SECTION -VII

TECHNICAL SPECIFICATIONS

TECHNICAL SPECIFICATIONS FOR ELECTRICAL WORKS

TECHNICAL SPECIFICATION – ELECTRICAL WORKS
CONTENTS

A. SCOPE OF WORK

The scope shall include design, supply, testing at manufacturers works, packing, transportation, shipping, unloading at site, transportation to site, storage, insurance, transportation from stores to erection site, erection, site testing, commissioning, training, demonstration of performance guarantee tests of the power distribution system and handing over to Client including submission of hardcopy and soft copy of all as-built drawings, O&M manuals etc. required for successful operation of entire Fintech tower building.

The major items covered under the power distribution system are as follows:

- Ring Main Grid (RMG)-As per TANGEDCO requirements
- HT Panels
- Transformers
- DG Set and Acoustic treatment for DG room
- LT Electrical Panels
- Bus Duct & Rising main.
- HT&LT Power & Control cables & Terminations
- Cable Trays and cable containment system
- Distribution boards with MCB, RCBO etc
- Internal Point Wiring,
- Modular Switches and Sockets,
- Light fixtures, lighting Management System, Fans installation
- Earthing and Lightning Protection system.
- Roof Top Solar PV System
- UPS and Batterries
- EV Charging Sockets.
- External Road Light Fixtures
- Façade and Landscape light Fixtures
- HSD Fuel Transfer system

Following are the scope of work involved in Electrical and its associated works.

- Incoming power supply from local Electricity Board to RMG & RMG configuration, EB metering arrangements shall be decided by local Statutory Department officials (TANGEDCO) directions.
- HT panels for consumer use at near RMG & near Transformers - Indoor/Outdoor Type based on application.
- 2 Nos. 2500 KVA, Dry type Distribution Transformer with OLTC
- 3 Nos. 2000 KVA, 415 V LT Prime Rated Diesel Generating Set and all its associated works for Room acoustics enclosures. 1No of 20 KL Aboveground High-speed Diesel tank Backup
- MAIN LT & DG Panels with Switchgears shall be of type tested assembly (As per IEC 61439) and Other all LT Panels with Switchgears shall be of

Non type tested assembly (IEC 60349). All main breaker status (ON/OFF/TRIP) and metering shall be interfaced with BMS system.

- LT Sandwich busduct, bus trunking system & rising mains along with end feed unit & tapoff box.
- LDB's, PDB's complete with MCCB & MCB. All external Lighting DBs shall be with timers.
- Earthing system shall be connected existing Structural Earthing system.
- All HT / LT power cable shall be XLPE insulated with FRLS properties. Control cables and wires shall be with PVC insulated ZHFR. Fire survival cables for Fire mode loads
- HT and LT power, Fire survival cables, control cables and Paired cables with required numbers of glands, lugs, termination kits, jointing kits, etc as required for interconnection between various electrical equipments along with cable markers
- Complete cable carrier system - cable trays, supports, brackets, clamps etc as well as GI conduits, floor and wall raceways, Hume pipes and all other installation materials as required for laying of power and control cables. HDPE/Hume pipes encased in concrete to be provided for crossing of cables below roads (If necessary).
- HDGI Ladder type and Perforated cable tray of approved colour shall be used. Raceways & conduits shall be used wherever required. PVC wall race ways shall be used wherever specified.
- High Efficiency LED lighting shall be used for the lighting system. Occupancy sensors / Motion sensors / Lighting Control with the help of DALI shall be used wherever required. All embedded conduits shall be Heavy duty PVC type (HMS) and exposed conduits shall be MS type.
- Yard Lighting for substation, STP & indoor Lighting for Electrical Room & Pump rooms.
- Modular switches and sockets shall be used all sockets shall be universal type with shutters for safety.
- Conventional UPS of the required capacity shall be provided for Emergency lighting & Emergency power loads.
- Earth pits can be conventional or Chemical (Maintenance free) as per the applicational requirements as per local statutory requirements.
- Roof top solar PV system along with all necessary accessories shall be provided.
- EV Charging Sockets as per LEED & Tamil Nadu EV Policy requirements.
- SITC of Complete relay setting, relay coordination, fault analysis, discrimination report and coordination documentation with calculation for the Power Distribution System
- Electrical system related miscellaneous items namely, three phase welding receptacles, rubber mats, danger boards, first aid charts, first aid boxes, insulated hand gloves, shock treatment chart, etc.
- All the required approvals from statutory department and related all the required coordination charges, professional charges, etc. shall be in the

scope.

- Execution of electrical works shall be based on the final shop drawings prepared by contractor and approved by consultant. Its contractor responsibility to check the interferences with other services before issuing the final shop drawing for review of Consultant.
- Electrical system related miscellaneous items namely, three phase welding receptacles, rubber mats, danger boards, first aid charts, first aid boxes, insulated hand gloves, shock treatment chart, etc.
- Civil work for wall opening, minor core cutting in floors, minor chipping works for lighting inside building, cable burial including excavation, back filling, and compression etc as detailed in technical specification. Foundation frames, bolts, bolts of special design, embedment's, anchor fasteners and inserts.
- All equipment shall be suitable for smooth, efficient and trouble-free operation for power supply variations as mentioned herein below. The equipment shall be designed to give efficient and reliable performance even during various extreme atmosphere.
- All services necessary for the erection, testing and commissioning and all instruments/services required for carrying out performance testing of all items of the plant electrics covered under this specification shall be arranged by the BIDDER.
- Type test certificates for electrical equipments like panels, etc. not less than 5 years shall be submitted for consultants' approval. All equipment supplied shall be with valid Type test certificates. If valid type test certificates are not available, vendor has to perform all required type tests and furnish the certificates as per relevant standards. Supporting calculation/documents will not be treated as justification of non-availability of type test certificates.
- Routine test shall be conducted for all equipment (100%) like Transformer, DG, HT/LTpanel, UPS ,DB, cables ,wires etc. during the final inspection.
- Providing and doing MS fabrication work as per the requirements.
- The final model for light fixtures, switches, sockets and industrial receptacles shall be selected based on the mockup approval by client/Consultant. Client/Consultant will select any one model out of the approved make indicated in the tender. Though other models are indicated in the tender, the model/make selected by client/consultant shall be supplied by the contractor without any price implication.
- Vendor to submit the QAP for all equipment. All test shall be conducted as per relevant standard and as per specification. Inspection will be carried out as per approved QAP.

B. STANDARDS

All Electrical works shall be carried out in accordance with following codes and standards.

1. PWD Specifications – As per Local PWD
2. Local By – laws
3. National Building Code of India – 2016.

4. Energy Conservation Building Codes.
5. Relevant codes of National fire Codes.
6. Relevant codes of Bureau of Indian Standards.
7. Institute of Electrical & Electronic Engineers (Design Hand Book).
8. Illuminating Engineering Society of North America (Design Hand Book).
9. NEC – NFPA 70, National Electric Code.
10. NFPA 101, Life safety code.
11. NEC, National Electric Code of India.
12. CEA, Central Electricity Authority regulations 2010.

C. GENERAL

Refer following Detailed Technical specifications for items which are not covered in above mentioned PWD Specifications. This specification is to be read along with SLDs and BOQs. In case of any conflict in specification, BOQ spec/ description will be followed.

D. DETAILED TECHNICAL SPECIFICATION

1. HT PANELS

This specification covers the requirements of metal enclosed switchgear (VCB) rated for 3.6 kV to 12 kV.

CODES AND STANDARDS

The codes and standards mentioned in the various specifications and requirements specified in the enquiry document shall be latest as on the day of award of contract of the works unless otherwise specified. Contractor shall be responsible to inform to the Consultant/ Owner in case of any revisions/re-affirm/amendment in the relevant codes and standards after the date of award of contract within 30 days of the issue of such revision/re-affirm/amendment of the code/ standard. Consultant/ Owner may approve use of the earlier code/ standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed.

MAIN PARAMETERS

The major parameters of the switchgear and other required features are given in data sheet. The BIDDER shall in his offer specifically conform compliance to these data in full. Deviation if any should be specifically brought out in the schedule of Technical Deviation.

FEATURES & DESIGN CRITERIA

The switchgear shall be indoor, metal clad with separate metal enclosed compartments for (a) control, metering and relaying devices (b) circuit breaker/ disconnecting switch (c) busbars (d) voltage transformers and (e) power cable terminations & current transformers. Doors with locking facility shall be provided for all compartments except for busbar compartment.

Adjacent switchgear cubicles shall be provided with inter-panel barrier sheets on

both sides to ensure complete isolation. The bottom of the switchgear shall be fully covered by sheet steel.

Separate removable gland plates shall be provided for power and control cables. The gland plate for the power cables shall be of non-magnetic material for single core cables.

All sheet steel work shall be thoroughly cleaned of rust, scale, oil, grease, dirt and swarf by pickling, emulsion cleaning etc. The sheet steel shall be phosphate and then painted with two coats of zinc rich primer paint. After application of the primer, two coats of finishing synthetic enamel paint oven baked / stoved, shall be applied. Powder coating method for above painting is preferable. For coastal areas, epoxy-based painting shall be provided.

The circuit breaker / disconnecting switch shall be fully draw out type and re-strike free. The circuit breaker / disconnecting switch shall have distinct service and test positions. In the test position the circuit breakers / disconnecting switch shall be capable of being tested for operation without energising the power circuits. Four normally open auxiliary contacts shall be provided for each of the service and test limit position switches.

The test position should preferably be obtained without the need to disconnect normal control connections and use of extension cords for testing.

The switchgear shall fully house the breaker both in the service position as well as in the test position.

The current transformers shall be mounted on the fixed portion of the switchgear and not on the breaker truck. The current transformer shall be placed in the cable chamber in such a way that its secondary terminals can be accessible without dismantling of current transformers & cable terminations.

The voltage transformers shall be draw out type & shall be mounted in such a way that it shall permit easy access, operation and maintenance.

The cable compartment shall house all power cable connections along with associated cable terminations. Wherever CBCT’s are provided for earth fault protection, these shall also be located inside the cable compartment. Inspection window shall be provided to facilitate viewing cable terminations.

Each switchgear cubicle shall be fitted with a label in the front and rear of the cubicle. The rear side label shall be fixed on the non-removable part of the switchgear. Each switchgear cubical shall also be fitted with a rating plate clearly indicating the switchgear details such as designation, ratings, duty, etc. Each of the components such as relay, instrument, switch, fuse, and other devices shall be provided with separate labels.

Notes:

A stands for : Authorised

F stands for : Front

L stands for : Lateral

R stands for : Rear

Base channel frame of the switchgear with hardware shall be considered.

The switchgear shall be used to supply power to HV motors, transformers and other loads for various plants.

The switchgear shall be located in a clean but hot, humid and tropical atmosphere.

For continuous operation at specified ratings, temperature rise of the various switchgear components shall be limited to the permissible values stipulated in the relevant standards and/or this specification.

The Switchgear and components thereof shall be capable of withstanding the mechanical forces and thermal stresses of the short circuit current without any damage or deterioration of material.

Circuit breaker shall not produce any harmful over-voltage during switching off induction motors, unloaded lines and unloaded transformers. If required, surge protective device shall be considered in the scope of supply to limit over-voltage.

Switchgear cubicle shall be so sized as to permit closing of the front access door when the breaker is pulled out to TEST position. The operating height of the switchgear shall be restricted within 750 mm to 1950 mm from floor level.

SAFETY INTERLOCKS AND FEATURES

Withdrawal or engagement of circuit breakers or disconnecting switch shall not be possible unless it is in the open position.

Operation of circuit breaker or disconnecting switch shall not be possible unless it is fully in service position, or in test position or in fully drawn-out position. The interlock shall prevent the closing of the circuit-breaker, switch or contactor in the service position unless any auxiliary circuits associated with the automatic opening of these devices are connected.

Operation of a disconnecting switch shall not be possible unless the associated circuit breaker is open.

Circuit breaker / disconnecting switch cubicles shall be provided with safety shutters operated automatically by the movement of the circuit breaker / disconnecting switch carriage to cover the exposed live parts when the breaker is withdrawn.

Caution name plate with inscription "Caution - Live Terminals" shall be provided at all points where the terminals are likely to remain live and isolation is possible only at remote end, e.g. incoming terminals of main circuit breaker/disconnecting switch.

A draw-out breaker / disconnection switch of given rating shall be prevented from engaging with a stationery element of higher rating.

The Circuit breaker / disconnector carriage shall be earthed before the carriage reaches test position from fully withdrawn position. Further while racking out,

earthing shall get disconnected only after test position. The earthing busbar & the contact shall be designed for full fault current with minimum contact resistance.

Emergency trip push button shall be provided for mechanical tripping of breaker with door closed condition and manual charging of closing spring to cater to emergency condition.

MAIN BUS BARS

Busbars shall be fully insulated with flame retardant heat shrinkable sleeves with removable shrouds for protecting all joints. The busbar phases shall be clearly identified with suitable colour coding at both end of each transport unit. The withstand temperature of sleeves shall be at least 5 deg centigrade more than maximum busbar temperature. The busbar temperatures shall be limited to the values indicated in the data sheet without forced cooling.

Busbars shall be supported on insulators capable of withstanding dynamic stresses due to short circuit.

