters/Relays	L&T,Siemens, Schneider, Legrand, ABB, Hager
kWh Meters (Electronic Digital type)/ Multifunction Meter/ Ammeter/Voltmeter	Schneider ,Neptune, L&T ,AE,SECURE,Elmeasure
Exhaust Fan	Usha, Orient, Atomberg, Havells, Crompton
Polycarbonate Junction Boxes	Hensel, Clipsal, Mennekes, Sintex
Energy Management System	Schneider, ABB, Siemens, L&T, Honeywell
Photo Chromatic Switch	Bajaj, Wipro, Philips, Trilux, Osram
Annunciation Panel	Crompton, Schneider, Kirloskar, ABB, Siemens, L&T
Industrial Switch socket	Schneider, Legrands, Naptune , Balls
Sub Panel Boards/Feeder Pillars	Advance, Adlec, Tricolite, Milestone, SPC, Ambit, EAP, LS Power, Elins
Capacitor	L&T, Siemens, Vishey, Epcos, Ducati, Schneider
Change Over Switch	L & T, ABB, Siemens, Schneider, Socomec
Bus Duct / Rising main (Sandwitch)	Schneider, ABB, Legrand , L&T (Henikwon/C&S/ MEGA Duct)
Bus bar	Jindal, Indalco, Century
PLC	Allen Bradley , Siemens, Schneider , L&T
Chemical Earthing	Vnt Terecplus, Erico, Alltech, Cape, OBO
HDPE/DWC Pipe	Duraline, Rex, AKG, Triputi, CPE ,Supreme
GI Pipes	TATA, JINDAL HISAR,JINDAL (STAR) ,PRAKASH, SURYA, BEC
Rubber Mat	Jyoti, Deep Jyoti, Premier (Only ISI Marked)

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 , Lapp India
F/UTP CAT6A Cabling System – Cables, IC, Patch Panels and other components	COMMSCOPE -SYSTIMAX, BELDEN, PANDUIT-PANNET, R & M
Communication Cables / Signal Cable	COMMSCOPE -SYSTIMAX, BELDEN, FINOLEX, FUSION, POLYMER, R & M
UTP CAT6A Cables (for IBMS System)	COMMSCOPE -SYSTIMAX, BELDEN, PANDUIT-PANNET, R & M
Networking Switches for IBMS System	Cisco, HP-Aruba, 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 controler	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
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

Material/ Equipment	**Approved Make**
'TF' Quality expanded polystyrene	Beardsell/ Styrene/ Toshiba
Air handling Units /treated fresh air units	Zeco/ Edgetech/ VTS/ System air/ Citizen
Air Washer / Scrubber	Zeco/ Edgetech/ System air/ Ravi Aircon/ Citizen
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
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/ Superlon / Aeroflex
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/ Bright flow/ Caryaire/ Tristar/ Cosmos/Trox
GSS Factory Fabricated Ducts/ Duct Flanges	Rolastar/ Zeco/ Ductofab/ Ecoduct/ Dustech
Inline Fans	Kruger/ Green heck/ Air flow/ Caryaire/ Systemair/ Malco
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
PPGL sheets for Ducts	JSW/ Shreya Polymers/ Malur Tube/ HV metal Arc
PPGL Ducts Manufacturer	Corrosion Control equipment/ Sagar Plastic/ Ppi projects/ Citizen
Pressure Gauge	Feibig/ H. Guru/ Emerald
Pressure Relief Dampers	Trox/ Titus/ Systemair
Propeller Fans	Kruger/ Green heck/ Air flow/ Crompton/ Bajaj/ Usha/ Havells
Puff pipe support	Malanpur/ lloyd/ Beardsell
PVC Eliminators	Munterz/ BKB extrusions

PVC Pipes	Finolex/ Prince/ Supreme/ KML Classic / Ashirvad / Astral
Refrigerant Piping	Mandev/ Rajco/ Indigo/ RR Shramik
Rock Wool insulation	Roxul-Rockwool/ Rockwool India/ Lloyd/ Mehta Tubes
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
VRV / VRF and Split units	Toshiba/Daikin/ LG/Hitachi/ Mitsubishi Electric / Bluestar
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
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
Weatherkoat	Pidilite
Propeller Fans	Crompton/ Bajaj/ Usha/ Havells
Note:-All electrical items makes to be considered from electrical list of makes	

Fire fighting system

Material/ Equipment	**Approved Make**
Fire Alarm Valve	HD / Newage / Tyco / Viking
Fire Bridged Inlet Connection	Minimax / Newage / Safex / Shah Bhogilal Jethalal
Fire Extinguishers	Cease Fire / Minimax / Safex
Kitchen Fire Suppression System	UL Listed of approved make

MECHANICAL WORKS

Material/ Equipment	Approved Make
Electro-mechanical Equipment's & Plants	
Pumps	
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
Drinking Water Equipment's	
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
Hot Water Equipment's	
Electric Geyser	A O Smith / Racold / Jaquar
Thermostat	Honeywell / Zoloto / Sant
Temperature Gauges	Honeywell / Zoloto / Sant
Hand drier	Jaquar / Euronics/Kohler/ Dolphy