DISCONNECTION SWITCHES

Unless otherwise specified, disconnect switches shall be 'off-load', draw-out type.

CIRCUIT BREAKERS

The circuit breaker type shall be VCB suitable for the switching duty as applicable to the type of loads being fed from the switchgear & over voltages shall be within limits for the type of loads connected.

Adequate provision shall be made on circuit breakers for motor switching off to limit the over voltage to 2.2 p.u. rated peak line to earth voltage (1.0 microsecond. to crest). Suitable surge arrestors, if necessary shall be provided to restrict the voltage peaks during switching off motor, to 2.2 p.u. of rated peak line to earth voltage.

Mechanical trip and close functions with pad locking facility shall be provided for circuit breaker operations during auxiliary supply failures conditions.

All VCB trucks of same rating shall be interchangeable. Closing coil shall be operable with control supply voltage variation in the range of 85-110% and tripping coil shall be operable in the range of 70-110%.

AUXILIARY CONTACTS

Auxiliary switch mounted on the fixed portion of the breaker and directly operated from the breaker operating mechanism shall be provided and shall have minimum 6 'NO' and 6 'NC' potential free contacts. The contacts shall be rated for 10 amps, 230V/240V A.C. and 1 Amp. (inductive breaking) at 220V D.C. The contacts shall be in addition to those utilised in the breaker control circuit. The above auxiliary switches shall not operate when the breaker is withdrawn to test position and operated. Latched type auxiliary relay shall be used for further

multiplication of breaker auxiliary contacts and shall be used as per scheme requirement. Non-latched type auxiliary relay shall be avoided.

SPRING OPERATED MECHANISM

The operating mechanism shall be complete with motor, opening and closing springs, limit switches for automatic charging and all necessary accessories. Facility for manual charging of the closing spring shall be provided. The operating mechanism shall be trip-free and non-pumping electrically. An anti-pumping relay to achieve electrical anti-pumping feature shall be provided even if the breaker has provision for anti-pumping by mechanical arrangement. At least one O-CO operation shall be possible upon failure of auxiliary power supply.

EARTHING

An earthing bus shall be provided at the bottom and extended throughout the length of the switchgear. It shall be bolted / welded to the frame work of each unit and each breaker/disconnector earthing bus. The earth bus shall be suitable to receive the purchaser's earthing conductor size specified in the data sheet

Busbar and circuit earthing facility shall be provided either through earthing switches or separate earthing trucks. These earthing devices shall be suitably interlocked with the circuit breaker / disconnector to avoid accidental earthing of live parts.

All non-current carrying metal work of the switchgear shall be effectively bonded to the earth bus. Hinged doors shall be earthed through flexible earthing braid.

Positive earthing of the circuit breaker/disconnector frame shall be maintained both in service and test position.

SWITCHGEAR ACCESSORIES AND WIRING

Switchgear shall be supplied completely wired internally up to equipment and terminal blocks and ready for the PURCHASER's external cable connections at the terminal blocks. Inter panel wiring between cubicles of same switchgear shall be provided by the VENDOR.

All auxiliary wiring shall be carried out with 1100 volts grade, single core, stranded copper conductor with PVC insulation. The sizes of wire shall not be less than 2.5 mm2 for CT circuits and 1.5 mm2 for other circuits. Red, Yellow & Blue coloured wires shall be provided up to the last equipment for CT & VT secondary circuit. Black coloured wire shall be provided for neutral. All control wires crossing the hinged door shall be provided with mechanical protection in the form of flexible PVC hose. FRLS cable shall be used for panel wiring.

Ring type tinned copper crimping lugs shall be provided for termination of all wires & insulating sleeves shall be provided on the crimp to prevent exposed live wires.

Tubular printed "Cross dependent end marking" ferrules shall be provided at each termination end. Wires used in circuit breaker tripping circuit shall have red coloured ferrules engraved with letter 'T' at end.

Terminal blocks shall be of stud type, 1100 volt grade, 10 amps. rated complete with insulated barriers. Terminal blocks for CTs and VTs shall be provided with test links and isolating facilities. All terminal blocks shall be shrouded by transparent epoxy sheet.

All spare contacts and terminals of cubicle mounted equipment and devices shall be wired to terminal blocks. Minimum 20% spare terminals shall be provided.

Accuracy class for indicating instruments shall be 1.0 or better. All analog instruments shall be minimum 96 mm square, 2400 scale and taut band for flush mounting with only flanges projecting. Energy meters shall be of accuracy class 1.0 or better. All digital instruments shall also be minimum 96 mm square.

Multifunction meters for measuring current, Voltage, frequency, power factor, MW, MVAR, MWh, MVA, MVAH and MVARh with built-in test and communication facilities shall be provided if specified in data sheet enclosed.

Main protection relays shall be numerical type fully meeting the protection functions specified. Relays shall be suitable for flush mounting with only flanges projecting. Meters and relays shall be communicable type with IEC 61850 compliant.

All protective relays shall be in draw-out cases with built-in test facilities. Necessary test plugs shall be supplied loose and shall be included in the VENDOR's scope of supply. Preferably all auxiliary relays and timers shall be supplied in draw-out cases. Externally operated hand reset fault indicators shall be provided on all relays if not specified separately. Timers shall be of electromagnetic or electronic type only.

Control and instrument switches shall be rotary type provided with escutcheon plates clearly marked to show operating position and suitable for semi flush mounting with only switch front plate and operating handle projecting out. Switches shall be non-lockable type if not specified separately.

Breaker control switches shall be pistol grip black and selector switches shall be oval or knob and black. Breaker control switches shall be 3 position spring return to neutral type. Instrument selector switches shall be of the maintained stay-put type. Contacts of the switches shall be spring assisted and contact faces shall be with rivets of pure silver. The contact ratings shall be adequate to meet the requirements of circuit capacity in which they are used.

Push buttons shall be provided wherever specified. They shall be provided with inscription plates engraved with their functions.

Indicating lamps shall be Cluster LED type. The minimum indications shall include circuit breaker ON / OFF/ TRIP, test & service position, spring charged / discharged, trip circuit healthy & auxiliary supply healthy.

Space heaters of adequate capacity shall be provided inside each panel. They shall be suitable for 230V/240V, 1 ph, 50 Hz supply. They shall be complete with MCB’s and thermostat.

Each switchgear panel shall be provided with 230/240 Volts, 1 phase, 50 Hz, 6

amps. 3 pin receptacle with switch located in a convenient position. LV compartment (control & metering) shall be provided with illumination lamp (LED) with door switch.

Provision shall be made for receiving, distribution and isolating of auxiliary D.C. and A.C. supplies for controls, space heating, etc. MCB's shall be provided for isolation of auxiliary power supplies. The MCB ratings shall be so chosen as to ensure selective clearance of sub-circuit faults.

The D.C. and A.C. auxiliary supply shall be distributed inside the switchgear with necessary isolating arrangements at the point of entry and with sub-circuit MCBs as required. 2x100% DC auxiliary power supplies shall be provided for the switchgear with manual changeover facility. DC failure annunciation shall be on AC auxiliary supply.

INSTRUMENT TRANSFORMERS

The ratings of instrument transformers specified in Data Sheet are estimated ratings. For Protection CT's, the minimum CT burden shall be 10VA with accuracy class of 5P20. For metering CT's, the accuracy class shall be 1.0 & ISF ≤ 5. Further for metering CT's, the actual connected burden shall be between 25 to 100%. CT VA burden & the accuracy class shall be valid for this range. BIDDER shall ensure that the specified ratings are adequate for the relays and meters furnished by him. If specified ratings are not adequate the BIDDER shall offer instrument transformers of required rating.

The CTs shall withstand momentary and short time current ratings of the associated switchgear. CTs & VTs shall be of the cast resin type and completely encapsulated. All CTs shall be window type.

The CTs shall be provided with quick disconnecting type of shorting links at CT secondary terminals.

The core balance CTs shall be suitable for the respective outgoing feeders and shall be suitably supported.

VTs shall be single phase, drawout type. VTs shall be provided with fuses on primary and MCB's on secondary side, except those terminals which are required to be connected to earth. These shall have an isolating link. Fuses on primary side shall have rupturing capacity equal to the switchgear rating. Suitable shutters shall be provided to seal off the HV live terminals when VT's are withdrawn.

One additional open delta winding with damper resistance shall be provided for all VTs.

VACUUM CONTACTOR UNITS

The vacuum contactor unit shall be suitable for the switching duty (AC-3 or AC-4 operation) as applicable to the type of loads being fed from the switchgear & over voltages shall be within limits for the type of loads connected.

The vacuum contactor unit shall be with HV HRC fuse and 3 pole contactors with electromechanically operated mechanism.

It shall have limited short circuit making & breaking capacity and suitable for high switching frequencies (more than 10,000 operating cycles).

It shall have with two different modules.

High voltage section: Vacuum interrupters and main contactor terminals.

Low voltage section: Operating mechanism, electronic module, mechanical closing latching and auxiliary contact block.

It shall be suitable in order to prevent impermissible over voltages when performing switching operations in inductive circuits, the chopping current must be limited to the lowest possible value.

It shall also have separate shunt trip coil.

If the vacuum contactor unit is used for motor feeder, BIDDER shall consider type-2 coordination and provide necessary coordination chart.

CABLE TERMINATION

Necessary number and sizes of double compression cable glands shall be supplied for terminating auxiliary power and control cables. Glands shall be of heavy duty brass castings, machine finished and complete with check nut,washers, neoprene compression ring etc.

Cable lugs for all power and control cable connections shall be supplied. The lugs shall be tinned copper/aluminium depending on cable conductor and of solder less crimping type.

All necessary materials required for terminating the power cables such as tapes, fillers, binding wires, armour clamps, brass glands etc. shall be supplied.

SPARE PARTS

The BIDDER shall furnish a list of recommended spare parts for five years operation along with unit prices.

TESTS AND REPORTS

Type test reports for the switchgear and circuit breakers shall be furnished along with the tender. Type tests shall be carried out free of cost to prove the design if not tested in the previous five years.

The switchgear, circuit breakers and all associated equipment shall be tested in accordance with relevant standards. All routine tests shall be carried out.

Type test and routine test reports shall be submitted for the PURCHASER's approval before the equipment is despatched. Bound copies of test reports shall be furnished along with the switchgear.

All meters and other reference devices used for testing shall have valid

calibration from reputed national laboratories/institutes. Inspection by PURCHASER/ENGINEER will not be carried out unless the VENDOR furnishes calibration certificates at the time of inspection.

Equipment shall not be despatched unless the test certificates are duly approved by the PURCHASER/ENGINEER.

DRAWINGS AND DATA

The following shall be furnished as part of the tender:

General arrangement drawing showing plan, elevation, typical section views, weight & panel line up GA.

Foundation plan showing location of fixing channels, floor openings, flooring requirement etc.

Schematic wiring drawings and Bill of materials for each module.

Technical literature on the breakers offered.

RING MAIN GEAR

SPECIFIC REQUIREMENTS:

The scope of this specification covers the complete design, manufacture, testing at manufacturer's works, inspection at manufacturer's works, supply, packing, forwarding and delivery from place of storage/ manufacturer's works to erection site including transit insurance, supervision of erection, testing & commissioning, performance demonstration at site of one (1) outdoor metal enclosed RMG

Supply of base frames / Steel structural supports for embedment in ground required for 11kV RMG in included in Bidder's scope.

PURCHASER reserves the right to add/delete different types of switchgear cubicles, breakers accessories, if found necessary during detailed engineering. Unit prices quoted by Bidder shall be binding on him for addition/deletion.

One set of spares recommended for three years of trouble-free operation, such as closing & tripping coil sets, gaskets, spring charging motor, bus bar support insulators etc. & critical spares. List of all recommended spares along with unit rates shall be furnished by Bidder along with commercial offer.

RMG shall comply to all requirement indicated in the TANGEDCO regulations in addition to the below specifications.

CODES AND STANDARDS:

The equipment shall fully comply with the requirements of enclosed specifications and the latest editions of codes and standards as specified in data sheet.

Other National Standards will be acceptable only if they are established to be equal to or superior to standard listed above and in data sheet. In all such cases copies of English translation of all standards shall be enclosed with the BID.

In the event of any conflict between the codes and standards referred to in the specification and more stringent shall govern.

CONSTRUCTION

The Outdoor enclosure shall be made up of CRCA of 3 mm thickness or galvanized of minimum 1.6 mm thickness, high tensile steel which must be tropicalised to local weather conditions, grit/sand blasted, thermally sprayed with Zinc alloy, phosphate or should follow the 7 tank pre-treatment process and be subsequently Painted with polyurethane based powder paint. The overall paint layer thickness shall be not less than 80 microns. Bidder shall produce QA plan and controlled document when demanded by Purchaser.

The metal base shall ensure rigidity for easy transportation and installation.

The enclosure should have two access doors one for the operation and relay monitoring and other for the cable access. The doors shall be provided with proper interlocking arrangement for safety of operator.

All doors shall be provided with locking facility or it shall not be possible to open or remove them before doors used for normal operation have been opened. When they are closed, they shall provide the degree of protection specified for the enclosure.

The doors shall open outward at an angle of at least 90 Deg & be equipped with a device able to maintain them in an open position.

Ventilation openings if provided, shall be so arranged or shielded that same degree of protection as specified for enclosure is obtained.

All metallic components shall be earthed to a common earthing point. It shall be terminated by an adequately sized terminal intended for connection to the earth system of the installation, by way of flexible jumpers/strips & Lug arrangement. The continuity of the earth system shall be ensured taking into account the thermal & mechanical stresses caused by the current it may have to carry.

There shall be an arrangement for internal lighting activated by associated switch.

Labels for warning shall be specified in min three languages including English, Hindi and Local Language. All the labels and manufacturer's operating instructions etc. shall be durable & clearly legible. They should be located within operating height of the equipment.

The paints shall be carefully selected to withstand tropical heat and rain. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.

SWITCHGEAR

The circuit breaker type shall be VCB Vacuum Circuit Breakers - Please Refer above HT panel section for VCB and its accessories ,wirings ,Vacuum contactors specifications and same specifications only shall be followed.

LOAD BREAK SWITCH BREAKER WITH INTEGRAL EARTH SWITCH

The Unit shall consist of Manual operated/ Motorized spring assisted, three pole Load Break Switch , with integral fault making / breaking earth switch.

It shall be ensured both the LBS and earth switch shall be naturally interlocked to prevent them being switched 'ON' at the same time & to make the LBS trip when the Earth switch is ON.

The selection of the main/earth switch lever on the panel, which is allowed to move only if the main or earth switches in the off position. Provision for padlocking shall be available for either the main or earth position.

The Load Break Switch shall be maintenance free type.

The position of the power and earthing contacts shall be clearly visible on the front of the switchboard. The Load Break Switch shall have at least 2 positions: Open-disconnected & closed and shall be constructed in such a way that natural interlocks prevent all unauthorized operations. They shall be fully mounted and inspected in the factory.

An operating mechanism can be used to manually close the circuit breaker and charge the mechanism in a single movement. It shall be fitted with a local system for manual tripping by an integrated push button. There will be no automatic re-closing.

The Load Break Switch shall have complete interlocking arrangement at fully inserted and fully drawn out position of the breaker. Withdrawal of circuit breaker shall not be possible unless it is in open position and operation of circuit breaker shall not be possible unless it is fully in service position or is fully drawn out.

Comprehensive interlocking system to prevent any dangerous or inadvertent operation shall be provided.

Provision for intertripping and closing interlock shall be provided between upstream (HT) and downstream (HT) breakers such that, If upstream (HT) breaker trips, downstream (HT) breaker shall also trip and downstream (HT) breaker cannot be closed unless upstream (HT) breaker is closed.

Automatic safety shutters shall cover live parts when the breaker is withdrawn and all other standard safety features shall be provided.

All operating switches shall be accessible without opening the compartment door.

Breaker control switches shall be of pistol grip type and selector switches shall be oval or knob. Breaker control switches shall be 3 position spring returns to neutral.

CURRENT TRANSFORMERS:

Current Transformers are Epoxy Resin cast, dual core dual ratio type and shall comply as per IS 2705. The rating & Class of CT (both metering and protection) should be decided by TANGEDCO directions.

POTENTIAL TRANSFORMERS:

Potential Transformers are Epoxy Resin cast Draw-out type and shall comply as per IS 3516. The rating & Class of PT should be decided by TANGEDCO directions.

PROTECTION RELAYS:

All relays as indicated in ‘11kV Single Line Diagram’ shall be mounted on the RMG.

Main Protection Relays shall be Numerical type with IEC 61850 protocol. Test terminal plug block for testing shall be provided.

Relays are of Flush Mounted Draw-out type pattern fully Comply as per IS 3231.All other Instruments/Switches and Wires & Cables shall comply with the latest IS.

BUSBARS

Electrolytic Grade Copper Busbar shall be used as Main Busbar and interconnections. Busbar shall have uniform cross section throughout the Ring Main Switchgear. Busbar is provided with a heat shrinkable PVC sleeve. Colour coding as per IS shall be made at regular intervals. The maximum current density of the busbars shall be 1.0A per Sq mm.

CT parameters indicated are tentative and subject to finalisation after award of contract. Bidder shall agree to accommodate changes, if any, without any extra price to PURCHASER.

GENERAL REQUIREMENTS

The continuous current ratings of the droppers in each switchgear cubicle shall at least be equal to the corresponding breaker rating. However short time current rating shall be same as the short time current rating of the bus-bars.

All bolted joints in the body of switchgear shall be earthed through flexible jumpers.

Circuit breakers of same ratings shall be completely inter-changeable with one another.

Panel wiring shall be securely supported, neatly installed by lacing and tying, readily accessible and connected to equipment terminals and terminal blocks.

Selector switches shall be of maintained (stay put) type. Ammeter selector switches (if provided) shall have facility such that the ammeters can be repeated at local and remote.

230V AC, 24V DC and other voltages shall be segregated to avoid mix-up of voltages.

The sizes of the cable indicated in ‘11kV Single Line Diagrams’ are tentative. The actual size of the cable will be informed to successful Bidder during detailed engineering.

Split gland plate to be provided.

D.C changeover scheme for control supply to be provided.

All bus bar inside panel shall be fully insulated to withstand normal rated as well as surge voltages and insulating boots shall be used at bus tap off & cable connections.

It shall be entirely the responsibility of the Bidder to ensure that characteristics of CTs, PTs and all other devices offered by him are such as to be suitable for the purpose for which they are intended.

Vendor to share the CIVIL Foundation Drawings.

MAINTENANCE REQUIREMENTS

Vendor shall supply maintenance tools including special tools, if required, for attending to the equipment supplied at no extra cost. As far as practicable, the equipment and accessories shall be so designed that no special tools are necessary for installation and maintenance of the equipment. However, if special tools are required, the Bidder shall supply one complete set for each type of equipment.

Bidder shall include supply of start-up and essential spares.

Vendor shall furnish detailed inter-panel diagrams, terminal connection wiring diagram and detailed component layout drawings to enable PURCHASER to carry out maintenance work.

Vendor shall ensure the use of calibrated test equipment having valid calibration test certificates from standard laboratories traceable to national standard.

COMMISSIONING SERVICES:

The VENDOR shall indicate the man day rates for specialist commissioning engineers and shall arrange for such visits if desired by the Purchaser. The Bidder shall note that the payment will be made on the basis of actual duration of time of personnel for which their service is required at the rates indicated. The man day rates for supervision charges shall be lump sum per day including travelling cost of Vendor's engineer from his office to site, lodging, boarding charges, local travel and incidental expenses, insurance charges etc.

Prices quoted shall include the cost of all routine tests specified in the Datasheet and the specifications. As regards type tests, copies of the earlier test certificates carried out on equipment of similar ratings shall be furnished along with the offer.

The bidder shall schedule his design, manufacture, testing at manufacturer's works, supply, packing, forwarding and delivery from place of storage/ manufacturer's works to erection site including transit insurance as per the schedule mutually agreed by Bidder & GCSC

Detailed General Arrangement and bill of material including detailed catalogue/specifications/datasheets of the equipment & components.

Note:

The RMG panel shall be manufactured as required by the TANGEDCO authorities directions and approval shall be obtained including commissioning.

Any additional features required by the authorities shall be carried out at no extra cost.

2. DRY TYPE TRANSFORMER

2.1 SCOPE

This specification covers the requirements of cast resin dry type distribution transformers up to 36kV, 3150 KVA with all the accessories and fittings for efficient and trouble free operation.

2.2 CODES AND STANDARDS

The design, material, construction, manufacture, inspection, testing and performance of equipment shall comply with all currently applicable standards, codes of practice, regulations, and safety codes in the locality where the equipment will be supplied & installed. Nothing in this specification shall be construed to relieve the CONTRACTOR of this responsibility.

The codes and standards mentioned in the various specifications and requirements specified in the enquiry document shall be latest as on the day of award of contract of the works unless otherwise specified. Contractor shall be responsible to inform to the Consultant/ Owner in case of any revisions/re-affirm/amendment in the relevant codes and standards after the date of award of contract within 30 days of the issue of such revision/re-affirm/amendment of the code/ standard. Consultant/ Owner may approve use of the earlier code/ standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed.

The VENDOR shall ensure that instruments and gauges to be used for testing and inspection shall have valid calibration and the accuracy can be traced to National and International Standards as applicable.

2.3 GENERAL CONSTRUCTIONAL FEATURES

All material used shall be of best quality and of the class, most suitable for working under the conditions specified and shall withstand the variations of temperature and atmospheric conditions, overloads, over-excitation, short-circuits as per specified standards, without distortion or deterioration or the setting up of undue stresses in any part, and also without affecting the strength and suitability of the various parts for the work which they have to perform.

The transformer shall be compact and suitable for easy installation at site. It shall be of modular design; i.e. windings can be individually mounted and replaced on site. The transformer shall be provided with 4 Nos. Bi-directional cast iron rollers fitted on cross channels to facilitate the movement of the transformer in both directions.

These rollers shall be suitable for being turned through an angle of 90deg. and locked in that position when the transformer/enclosure is jacked up. Steel bolts and nuts shall be galvanized. Transformer shall be suitable for tropical climate and shall be anti-fungal treated. It shall be capable of withstanding thermal effect and stresses caused by short circuit or voltage surges. Rating and diagram plates of stainless steel shall be provided on LT box of the transformer and shall be

easily accessible. Rating and diagram plate shall be riveted to the transformer enclosure at a proper height so that it is readable. The rating diagram plate shall bear details as specified in relevant standards. Lifting eyes or lugs shall be provided on all parts of the transformer, which require independent handling, during loading, unloading, assembly or dismantling.

2.4 CORE

The magnetic circuit shall be constructed from high grade cold-rolled non-ageing grain-oriented silicon steel laminations with non-hygroscopic insulation material on both sides. The magnetic circuit shall be of “core type” Construction. The core shall be built up with ‘step-lap' configuration. The grade of laminations shall be low loss type to meet the loss figures specified in the Relevant standard

It shall be carefully interlaced step lap epoxy arranged yoke. It shall be mitered to have low noise and losses. An adequate painting of resin coat shall cover the complete core and the clamping structure and shall protect it against corrosion. The Final assembled core shall be free from distortion. It shall be rigidly clamped to ensure adequate mechanical strength and prevent vibration during operations.

The core shall be provided with lugs suitable for lifting the complete core & coil assembly.

The core clamping structure shall be designed to minimise eddy current loss and bolts shall not pass through the laminations for any purpose. The bandages for the core shall be of polyester tape/fibre glass, the spacers for clamping the windings shall be of high-quality rubber/fibre glass to withstand the temperature rise specified in Relavant standard and the supports shall be of porcelain.

The insulation structure for the core to bolts and core to clamp plates shall be such as to withstand a voltage of 2500V for one minute.

2.5 WINDINGS

LV WINDING

LV Winding shall be of copper foil, coated with class F insulation, epoxy resin reinforced with fibre glass layers pre-impregnated and casted under vacuum, to be thermally bound to the winding. The conductors shall be transposed at suitable intervals in order to minimize eddy current and to equalize the distribution of current and temperature along with windings.

Insulation of LV winding shall be adequate to withstand surge voltages appearing across them as a result of transfer due to an impulse striking on HV terminals. Adequate cooling ducts in epoxy cast shall be provided in the LV winding to obtain the required cooling in axial and radial directions.

The resin used for winding insulation shall be non-hygroscopic. It should be possible to energise the transformer without drying even after long period of service interruption. In case of Dyn11 transformers, neutral shall be brought out in open for solid earthing on secondary side.

The winding shall be designed to reduce the out of balance forces in the transformer at all voltage ratios at all operating conditions. The winding shall be so designed that all coil assembly of identical voltage rating shall be interchangeable and field repairs to the windings can be made without special equipment's.

HV WINDING

HV Winding shall be of copper wire, double layer winding, and cast under vacuum with epoxy resin. The resin shall be pure low viscosity epoxy resin, fibre glass reinforced. The resin cast winding shall be void free.

Insulation of HV winding shall be Class 'F' with temperature rise limited to Class 'B'. Resin on winding shall be casted under vacuum and then pressure impregnated. It shall be thermally bound to the winding after initial curing. Casting shall be cured thermally in controlled autoclave with complete cycle and temperature (typically 145˚C for 4-6 hrs.) recommended by manufacturer / standards.

The winding shall be designed to reduce to a minimum the out of balance forces in the transformer at all voltage ratios at all operating conditions. The winding shall be so designed that all coil assembly of identical voltage rating shall be interchangeable and field repairs to the windings can be made without special equipment.

Adequate cooling ducts in epoxy cast shall be provided in the HV winding to obtain the required cooling in radial and axial directions.

HV and LV winding shall be suitably braced and supported at top as well as bottom to withstand short circuit stresses set up by surges and damage because of inertia.

The resin casting process shall be carried out under the most strict and automated controlled conditions in order to ensure optimum insulating and mechanical properties.

The coil finishing shall provide smooth surface eliminating dust accumulation and give effective cooling.

2.6 ENCLOSURE

The enclosure shall be of CRCA mild steel sheet. The enclosure frame shall be fabricated using suitable CRCA pressed and shaped sheet steel of thickness not less than 3mm for structural members and 2mm for all doors & covers. Enclosure shall be provided with adequate doors, covers for inspection, maintenance and removal of the active parts from the enclosure.

The material used for gaskets shall be cork neoprene or nitrite butyl rubber gasket. Suitable mechanical stops shall be provided to prevent excess squeezing of gaskets.

The enclosure shall not have degree of ingress protection less than IP-33. Enclosure doors/covers shall be pad lockable and shall have limit switch for tripping HV circuit breaker to avoid accidental contact with live parts. Instruction in

three languages (Hindi/English/Local language) shall be displayed on each openable door/cover.

The transformer shall be natural air cooled, or fan cooled as indicated in relevant standard . If forced cooling is specified, cooler fan shall be isolated from live parts and shall have separate door without interlock.

An emergency trip push button of lockable type shall be provided at a prominent and convenient place near the transformer to facilitate easy tripping of HV circuit breaker feeding the transformer during an emergency. The enclosure door shall be interlocked with service transformer incoming breaker such that the door can be opened only when the service transformer HV side circuit breaker is in Test/Isolated position and HV side circuit breaker can be closed only when the doors are closed.

All wheels should be detachable and be made of cast iron. Wheels shall be mounted on separate ISMC (MS channel), provided at bottom of the frame.

Lifting eyes or lugs shall be provided on all parts of the transformer, which require independent handling, during loading, unloading, assembly or dismantling such as core , enclosure etc.

2.7 EARTHING

The framework and clamping arrangement of core and coil shall be suitably earthed internally to the body of enclosure. Separate 2 nos. earthing terminals shall be provided on enclosure for connection to PURCHASER's earth grid. Core shall be earthed to the frame. Suitable arrangement shall be provided for disconnecting the core earthing for insulation measurement.

2Nos. separate earthing pad / terminals shall be provided on the HV cable box for armour earthing from inside and for OWNER's grid connection from outside. Apart from the neutral leads for power connection, a separate neutral terminal shall be provided to facilitate termination of 2 nos. earthing conductors, which in turn will be connected to two (2) distinct earthing pits by direct connection. The connection may be by insulated cable or by bare strip. In case of cable connection, suitable cable box to terminate the cables shall be provided Flexible earthing braid shall be provided between all metal parts joined with gaskets.

Arrangement for supporting 2 runs of GI, up to grade level, from neutral terminal connection installed outside shall be provided.

2.8 TERMINATION

Transformers shall be suitable for the following terminal arrangements:

- LV Side: - The LV side including the neutral shall be brought out through bushings and suitable arrangement for bus trunking with horizontal or vertical take-off of bus duct or cable box suitable for top/ bottom cable entry as specified in Relevant standard shall be provided.
- HV cable box: - HV side leads shall be brought out through bushings to a cable box and cable box shall be suitable for top or bottom entry as specified in Relevant standard and provided with plug-in terminals.
- Support insulator i.e. bushings material shall be of porcelain/ epoxy resin cast.

Manufacturer shall indicate the method of connection (type of welding /brazing etc.) between the winding and the termination bar.

2.9 MARSHALLING BOX

A marshalling box shall be provided for housing transformer control and other signalling equipment. The marshalling box shall be of mild steel sheet and shall be with IP 54 or better degree of protection for enclosure. The marshalling box shall be complete with necessary cable glands and cable lugs. All sensor and equipment connection shall be wired up to the terminal with ferrules.

The marshalling box shall accommodate digital temperature indicator and gland plates for incoming and outgoing cables. Marshalling box shall be provided with toughened glass visor to facilitate the reading of temperature indicators. Marshalling box shall be provided with cubicle illuminating lamp along with control switch and door limit switch and a thermostatically controlled space heater. Also it shall have one 16A utility socket.

All spare contact and terminals shall be wired up to the terminal block. 20% spare terminals shall be provided. Terminal block shall be rated for 10A. Wiring shall be with PTFE/FRLS PVC insulated multi stranded copper conductors of sizes not less than 1.5 sq.mm for control cables and 2.5 sq.mm for CT circuits. CT terminals shall be provided with shorting and earthing facility. Printed identification ferrules shall be of yellow colour with black lettering.

Control voltage shall be 220V/110V/24V DC for all equipment, as per project requirements and 230V, 1 phase, 50 Hz for utility requirements.

2.10 PAINTING

All interiors and exteriors of transformer/enclosure / shall be finished and painted to produce a neat, fire resistant and durable surface which would prevent rusting and corrosion. Sheet metal components shall be pre-treated using the seven-tank phosphating process consisting of de-greasing, acid pickling, de-rusting, phosphating and passivation including repeated rinsing in between, thickness of painting shall be minimum 75-80 microns. The colour shade of the sheet metal work shall be as indicated in Relevant standard.

2.11 ELECTRICAL AND PERFORMANCE REQUIREMENTS

Transformers shall operate without injurious heating at the rated KVA at any voltage within + /- 10 percent of the rated voltage of that particular tap.

11.2 Transformer shall be capable of delivering rated current at a voltage equal to 105% of rated voltage. Transformers shall be designed for 110% continuous overfluxing withstand capability.

Overloads shall be allowed within the conditions defined in the loading guide of the applicable standard. Under these conditions, no limitations by terminals, tap changers or other auxiliary equipment shall apply. Transformer shall be self-

extinguishing in the event of fire or arcing and no toxic or corrosive gases shall be released.

There shall not be any risk of cracking of the epoxy casting in the transformer.

Transformer shall have partial discharge level of less than 10pC.

The neutral terminal of windings with star connection shall be designed for the current that can flow through this winding. Transformer shall be of low noise.

Transformer shall be certified for following:

(a) Class for “Fire Behaviour”- As specified in Relavant standard or Section C

(b) Class for “Climatic”- As specified in Relavant standard or Section C

(c) Class for: - “Condensation and humidity”- As specified in Relavant standard or Section C

Transformer shall be suitable for switching with Vacuum Circuit Breakers (VCBs). Resonance frequency of the winding shall be such as to avoid resonance with the switching impulse of VCBs and overstress of the insulation.

The sound level of the transformer shall not exceed the limit indicated by relevant standard under any specified operating conditions.

2.12 FITTINGS AND ACCESSORIES

The transformer shall be provided with following fittings and accessories:

- Enclosure with Top cover
- Rating & diagram plate
- Terminal markings plate.
- 2 Earthing terminals.
- Cable box with HV plug-in connectors.
- Bus duct termination arrangement/ cable box
- Neutral cable box for neutral earthing if applicable
- Lifting lugs
- Hauling lugs
- Base Channel
- Undercarriage with 4 nos. rollers, which can be turned 90 degrees and bidirectional.
- High-voltage danger notices against touching of coils.
- Louvers
- Winding Temperature indicator with RTD sensor (minimum 2 per phase). Pre-set PTC sensors shall be provided and attached to each of the LV winding as close as possible to the hottest spot. The PTC sensors shall be selected in order to protect both, HV and LV windings. Contacts for alarm and trip and shall be suitable for 220V/110V/24V D.C. The indicators shall have a suitable RS 485 port for transfer of data to plant SCADA/DCS system).
- Marshalling Box.
- ON LOAD Tap Changing Links (Refer detailed specification for OLTC)
- The tap-changing shall be performed by link mechanism. The links shall be accessible after opening the door/cover.

- Cast resin current transformer on transformer neutral for stand-by earth fault protection, Restricted Earth fault protection, as specified in relevant standard.
- All necessary cable glands, cable lugs, armour earthing clamps, terminal connectors, cable sealing ends and accessories required for termination of the PURCHASER's cables/ bus duct shall be included.

2.13 TESTS

The routine tests shall be carried out as per applicable standards and shall be deemed to be included in the VENDOR'S scope. The following additional points/tests shall also be considered as part of routine tests and included in the scope.

- Resistance must be measured at extreme taps also in addition to principal tap.
- Impedance must be measured at extreme taps also in addition to principal tap.
- No load loss and exciting current shall be measured at rated frequency at 90%, 100% and 110% rated voltage. These tests shall be done after impulse tests if the latter are specified.
- No load loss and exciting current shall be measured and recorded with 415V, 3-phase, 50 Hz input on LV side.
- Magnetic circuit (Isolation) test as per relevant standard.
- Measurement of zero sequence impedance

Type tests, if required, shall be carried out, as per applicable standards and the BIDDER shall quote extra unit prices for carrying out each of the type test.

In addition, if required, special Tests as listed below shall be carried out as per applicable standards and the BIDDER shall quote extra unit prices for carrying out the same.

- Partial Discharge test
- Acoustic Sound Level measurement
- Short Circuit Test
- Thermal Shock Test
- Environmental Test
- Climate Test
- Fire Behaviour Test

2.14 TEST AT SITE

- Preliminary checks
- Compare nameplate details with the specifications.
- Check for any physical damage, in particular of support insulators.
- Check tightness of all bolts, clamps and connecting terminals.
- Check cleanliness of support insulators, core coil assembly, marshalling panels, enclosure, etc.
- Check for clearances.
- Check earthing of transformer supporting structure/enclosure and neutral terminals.

- Check that the transformer is correctly installed with reference to its phasing and properly aligned with respect to switchgear and interconnecting external bus duct if any.
- Check for proper termination support of HV and power cables, and provision of cable glands for the same.
- Check welding/bolting to embedded parts/floor of the building.

The following tests/checks on dry type transformer shall be performed by the VENDOR at site at the time of erection and commissioning if included in scope. Typical checks to be carried out at site are listed below:

2.15 COMMISSIONING CHECKS (IF INCLUDED IN SCOPE)

- Insulation resistance test of windings and polarisation index on winding.
- Vector group test.
- Phase sequence test.
- Winding resistance test at all taps.
- Insulation resistance of control wiring.
- Core loss test at service tap.
- Voltage/turns ratio at all the taps.
- Magnetic current balance at full voltage.
- Capacitance and tan delta measurement.
- Tests on current transformers
- Continuity test
- Polarity test
- IR tests
- Magnetization characteristics
- Ratio test
- Secondary winding resistance measurement.
- Measurement of mV drop across HV and LV power connections and joints.

2.16 LOSSES

- Low Losses shall be as per ECBC 2017 latest amendments.

2.17 REJECTION

PURCHASER may reject any transformer if during tests or service (during warranty period) any of the following conditions arise:

- Total loss exceeds the guaranteed value.
- impedance value differs the guaranteed value by +/-10% or more.
- Winding temperature rise exceeds the specified value
- (d) Transformer fails on any High voltage tests.
- (e) Transformer is proved to have been manufactured not in accordance with the agreed specification.

The PURCHASER reserves the right to retain the rejected transformer and take it in to service until the VENDOR replaces, at no extra cost to PURCHASER, the defective transformer by a new acceptable transformer. Alternatively, VENDOR shall repair or replace the transformer within a reasonable period to the PURCHASER's satisfaction at no extra cost to the PURCHASER.

2.18 SPARES

The BIDDER shall quote item wise prices for the spares recommended for 3 years trouble free operation or as per the agreement between VENDOR and PURCHASER.

2.19 ON LOAD TAP CHANGING GEAR FOR TRANSFORMERS

SCOPE

This specification covers on load tap changing gear (OLTC) for power transformers.

CODES & STANDARDS

The codes and standards mentioned in the various specifications and requirements specified in the enquiry document shall be latest as on the day of award of contract of the works unless otherwise specified. Contractor shall be responsible to inform to the Consultant/ Owner in case of any revisions/re-affirm/amendment in the relevant codes and standards after the date of award of contract within 30 days of the issue of such revision/re-affirm/amendment of the code/ standard. Consultant/ Owner may approve use of the earlier code/ standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed.

REQUIREMENTS

OLTC over loading capability shall be compatible with the overloading capability of transformer as specified in relevant National/ International standard. Devices shall be incorporated to prevent tap change when the through current is in excess of the safe current that the tap changer can handle. The OLTC gear shall withstand through fault currents without injury.

In case of on-load tap changer, the tappings shall be on the high voltage winding.

When a tap change has been commenced it shall be completed independently of the operation of the control relays and switches. Necessary safeguard shall be provided to allow for failure of auxiliary power supply or any other contingency which may result in the tap changer movement not being completed once it is commenced.

Oil in compartments which contain the making and breaking contacts of the OLTC shall not mix with the oil in other compartments of the OLTC or with transformer oil. Gases released from these compartments shall be conveyed by a pipe to a separate oil conservator or to a segregated compartment within the main transformer conservator. An oil surge relay shall be installed in the above pipe. The conservator shall be provided with a prismatic oil level gauge.

The OLTC switch contacts shall be located in a separate oil-filled chamber complete with its own oil preservation system, oil surge relay, shut-off valves, oil level gauge, gas vent, filling plug, drain valve with plug, dehydrating breather, oil sampling device inspection window with view glass. Oil, in compartments of OLTC which do not contain the make and break contacts, shall be maintained under conservator head by valved pipe connections. Any gas leaving these compartments, shall pass through the oil surge relay before entering the conservator.

OLTC driving mechanism and its associated control equipment shall be mounted in an outdoor, weatherproof cabinet conforming to degree of enclosure protection IP55. The finish shall match with that of the transformer on which it is mounted. The cabinet shall include:

- On-load tap changer driving gear Motor shall be of squirrel cage totally enclosed type and shall comply with applicable Standard. It shall be suitable for direct starting and continuous running from 415 volts 3-phase or 240 volts single phase 50 Hz supply.
- Mechanically & electrically interlocked motor starting contactors with thermal overload relay, isolating switch and HRC fuses / MCCBs.
- Duplicate sources of power supply with automatic changeover from the running source to the standby source and vice versa shall be provided in transformer cooler control cabinet / marshalling box and one no. out going feeder extending to OLTC DM cabinet, with appropriate provision for receiving the same.
- Control switch: Raise/off/lower (spring return to normal type) or independent push buttons.
- Emergency 'OFF' push button (stay put type).
- Provision shall be made for locking the new tapped position.
- Remote/local selector switch (maintained contact type).
- Mechanical tap position indicator.
- Tap changing switch shall be provided with make-before-break contacts with one fixed contact for each tap position.
- Limit switches to prevent motor over-travel in either direction and final mechanical stops.
- Appropriate scheme/device to permit only one tap change at a time on manual operation.
- Emergency manual operating device (hand crank or hand wheel).
- A five-digit operation counter.
- Space heaters with thermostat and HRC fuses / MCB.
- Control transformers with HRC fuses / MCBs on HV and LV sides for each supply.
- Interior lighting fixture with lamp, door switch/ ON-OFF switch and HRC fuses / MCB.
- Gasketed and hinged door with locking arrangement.
- Terminal blocks, internal wiring, earthing terminals and cable glands for power and control cables.
- Necessary relays, contactors, current transformers etc.
- Transducers or any other appropriate device for remote tap position indication.
- OLTC shall be designed suitable for local manual as well as local electrical operation and Remote electrical operation including SCADA operation with provision of master follower scheme for parallel operation. The OLTC shall be housed in a separate tank so that oil of the OLTC chamber does not come in contact with the oil of main tank in any way. There shall be separate conservator with the arrangement of having the dehydrating breather for OLTC tank.

CONTROL REQUIREMENTS FOR OLTC
The following electrical control features shall be provided:

- Positive completion of load current transfer, once a tap change has been initiated, without stopping on any intermediate position, even in case of failure of external power supply.
- Only one tap change from each tap change command even if the command is maintained.
- Cut-off of electrical control when manual operation is resorted to.
- Cut-off of a counter impulse for a reverse tap change until the mechanism comes to rest and resets the circuits for a fresh operation.
- Cut-off of electrical control when it tends to operate the tap beyond its extreme position.

REMOTE CONTROL EQUIPMENT
The OLTC remote control equipment shall be housed in an indoor sheet steel cubicle to be located in a remote-control room. It shall conform to degree of enclosure protection IP42 or better and shall comprise the following:

- Control switch: Raise / Off / Lower (spring return to normal type) or independent push buttons.
- If automatic operation is specified, auto / manual selector switch (maintained contact type) and other items as required.
- If parallel operation is specified, master / independent / follower selector switch (maintained contact type) with 'out of step' annunciation.
- Tap position indicator.
- Facia type alarm annunciators with "accept", "lamp test" facilities and hooter / buzzer for alarms as required.
- Necessary auxiliary relays.
-
- Lamp indications for:
- Tap change in progress.
- Lower limit reached.
- Upper limit reached.
- (Transformer cooler control apparatus conditions (if specified)

Cable glands for power and control cables.
240 V rated panel space heater with thermostat.
HRC fuses / MCBs.
Terminal blocks and internal wiring.
Earthing terminal.
Apparatus for control of transformer cooler equipment (if specified in relavant standard). The control and annunciation shall consist of Manual and Auto switch, indication of "On" condition of each pump and fan, and all annunciations related to cooler.

Each tap changing gear shall have two local selector switches: Remote-local and Electrical-Manual. OLTC shall normally be operated from DCS. All necessary control and monitoring features shall be available in DCS. Provision for various modes of operation of the tap changers of transformers like individual operation, remote DCS/local operation, etc. and for various interlocks shall be kept in the transformer local OLTC panel. Necessary equipment switches, relays, etc. shall

be provided in this panel. Suitable I/O for interface with DCS shall also be provided. Any other feature desired for proper and safe operation of equipment shall be provided.

AUTOMATIC CONTROL OF OLTC

Automatic voltage regulator (AVR) for auto control of OLTC shall include:

- Voltage setting device
- Voltage sensing and voltage regulating devices
- Line drop compensator with adjustable R and X elements.
- Timer 5-25 seconds for delaying the operation of the tap changer for every tap change operation.
- Adjustable dead band for voltage variation.
- Additional features as required when parallel operation with other transformers is specified.

ALARMS

The following alarms shall be provided:

- A.C. supply failure
- Drive motor auto tripped
- Other protective purpose considered essential by the VENDOR.
- Out of step operation when paralleled transformers supposed to operate on the same tap are operating at different taps.
- Tap change delayed
- Tap change incomplete
- AVR failure (if AVR is specified)
- Transformer cooler fail (if specified)
- For all the alarms specified above a “OLTC trouble” group alarm to be provided in DCS which is located in control room.
- Others, as specified.

TESTS

Routine Tests

Routine tests as per relevant standards shall be performed on all OLTC’s & Motor drive mechanisms. Over and above, Pressure and Vacuum tests shall be conducted as per relevant standards.

Type Tests

Type tests as per relevant standards shall be carried out on OLTC & Motor drive mechanism when called for. The bidder shall indicate in his price schedule extra price, if any, for carrying out these tests. Type test reports (not older than 5 years) for tests conducted on a similar OLTC & Motor drive mechanism shall be submitted for Consultants / Purchasers approval. If the bidder does not have type test reports, bidder shall carry out the tests without any cost implication to the Purchaser to prove the design integrity of the equipment without impacting the project schedule.

ADDITIONAL REQUIREMENTS

Tap position indicators and OLTC control switch shall be supplied loose if customer decides to mount the same in the power transformer control panel.

In addition to the items listed in this specification, the remote OLTC control panel shall be provided with apparatus required for control and monitoring of transformer cooling equipment if the same is asked in relevant standard.

The finish and dimensions of the panel shall be as specified so as to match with the other panels in remote control room.

3. RAISING MAINS & BUSDUCTS

SCOPE

This specification covers the design, material, construction features, manufacture, supply, inspection and testing at the VENDOR's/his SUB-VENDOR's Works, delivery to site and performance testing of Bus Bar Trunking (BBT) and accessories at site.

CODES & STANDARDS

The design, material, construction, manufacture, inspection, testing and performance of bus duct shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility.

The codes and standards mentioned in the various specifications and requirements specified in the enquiry document shall be latest as on the day of award of contract of the works unless otherwise specified. Contractor shall be responsible to inform to the Consultant/ Owner in case of any revisions/re-affirm/amendment in the relevant codes and standards after the date of award of contract within 30 days of the issue of such revision/re-affirm/amendment of the code/ standard. Consultant/ Owner may approve use of the earlier code/ standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed.

GENERAL

The busbar trunking (BBT) system shall be of low impedance and sandwiched construction, i.e. no air gap shall exist between bus-bars except at plug-in opening.

It shall be possible to mount the BBT in any orientation, without affecting the current rating. The length of each section will be limited to max. 3 meters.

It shall be totally enclosed pre-painted galvanized steel and be of the non-louvered type maintaining an overall degrees of ingress protection as specified in Data Sheet.

BUSBARS

Busbars shall be of electrolytic grade copper / Aluminium as specified in Data sheet with purity not less than 99.9% and 99.9% conductivity for copper and >60% for Aluminium. The bus bar joints shall be silver plated copper/silver plated

or tin-plated Aluminium. The busbars shall have rounded or radial edges.

Neutral shall be 100% of cross-sectional area of the phase conductor.

A continuous external earth busbar of material as specified in Data Sheet shall be provided.

Flexible connections shall be provided with Cu braided / multi leafed conductors for termination at both the ends

The busbars shall be individually insulated with by minimum 2 layers of insulating film.

Bus bar conductors shall be insulated with insulation Class F material or as specified in Data Sheet

All the insulation materials shall be halogen free, non-hygroscopic, high thermal conductivity and fire retardant.

HOUSING

The busbar trunking housing shall be totally enclosed, non-ventilated, natural cooled.

The enclosure shall be of hot dip galvanized and pre-painted sheet steel or Aluminium.

The housing shall be made of minimum 1.6 mm galvanized sheet steel / 1.6mm CRCA / 2.5mm Aluminium with an epoxy powder coated paint finish. It shall pass at least 1000 hours salt spray test to ensure the anticorrosion ability.

The housings shall be profiled, to provide higher strength, tested for IK-10 and efficient heat dissipation.

The width of the housings shall be preferably the same for all ratings of busbars, in order to provide interchangeability of tap off boxes.

Inspection cover shall be provided over joints to inspect the tightness of the connection.

Space heaters shall be provided in the BBT wherever the manufacturer considers required based on site conditions to prevent moisture condensation.

JOINTS

The electrical joints shall be of one to four bolt type designed for even distribution of contact pressure.

Bolts shall be accessible without removing covers.

The joints between sections shall be made so as to provide flexibility during installation and expansion / contraction of busbar during operation. The joints shall be of the Uniblock Joint. The joint construction must have the following features.

a) Shear off nut: To ensure tightness of joint at desired torque.

b) Tamper proof cap over shear off nut to prevent opening of nut after achieving desired torque.

c) Heat expansion of atleast 3 mm per joint.

d) The joint insulation must be of one-piece mould design and not have any cut edges which can absorb moisture.

e) Joint assembly shall be removable as separate sub-assembly so that it can be inserted or removed without disturbing the adjacent sections.

f) The busbars ends shall not have any holes or slots at the joints – the electrical continuity shall be through pressure plates, achieving a high area of joint cross section and expansion capability.

EXPANSION JOINT

Busbar expansion units shall be used in cases to reduce the stress on the system by differential expansion between the busbars and the casing; particularly for long run of the busbar.

It shall consist of a flexible joint in the middle on the conductors and a sliding casing in 2 sections which can absorb the relative movements of each section of the length.

TAP-OFF UNITS

Tap-off units of suitable rating shall be provided for bus trunking. Necessary provision for tapping on bus trunk at maximum 1 meter interval on one side & 0.5 meter interval on both the side shall be made on bus trunking.

Tap-off units shall be of dust and damp-proof version, degree of protection IP54 and sprinkler proof. Tap-off unit enclosure shall be same as the BBT enclosure.

Tap-off units shall be suitable for any brand of MCCB, shall be interchangeable, to suit site requirements.

The tap off units shall have all safety features like mechanical interlocking so as to prevent installation or removal of the unit when the MCCB is in ON condition. Also, it shall not be possible to open the cover of the tap off box when the MCCB is ON.

Tap-off units shall be suitable for terminating armoured cables.

The plug-in tap-off units shall be connected to the busbar trunking whilst live via silver plated copper spring jaw connections.

The earth contact of the tap-off unit shall always be made before that of the live conductors and the last to break during removal. The tap off box shall be equipped with door isolating facility to carry out any maintenance of the circuit breaker without removing the tap off box from the main busbar system

Tap-off outlets shutter shall be able to open and close automatically when plug-in units are plugged in or removed.

The live parts or terminals inside the tap-off box unit shall be guarded with transparent visible sheet / insulated barrier to prevent accidental physical touch.

Bidder shall submit full discrimination charts for the selection of MCCB for the deployed BBT rating. The MCCB shall be current limiting type and the protection functions shall be as per SLD.

End Feed Unit / Centre Feed Unit:

End/Centre feed unit (EFU/CFU) with off load isolator / MCCB with RYB & ON / OFF/TRIP indications shall be provided as per indicated in SLD or as specified in Data Sheet.

Door interlock shall be same as per described for tap-off box.

EFU/CFU shall be suitable for termination of cables as per indicated in SLD.

Colour shade of tap-offs & EFU/CFUs shall be same as that of main bus trunking.

ACCESSORIES

The bus trunking system shall be complete with all the accessories such as straight run lengths, bends/elbows / flat elbow/ edge elbow/ T sections, vertical anchors, expansion joints, flexible connections, flange ends, reducer, end covers etc. All the accessories as required to suit site conditions are deemed to be included in straight length of the bus trunk.

Flanged end boxes shall be provided to accommodate flange end for connecting the bus trunking with flanges of panels, transformers & DG sets etc. At every terminal point at flanges the connection shall be done using flexible connections.

Any other item/ accessory not specifically mentioned above but deemed necessary by the bidder for successful implementation.

TESTS

All routine tests as specified in IS/IEC shall be conducted at the works and all site tests shall be conducted as per IS/IEC at site after the complete bus bar is assembled.

Certified copies of reports/certificates with final conclusions of type tests carried out as per relevant standards on similar type and rating of the equipment within last five years shall be furnished for review along with the Bid. Type test reports older than 5 years may be acceptable only if there were no change in relevant standard & manufacturer's product design and subject to purchaser's approval. In case the type test reports are not found to be meeting the specification requirements or older than five years with change in design, then the VENDOR shall conduct all such tests free of cost and submit the reports for approval without any cost and time implication to the PURCHASER.

Type test assembly shall comprise of all the major components such as Insulations, joints, Tap-off units, etc., and shall depict the actual site installation. The components used in the type test assembly shall not be used in the bus bar sections being supplied for the project.

The busbars shall be type tested at a reputed national / International test laboratory (ASTA / KEMA /CPRI/ERDA/LOVAG) for short circuit withstand. The test shall be for a minimum duration of one second.

Degree of ingress protection (IP rating) shall also be tested at any reputed independent laboratory. This test shall be for IP54 / IP 55 for indoor and IP 65 / IP 67 FOR OUTDOOR application.

TYPE TESTS

The Bidder shall furnish type test certificate for the following tests conducted on similar equipment:

a) Temperature Rise Limits

b) Dielectric Properties

c) Short Circuit Strength

d) Degree of Protection

ROUTINE TESTS

Following routine tests shall be conducted on the Bus trunking:

a) Physical verification check

b) Megger Test

c) Power frequency withstand test

d) Any other tests as stipulated by the relevant standards

EXECUTION

Installation

The equipment manufacturer shall provide technical guidance during and/or following construction to perform a checkout of the system. At such time, factory-trained technicians shall carryout all necessary adjustments and instruct operating and maintenance personnel on the proper use and care of the system.

Any damage to BBT and its accessories during transportation / handling shall be immediately replaced by the VENDOR without any cost and time implication and the same shall be reported to the Purchaser.

The BBT and its accessories shall be properly supported on the truck or trailer by means of ropes to avoid any chance of damages.

DATA TO BE SUBMITTED BY VENDOR AFTER AWARD OF CONTRACT FOR APPROVAL

General arrangement with sections for BBT, tap off units, End feed units and centre

feed unit.

Technical datasheet of BBT including all components.

Itemised Bill of material for complete BBT covering all the components and accessories along with the rating.

Details of joints between sections, expansions joints and terminal connections.

Quality assurance plan and Testing procedures

FOR INFORMATION

Copies of instruction manuals to cover installation, commissioning, operation and maintenance.

1.	BUS BAR TRUNKING	✓ IEC 61439 -6 / IS 8623
2.	DEGREE OF PROTECTION	✓ IEC 60529
3.	FIRE RATING	✓ (ISO 834) 55

4. LT PANELS

This specification covers the design, material, construction features, manufacture, inspection and testing at VENDOR's/SUB-VENDOR's works, delivery to site and performance testing of metal enclosed Low Voltage switchgear for voltage not exceeding 1000 V A C

CODES AND STANDARDS

The design, manufacture, testing and performance of equipment shall comply with all currently applicable standards, codes of practice, regulations and safety codes in the locality where the equipment will be supplied. Nothing in this specification shall be construed to relieve the VENDOR of his responsibility. In case of conflict between these standards and this specification, more stringent of the two requirements shall govern. Some of the currently applicable standards are indicated in Data Sheet.

All codes and standards referred to in the specification shall be understood to be the latest version on the date of offer made by the Bidder unless otherwise indicated.

The VENDOR shall ensure that instruments and gauges to be used for testing and inspection shall have valid calibration and the accuracy can be traced to National and International Standards as applicable.

CONSTRUCTIONAL FEATURES

The major parameters of the switchgear and other required features are given in Data sheet - . The bidder shall in his offer specifically confirm compliance of these data in full. Deviation if any should be specifically brought out in the schedule of Technical Deviation.

The switchgear shall be indoor, metal enclosed, floor mounted of uniform height not more than 2450 mm, made up of the requisite vertical sections, dust and vermin proof construction with IP - 52 degree of protection, unless otherwise stated in Data Sheet. The degree of protection provided by enclosures against external

mechanical impacts shall be IK08 minimum. Panels shall be supplied with base channel (Minimum ISMC 75/ 100) which will be an integral part of the panel.

Adjacent switchgear cubicles shall be provided with side sheets on either side to ensure complete isolation. The switchgear shall be easily extendable on both sides by the addition of vertical sections.

From internal isolation point of view, the switchgear shall be designated in the following form of separation:

Form 1 : No internal separation

Form 2 : Separation of busbars from the functional units

Form 2a : Terminals not separated from bus bars

Form 2b : Terminals separated from bus bars

Form 3 : Separation of busbars from the functional units

Separation of all functional units from one another

Form 3a : Terminals not separated from bus bars

Form 3b : Terminals separated from bus bars

Form 4 : Separation of busbars from the functional units

Separation of all functional units from one another

Separation of terminals from those of any other functional unit

Please refer Data sheet for the specified form of separation

The bottom of the switchgear shall be fully covered by sheet steel.

Removable gland plates shall be provided for power and control cables. The gland plates shall be 3mm thick for panel with circuit breaker cubicles (ACB/ MCCB) and 2mm thick for other cubicles. The gland plates for single core cables shall be of non-magnetic material.

The Painting shall be carried out with Powder coating which includes following main activities:

(a) Panel shall be complete with all fabrication work like drilling, punching, shearing and welding etc. before proceeding to pre painting processes.

(b) Pre-treatment of all sheet steelwork, including degreasing, acid pickling, de-rusting, phosphating, passivation including repeated rinsing in between each process shall be carried out as per applicable standard.

(c) After Pre-treatment, the panel shall be provided with protective coating including compatible primer with the shade as indicated in Data Sheet for exterior and interior with minimum thickness of 80 microns DFT.

(d) After coating, Curing shall be carried out as per the required process. Any post painting fabrication activity like drilling, cutting, welding may liable for rejection of complete panel

Each switchgear cubicle shall be fitted with a label in the front and back of the cubicle. Each switchgear shall also be fitted with label indicating the switchgear designation, rating and duty. Each relay, instrument, ACB, MCCB, switch, fuse and other devices shall be provided with separate labels. These shall be with Aluminium anodized / 3 ply Lamicold/ Acrylic name plates (with white letters on Black background) at front, inside & rear side

Operating devices shall be incorporated only in the front of the switchgear. No equipment needing manual operation shall be located less than 300 mm or more than 1800 mm above ground level.

The switchgear shall be divided into distinct vertical sections comprising of:

Individual feeder module which shall be integral multiples of basic module, containing all associated equipment, enclosed in sheet steel enclosure on all sides and the rear except cable alley side and provided with hinged door on the front. Cable alley side of the feeder enclosure shall be as per the Form specified in Data Sheet

A completely metal enclosed, busbar compartment running horizontally, and a vertical busbar compartment serving all modules in vertical section.

Wherever a vertical cable alley covering the entire height except horizontal busbar compartment is provided, the width shall be minimum 300 mm with adequate number of slotted cable support arms.

A horizontal separate enclosure or enclosures separated by Hylam/FRP sheets for power and control buses with tap off connections to each vertical section.

The exposed bus / live parts in the cable alley shall be totally covered against accidental contact by a shroud (not by PVC sleeve) to protect the workmen working on the switchgear

The circuit breakers shall be fully draw out type if specified In Data Sheet /SLD. These circuit breakers shall have distinct service, test, isolated and maintenance positions. In the test position the circuit breakers shall be capable of being tested for operation without energising the power circuits. Four normally open auxiliary contacts shall be provided for each of the services and test limit switch positions.

The test position should preferably be obtained without the need to disconnect normal control connections and use extension cords for testing.

The current transformers shall be mounted on the fixed portion of the switchgear but not directly on buses or the breaker truck.

The chassis housing feeder for motor control equipment except circuit breakers/common control transformers of big size, shall be of the fully draw-out, semi-draw-out, or fixed type as specified in the Data Sheet.

Fully Drawout Type Withdrawable Chassis

In this type of construction, it shall be possible to drawout the withdrawable chassis without having to unscrew or unbolt any connections to the equipment mounted on the withdrawable chassis. The power and control drawout type connections shall be of the stab-in or sliding type. All drawout contacts, including for auxiliary and control wiring shall be of self-aligning type.

Semi-Draw-out Type Withdrawable Chassis

In this type of construction, it shall be possible to draw-out the withdrawable chassis after manually unplugging at the terminal blocks the control circuit connections of

the equipment mounted on the withdrawable chassis, without having to unbolt any power connections of the equipment. The power connections shall be of the stab-in or sliding type and shall be disconnected when the chassis is withdrawn.

Fixed Type Withdrawable Chassis

In this type of construction all power connections to the equipment mounted on the withdrawable chassis shall be of the bolted type. All control circuit connections to equipment mounted on the withdrawable chassis shall be carried out through conventional terminal blocks mounted in the respective chassis. It shall be possible to draw-out the chassis after unbolting/ unscrewing all the power and control circuit connections to the equipment mounted on the withdrawable chassis.

All identical equipment and corresponding parts including chassis of drawout modules of the same size shall be fully interchangeable, without having to carry out modifications.

The draw-out contacts shall be made of copper/ copper alloy/aluminium faces, which shall be silver or tinplated.

If ventilating louvers are provided, they shall be provided with fine-screened brass or GI meshes from inside to prevent entry of vermin and dust

MODULE TYPES

The various types of modules indicating the control requirements of each type, together with the list of component equipment required for each type are detailed in the standard drawings. These are as follows:

A - Incoming circuit - Isolating switch and fuse.

B - Incoming circuit - Circuit Breakers.

C - Incoming circuit - Isolating switch.

D - Voltage transformer circuit.

E - Outgoing feeder - Circuit breaker.

F - Outgoing feeder - Switch-fuse unit controlled.

G - Bus coupler

H - Auxiliary services - Common equipment for Annunciation scheme

J - Auxiliary services - Common equipment for Space heater supply

K - Motor control - Direct-on-line-non essential motors

L - Motor control - Direct-on-line essential motors

M - Motor control - Automatic Star-Delta motor (Open-transition)

P - Motor control - Automatic Star-Delta motor (Close-transition)

R - Motor control - Reversing control

Motor control modules are further differentiated by suffixes as described below, unless otherwise stated in Data Sheets-A3.

Suffix in First Digit	Denotation (Control location)	Suffix in second digit	Denotation (Motor kW rating range)
1	Controlled from MCC	1	Up to 30 kW
		2	31 - 49 kW
		3	50 -125kW
		4	above 125 kW
2.	Controlled remote from MCC	1	Up to 30 kW
		2	31-49 kW
		3	50-125 kW
		4	above 125 kW

MAIN AND AUXILIARY BUSES

Busbars shall be of uniform cross section throughout the length of the switchgear, and up to the incoming terminals of the incoming feeder circuit breaker/ switch. Busbars shall be of Aluminum or Copper as specified in Data Sheet / SLD

All busbars shall be provided with heat shrinkable type PVC sleeves, all bus taps, joints shall be insulated with moulded caps. If insulating sleeve is not colored, busbars shall be color coded with colored bands at suitable intervals.

Busbars shall be adequately supported on insulators. These shall withstand dynamic stresses due to short circuit currents specified.

Auxiliary Buses

Auxiliary buses for control power supply, space heater power supply or any other specified service shall be provided. These buses shall be insulated, adequately supported and sized to suit specific requirements. The material of control power supply buses shall be electrolytic copper. The material for space heater power supply buses shall be same as that for the main power buses. Supply transformer(s), auxiliary busbars and necessary connections to the supply transformers and associated circuits shall be in the VENDOR'S scope,

The bus-bars shall be designed considering the following criteria:

(a) Sleeving made of insulating material on all bus bars.

(b) Site ambient and final temperature of the bus-bars as specified in Data sheet-.

(c) Bus bars being inside the panel - duration for enclosure and ventilation.

(d) Bus bars carrying rated current continuously.

(e) Configuration of bus bars and Proximity effect

(f) Bus bars shall withstand the short time rating of the panel for given duration

(g) Main Horizontal bus-bars of PCC above 4000A with Aluminium bars shall be interleaved type if required

(h) The Bidder shall furnish calculations establishing the adequacy of the bus bar sizes to meet the continuous and short time current ratings specified for approval before manufacturing

Bus bar supports shall only be SMC irrespective of bus bar size. The span between the two insulators shall be as per the approved type test report for short time rating. Joint positions and insulators shall be properly adjusted so that they don't interfere. Bus bar bending shall be carried out on appropriate machines designated for the same rather than doing manually

All bus-bar shall be treated with anti-oxide paste wherever bi-metallic contact is required

Size of the vertical busbars in each vertical section shall be such that it shall carry minimum 80% of the sum of the connected load to that vertical bus

BIDDER shall ensure that incoming feeder shall be suitably designed for terminating the required no. of runs of 1.1kV grade XLPE insulated armoured cables with 20% spare capacity. BIDDER shall consider the necessary arrangement (dummy panel, adapter panel, rear extension etc.) if required, for terminating the cables.

In case of busduct termination at the incomer, flange arrangement as per requirement of busduct Vendor shall be considered. Phase crossover arrangement shall be considered if specified in Data Sheet

Neutral bus-bars of different panel boards shall be as indicated in the corresponding SLDs

DP MCB shall be provided for all control circuits where the fault level is less than fault withstand capacity of MCB. Else the control supply shall be tapped through a control transformer of adequate capacity supplied with MCCB/ MPCB / SFU of adequate short time rating. Independent DP MCBs shall be provided for each circuit such that tripping due to fault in one circuit should not affect other functions adversely. The insulation class for control transformer shall be Class B

Where control transformer has been provided, a separate control bus shall be run maintaining adequate clearance of atleast 300mm from the power bus with provision of tapping at each vertical column section. The control bus should be preferably a bus bar with Heat shrinkable sleeve

All electrical panels (internal components & arrangement) shall have finger touch protection, for human safety viz. working on one component shall not cause shock to the personnel due to any other live component in the panel. Also, the terminal live parts shall not be accessible by fingers (finger cannot come in contact with live parts of the terminals)

No openings/ holes meant for fixing hardware shall be left open. All the hardware (esp. screws, nuts, bolts, and washers) shall be in all appropriate positions & properly tightened

Phase separators, shrouds, falling tool barriers shall be suitably provided. Any additional requirements as observed at any stage up to handing-over shall be provided (for safety and ease of maintenance)

SAFETY INTERLOCKS AND FEATURES

Withdrawal or engagement of circuit breakers or switch (isolator) shall not be possible unless it is in the open position.

Operation of circuit breaker shall not be possible unless it is fully in service positions or in test position or is fully drawn out.

Circuit breaker cubicles shall be provided with safety shutters operated automatically by the movement of the circuit breaker carriage, to cover the exposed live parts when the breaker is withdrawn.

Caution name plate with inscription "Caution - Live Terminals" shall be provided at all points where the terminals are likely to remain live and isolation is possible only at remote end, e.g. incoming terminals.

A breaker of given rating shall be prevented from engaging with a stationery element of higher rating.

Padlocking provisions shall permit locking the circuit breaker in either the “test” or “disconnected” position

Each door and cover shall have adequate reinforcement of suitable ribs and stiffeners from inside. All doors shall be with concealed type hinges and captive screws. Side covers of panels shall be with removable panels. Rear doors of panels requiring rear access shall be provided with removable hinged doors.

All door locks shall be provided with special keys to ensure opening by authorized personnel only

Feeder shall have hinged openable (more than 90˚) type door with panel locks. All bus-bar covers and other panel covers shall be screw fixed.

Etched Aluminium Caution boards for 433V written in three languages (English, Hindi and Marathi) shall be riveted on the panel on all four sides at locations where live bus bars are present and need isolation before any access to it. In case secondary covers have been provided inside the panel, then caution boards shall be also marked on these boards in addition to the external covers. Stickers are not acceptable.

Feeder and board name plates to be provided at front and rear of switchboard

Stud type terminals and ring type lugs shall be used for control cables

Equipment nameplates shall be fixed by screws/ rivets and shall not be pasted.

Drawing pocket shall be provided on the inside of incomer feeder door. Self explanatory wiring diagrams with terminal and wire numbers, component numbers shall be provided on the inner face of the door of each feeder. Drawing set in the panel shall be laminated

All hardware e.g. Nuts, bolts, gasket, anchor fasteners, etc, are included in the Bidder’s scope. Atleast 10% extra hardware shall be considered for any installation/fixing work. This is to ensure ready availability of hardware in case of loss of some hardware during installation. All hardware shall be hot dip galvanised.

Gaskets shall be EPDM type

All PVC/ engineering plastic based items (including but not limited to trough, trunking, enclosures, covers, plugs, etc) shall be with FR properties

The Vendor shall supply switchgear in various shipping sections comprising incomer, etc. Maximum single shipment section shall not be more than 2000 mm in length. Lifting hooks/ eyes shall be provided in each shipping section of the equipment and shall be removable type

Breaker up to 1600A shall be installed in two tiers and above 1600 A, it shall be mounted in single tier unless otherwise specified in Data Sheet

Panel shall be Salt spray tested for minimum duration of 500 hours if specified in Data Sheet

Component mounting plate thickness shall be minimum 2.0mm

The current transformers shall be mounted on the fixed portion of the switchgear but not directly on buses or the breaker truck.

All identical equipment and corresponding parts including chassis of drawout modules of the same size shall be fully interchangeable, without having to carry out modification

AIR CIRCUIT BREAKERS

Circuit breakers shall be provided with following accessories:

Accessories as asked in Data sheet -

Mechanically operated targets to show 'Open', 'Closed', 'Service' and 'Test' positions of the circuit breaker. Padlock devices shall be provided in order to control opening/closing and racking in/out of the circuit breaker

Mechanically operated, red 'trip' push button, shrouded to prevent accidental operation. Circuit breaker main contacts should be separate from arcing contacts

Locking facilities in the 'Service', 'Test', and 'Isolated', positions. In test position the breaker will be tested without energizing the power circuits. The breaker shall remain fully housed inside the compartment in the test position. Complete operation of the circuit breaker and trip unit must be accessible without opening the circuit breaker door

Minimum 6 NO and 6 NC potential free auxiliary contacts, rated 10 A at 240V AC and 1A inductive breaking at 220 V DC

Following indicating lamps for ACBs shall be considered :

(a) On

(b) Off

(c) Trip

(d) Test Position

(e) Service Position

(f) Spring Charged

(g) Trip Circuit healthy

(h) Control Supply Healthy

R, Y, B indication lamps, Lamp test push button, Emergency trip push button shall be considered at incomers.
Trip shall be independent of local/remote. Emergency trip push button shall be mushroom type with lockable key
Closing and trip coil shall operate satisfactorily under the following conditions of supply voltage variation:

(a) Closing coils - 85% to 110% of rated voltage.

(b) Trip coils - 70% to 110% of rated voltage.

When series trip circuit breakers are specified the following micro processor releases with adjustable settings shall be provided:

(c) Overload

(d) Short circuit

(e) Under voltage

(f) Earth fault

For four pole breaker the microprocessor based earth fault release shall be in built. For TPN breaker the microprocessor based earth fault release shall be in built with input from a separate neutral CT

In addition to the adjustable current setting range specified in the Data Sheet- short circuit releases shall be provided with at least four adjustable time delay settings, If it is not possible to provide the specified adjustable current setting range for the short circuit releases, shunt trip circuit breakers together with necessary protective relays shall be offered and shall be indicated in Data Sheet-B by the VENDOR.

Facilities shall be provided for blocking the under-voltage release, if so required at Site.

Each of the foregoing releases shall be provided with a single pole, double throw, potential free alarm contact rated for 0.5A, 220V D.C / 10A, 240V AC.

The breakers controlling motors shall operate satisfactorily under following conditions:

(g) Direct-on-line starting of the specified motor.

(h) Breaking no load current of the specified motor.

SPRING OPERATED MECHANISM

The operating mechanism shall be manually operated spring charging stored energy type or with motor, opening and closing springs, limit switches for automatic charging and all necessary accessories. Facility for manual charging of the closing spring shall be provided. The operating mechanism shall be trip-free and non-pumping electrically.

Power operated mechanism shall be provided with facilities for remote panel closing and opening operations whenever specified in Data Sheet-A3 as per breaker module designation and respective enclosed control scheme drawings if attached.

The control scheme will be as follows for remote control:

Sl.No.	Breaker Position	Service	Test

	Selector Switch	Local	Remote	Local	Remote
(i)	Switchgear Protection Tripping	Yes	Yes	Yes	Yes
(j)	Remote Interlock Tripping	Yes	Yes	-	-
(k)	Switchgear Manual Closing	-	-	Yes	-
(l)	Remote and Auto Closing through Interlocks	-	Yes	-	Yes
(m)	Switchgear Manual Tripping	Yes	-	Yes	-
(n)	Remote Manual Tripping	Yes	Yes	-	Yes
(o)	Local P.B. Station of Motor (For breaker Operated motors)				
	(i) Closing for trial run	Yes	-	-	-
	(ii) Tripping	Yes	Yes	Yes	Yes

Power operating mechanisms shall be provided with the following additional features:

(a) Closing of the circuit breaker shall automatically initiate recharging of the spring ready for the next closing stroke.

(b) The motor shall be mechanically decoupled as soon as the emergency manual charging handle is coupled.

All ACBs shall be with Icu=Ics=Icw=100%

The ACBs shall be suitable for remote communication (SCADA control) if specified in Data Sheet A

PROTECTION COORDINATION

It shall be the responsibility of the Vendor to fully coordinate the overload and short circuit tripping of the circuit breakers with the upstream and downstream circuit breakers/fuses/motor starters, to provide satisfactory discrimination. Protective releases shall be EMC compliant. The release shall be protected against non-linear loads and shall not cause nuisance tripping due to harmonics. All protective components esp. ACBs and MCCBs installed in PCC and at Incomer of downstream Panels shall be with Utilisation Category "B" (i.e. offering time discrimination with downstream devices)

AIR BREAK SWITCHES

Air break switches shall be of the heavy duty, group operated load-break, fault-make type, complying with the requirements of applicable standards mentioned in Data Sheet

Continuous current rating of switches shall be as specified in Data Sheet-A3 or single line diagram enclosed with specification.

Whenever solid link are used for the connections between switches and fuses, such links shall be fitted with insulated sleeves. Whenever the links are of less than 100 mm length where sleeves cannot be fitted, taping is acceptable.

All live parts of the switch shall be shrouded.

Switch operating handle shall be suitable for padlocking in 'OFF' position.

It shall be possible to open the door only when the switch is in the 'off' position.

Suitable means shall be provided to intentionally release the interlocks specified in the preceding clause 6.6 for making trip setting adjustments and operation tests.

FUSES

Fuses generally shall be of the HRC cartridge fuse-link type having a certified rupturing capacity of not less than 80 kA at 440V.

Fuses shall be provided with visible indication to show that they have operated.

Fuse ratings chosen by the VENDOR for application in various circuits shall be subject to the PURCHASER'S approval.

Fuses shall preferably be mounted in moulded plastic carriers and shall be complete with fuse bases.

Wherever it is not possible to mount fuses on carriers, fuses shall be directly mounted on plug-in type of bases. In such cases an insulated fuse pulling handle shall be provided for each size of fuse for each switchboard.

Current time characteristics of fuses shall be furnished along with bid.

MOTOR STARTERS

CONTACTORS

Motor starter contactor shall be of the electromagnetic type rated for uninterrupted duty as defined in applicable standards unless otherwise specified in Data Sheet-.

Operating coils of contactors shall be suitable for operation from the control supply system specified in Section-B or as per control schemes if enclosed. Operating coils shall be of the low burden type if specified in Data Sheet

Class of coordination for starter module shall be Type '2'.

DIRECT-ON-LINE STARTERS

Direct-on-line starters shall be suitable for Class AC 3 utilization category as specified in applicable standards, unless otherwise mentioned in Data Sheet.

AUTOMATIC STAR-DELTA STARTERS

Automatic star-delta starters shall comprise three sets of contactors one for the line, one for the star point and one for the delta, and a timer to automatically change the connections from star to delta.

Star-delta contactors shall be electrically interlocked to permit starting of the motor in the proper sequence, namely star contactor closing, line contactor closing, timer energized after time delay, timer contact de-energizing the star contactor, and delta contactor closing.

Star-delta starters shall be suitable for AC 3 utilization category as specified in applicable standards, unless otherwise mentioned in Data Sheet-.

The Star-delta starters shall be with open or closed transition as specified in Data Sheet

REVERSING STARTERS

Reversing starters shall comprise forward and reverse contactors, electrically interlocked with each other.

Reversing starters shall be suitable for Class AC 4 duty as specified in applicable standards, unless otherwise mentioned in Data Sheet-.

THERMAL OVERLOAD RELAYS

Starters shall be complete with a three element, positive acting, ambient temperature compensated, time lagged thermal overload relay with adjustable settings and built in single phasing preventer. The setting range shall be properly selected in accordance with the rating of the motor.

Thermal overload relays shall be hand reset type, unless otherwise specified in Data Sheet-.

'Stop' push button of the starter and hand reset device shall be separate from each other.

Overload relay hand reset push button shall be brought out on the front of the compartment door.

SWITCH AND CONTACTOR RATINGS

Switch and contactor rating for various motor starter modules shall be selected by the bidder and indicated in the bid. BIDDER shall also select appropriate ratings for HRC fuses and ranges for thermal overload relays and indicate the same in the bid. These details shall be subject to the PURCHASER'S approval.

MOULDED CASE CIRCUIT BREAKERS (MCCB)

Moulded case circuit breakers (MCCBs) shall be provided when called for in Data Sheet-/SLD, for use in lieu of switch-fuse for the motor controls. The MCCBs shall conform to the latest applicable standards.

MCCBs in AC circuits shall be of triple/four pole construction arranged for simultaneous three/four pole manual closing and opening as indicated in Data Sheet /SLD. If indicated in Data Sheet-, power closing device for remote operation shall be provided. Operating mechanism shall be quick-make, quick-break and trip-free type. The ON, OFF and TRIP positions of the MCCB shall be clearly indicated and visible to the operator. All MCCBs shall be provided with rotary operating handle with door interlock feature

The instantaneous short circuit release shall be so chosen by the VENDOR as to operate at a current in excess of the peak motor inrush current and a range of settings shall be provided for the PURCHASER'S selection.

MCCB terminals shall be shrouded and designed to receive cable lugs for cable sizes relevant to circuit ratings.

All MCCB feeders shall be provided with ON/OFF/TRIP indicating lamps through auxiliary contacts.

All MCCB's shall be with Icu=Ics=100%.

All MCCBs shall be provided with 2 NO + 2 NC aux. contacts exclusively for Purchaser's use or as specified in Data Sheet

All the MCCBs shall be of current limiting type and shall provide a cut off in, < 10 ms for prospective currents during faults.

The MCCB's shall be provided with thermal magnetic or microprocessor-based overload, short circuit and earth fault releases as specified in Data sheet . For four pole MCCB the microprocessor-based earth fault release shall be inbuilt. For TPN MCCB the microprocessor-based earth fault release shall be inbuilt with a separate neutral CT input or the earth fault protection shall be provided by CBCT, ELR and shunt trip coil. For thermal magnetic release the earth fault protection shall be provided by CBCT, ELR and shunt trip coil.

MINIATURE CIRCUIT BREAKERS

Miniature circuit breakers for use on motor, space heater control circuits shall comply with the requirements of applicable standards, unless otherwise mentioned in Data Sheet-.

MOTOR PROTECTION CIRCUIT BREAKERS(MPCB)

Motor protection circuit breakers (MPCBs) shall be provided when called for in Data Sheet-/SLD, for use in lieu of switch-fuse for the motor controls. The MPCBs shall conform to the latest applicable standards.

ELECTRONIC OVERLOAD RELAYS

Electronic overload relays shall be provided when called for in Data Sheet-. The relays shall conform to the latest applicable standards.

SOFT STARTERS/AUTO TRANSFORMER STARTERS

Magnetic flux controlled or electronic or auto transformer starters shall be provided when called for in Data Sheet. They shall conform to the latest applicable standards.

EARTHING

An earthing bus shall be provided at the bottom and extended throughout the length of the switchgear. It shall be bolted / welded to the frame work of each unit and each breaker earthing bar. Earth bus-bar shall be extended outside the Panels/DBs at both the ends. The size shall be selected based on the rated symmetrical short circuit rating of the associated switchboard/ panel. The same shall be properly

supported to withstand stresses induced by the rated symmetrical short circuit current.

All non-current carrying metal work of the switchgear shall be effectively bonded to the earth bus. Hinged doors and detachable components inside the feeder shall be earthed through individually flexible earthing braid. The earth wire shall be green colour (with yellow band), FRLS PVC insulated, multi stranded copper conductor wire of size 4 sq.mm duly crimped with ring type lugs and to be looped & connected to horizontal earth bus

Positive earthing of the circuit breaker/ disconnector frame shall be maintained both in service and test position.

INSTRUMENT TRANSFORMERS

The ratings of instrument transformers specified in SLD or A3 are approximate. The BIDDER shall ensure that the specified ratings are adequate for the relays and meters furnished by him. If specified ratings are not adequate the BIDDER shall offer instrument transformers of required rating.

The CTs and VTs shall be cast resin type or nylon encapsulated as specified in Data Sheet with insulation Class B or better and withstand momentary and short time current ratings of the associated switchgear. For feeders with fuse, CTs shall have withstand capacity equal to let-through current of associated fuse.

Unless otherwise specified in SLD or Data Sheet A3 minimum performance requirements of CT's & VTs shall be as follows :

Current Transformers:

(p) Measuring CTs - 10VA, accuracy Class 0.5 and ISF of 5 Protective CTs - 5 VA , accuracy class of 5P-10

(q) CTs shall be provided with test links in both secondary leads for carrying out current and phase angle measurement.

Voltage Transformer

(r) Measuring VT's - 50 VA per phase with accuracy class of 0.5

(s) Protective VT - 50 VA per phase with accuracy class of 3.0.

(t) Dual purpose VT - 100 VA per phase and dual accuracy of 1.0/3.0 for metering and protection respectively

(u) Voltage transformer shall have continuous over voltage factor of 1.2 and short time over voltage factor of 1.5 for 30 seconds for effectively earthed system and 1.9 for 8 hours for non-effectively earthed system.

(v) Voltage transformers shall be complete with suitable rated protective devices like Fuse / MPCB/ MCB for primary, secondary and tertiary winding. Primary protective device shall have a rupturing capacity equal to the rupturing capacity rating of the associated switchgear. Protective device shall be provided on each sub circuit.

(w) It shall be possible to replace voltage transformers without having to de-energies the main bus bars.

(x) The terminals of VT secondary and tertiary windings which are required to be connected to earth shall be earthed by an isolating link without a fuse.

Current transformers shall have polarity markings indelibly marked on each transformer and at the lead terminations at the associated terminal block

Current transformers shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit and momentary duties of the switchgear, as indicated in the Technical Specification. CT core laminations shall be of high grade silicon steel. Identification labels shall be fitted giving type, ratio, rating, output and serial numbers

SWITCHGEAR ACCESSORIES AND WIRING

Switchgear shall be supplied completely wired internally up to terminal blocks ready for the PURCHASER's external cable connections at the terminal blocks. Inter panel wiring between cubicles of same switchgear shall be routed inside by the VENDOR.

All auxiliary wiring shall be carried out with 1100 volts grade, single core, multistranded copper conductor with FR PVC insulation.

Following sizes and colour coding shall be used for the Panel wiring :

(a) Control circuit wiring minimum 1.5 Sq.mm Grey colour wire.

(b) CT circuit wiring minimum 2.5 Sq.mm Red, Yellow & Blue colour wire.

(c) PT circuit wiring minimum 1.5 Sq.mm Red, Yellow & Blue colour wire.

(d) Power circuit wiring minimum 4.0 Sq. mm Red, Yellow & Blue colour for Ph and Black for Neutral wire.

(e) Earthing wire – Green/ Green with Yellow colour Band

Terminal blocks shall be of stud type, 1100 volts grade, 10 amps. rated complete with insulated barriers. Terminal blocks for CTs and VTs shall be provided with test links and isolating facilities and CT terminals shall have short circuiting and earthing facility. Terminals shall be suitable to take up two numbers of 2.5 sq. mm. copper wires. All terminals of different control voltages shall be separate from each other. Suitable barriers shall be provided between two terminals connected to different voltage supplies

All spare contacts and terminals of cubicle mounted equipment and devices shall be wired to terminal blocks. 20% spare terminals to be provided for each terminal strip for each panel. The terminal blocks shall be located suitably spaced from each other and atleast 200mm from the side/ bottom wall or any adjacent feeder component to provide better convenience for running the wire troughs and termination of the control cables. All panels shall have Terminal block suitable for connecting minimum 6sq.mm. conductor unless otherwise stated

Accuracy class for indicating instruments shall be as specified in Data Sheet. Instruments shall be 96 mm square 90° scale or 144 mm square taut band type as specified in Data Sheet for semi-flush mounting with only flanges projecting. The instruments shall be analogue or digital type as specified in Data Sheet . All digital meters shall indicate true RMS. Digital Multifunction meter shall display all electrical parameters like (but not limited to) following metering features : Current,

Voltage, Frequency, Energy (kWh), MD (kW/kVA), PF, kVAh, kVAr, kVARh, V THD, I THD, etc. For analogue meters dials shall be white with black numbers and lettering

Relays shall be suitable for semi-flush mounting with only flanges projecting.

All protective relays shall be in draw-out cases with built-in test facilities. Necessary test plugs shall be supplied loose and shall be included in the VENDOR'S scope of supply. All auxiliary relays and timers shall be supplied in non-draw-out cases. All relays shall be of self reset type except lockout relay unless otherwise specified. Externally operated hand reset flag indicators shall be provided on all relays and timers. Timers shall be of electronic type only. All protective relays shall be electro magnetic type or numerical as specified in Data Sheet

Control and instrument switches shall be rotary type provided with escutcheon plates clearly marked to show operating position and suitable for semi flush mounting with only switch front plate and operating handle projecting out.

Breaker control switches shall be pistol grip black and selector switches shall be oval or knob, black. Breaker control switches shall be 3 position spring return to neutral. Instruments selector switches shall be of the maintained stay-put type. Contacts of the switches shall be spring assisted and contact faces shall be with rivets of pure silver. The contact ratings shall be adequate to meet the requirements of circuit capacity in which they are used. If specified in Data sheet , control switches with built-in flashing type discrepancy lamp shall be provided to control circuit breaker.

Push buttons shall be provided wherever specified. They shall be provided with inscription plates engraved with their functions. Push buttons shall be rated for 10A at 240 AC and 1A at 220 VDC, with 2 NO and 2NC contacts. Start PB shall be green in color and stop PB shall be red colored stay put type.

Indicating lamps shall be Cluster type LEDs.

Space heaters of adequate capacity shall be provided inside each vertical section of the switchboard. They shall be suitable for 240 V, 1 ph, 50 cycles supply. They shall be complete with MCB or HRC fuses as specified in Data Sheet , isolating switches and adjustable thermostat (range 25 to 90 degree centigrade). Heater shall be mounted at bottom of the panel with cover to avoid accidental contact of heater with skin.

Each switchgear panel shall be provided with 240 Volts, 1 phase. 50 cycles, 6 amps. 5 pin receptacles with switch/ MCB located in a convenient position.

The single phasing preventer relay shall be provided when called for in Data sheet- and shall have following characteristics:

(a) Operate for supply voltage unbalance of more than + 5% and when relay internal wiring is open circuited.

(b) Not operate for 3 ph supply failure.

(c) Instantaneous hand reset type

(d) Visual indication for operation

(e) Suitable for reversible and non-reversible motors

<u>WINDOW TYPE ALARM ANNUNCIATOR</u>

The alarm annunciator if called for in Data Sheet- shall consist of flush mounted facia and shall have following features:

(f) Fault indication by steady lit window

(g) Audible alarm on fault occurrence

(h) Acknowledgement, resetting and test

(i) Suitable for NC/NO initiating contacts

(j) Facility for separate audio-visual alarm on control supply failure

The alarm annunciator scheme operation shall be as follows:

			Visual Alarm	Audible Alarm
(k)	Normal		OFF	OFF
(l)	On occurrence of fault -			
	(i)	First fault	Flashing	ON
	(ii)	Subsequent faults	Flashing	ON
(m)	Accept fault -			
	(i)	First faults	Steady	OFF
	(ii)	Subsequent faults	Steady	OFF
(n)	Reset - Faults cleared		OFF	OFF
(y)	Faults not cleared		Steady	OFF
(z)	Lamp test		Steady	OFF

Panel wiring and cabling shall be cross-ferruled. Each control wire shall be with identification ferrule of Terminal No., component designation and cross ferruling on both sides. Ferrules shall be printed type.

Panel illumination lamp shall be 9 W LED lamp with fixture & door limit switch. It shall be provided inside incomer and each cable alley / compartment.

Separate metering compartment shall be provided for all analogue / digital meters and its accessories like load manager, voltmeter, ammeter, indication lamp, Voltmeter and ammeter selector switch etc. All wiring & MCB / fuses shall be mounted in metering compartment such that meter maintenance is independent of the power compartments.

All power wiring for rating up to and including 63A shall be carried out with 1.1kV grade coloured FR PVC insulated, for phase identification, multi stranded copper wires duly crimped with ring type lugs.

Power connections for rating above 63A shall be done with bus bars (machine bend for proper profile) insulated with black heat shrinkable sleeves with phase identification-coloured tapes duly supported on SMC insulators and placed with required clearance between phases and between phase to ground/ neutral as specified in Data Sheet . Such bus when brought out of the feeder for cable connections shall be sufficient enough and profiled suitable for termination of the prescribed number of cables as indicated in the SLDs enclosed

ARC RESISTANCE

The switchgear assembly shall be certified as Arc Resistant. The minimum arcing duration used for testing shall be 500ms as specified in the applicable standard.

Rear venting flaps in the panel shall be provided for added air flow under normal operating conditions but automatically close during an arc event to prevent pressure and gases from escaping.

The panel top shall be provided with roof flaps for pressure relief created by an internal arcing event.

CABLE TERMINATION

If asked for in Data Sheet- the necessary number of cable glands and lugs shall be supplied for terminating power and control cables. Glands shall be double compression type, of heavy-duty brass castings, machine finished and complete with check nut. washers, neoprene compression ring etc. The lugs shall be tinned copper/ aluminum depending on cable conductor and of solder-less crimping type.

LOCAL PUSH BUTTONS/ PB STATIONS

The local P.B. stations shall be metal enclosed, provided with IP-55 protection, made up of die-cast aluminum or 2 mm thick sheet metal.

The P.B. station shall be suitable for wall or structure mounting, provided with labels, earthing terminals, suitable lugs glands.

Push buttons shall be fitted with 2NO and 2NC contacts (1A at 220V DC and 10A at 240V AC) with stop PB of stay put type and red in color. Other PB's shall be green in color.

PB station shall be of one of the following types.

Type A - Three PB’s forward-reverse-Stop for reversible motors

Type B - Two PB's start-stop for non-reversible motors

Type C - One PB STOP for emergency

Start push button shall be recess type, spring return. Stop push button shall be stay-put lockable type with Mushroom head.

Start" and "Stop" push buttons shall be coloured green and red respectively.

SPARE PARTS

The BIDDER shall furnish a list of recommended spare parts for five years operation along with unit prices.

TESTS AND REPORTS

Type test reports for the switchgear panel of similar rating for the following tests shall be submitted along with the Bid (not older than 5 years):

(a) Temperature rise

(b) Degree of protection

(c) Internal arc

(d) Short circuit

(e) Salt spray test for a minimum duration of 500 hrs (if asked for in Data Sheet)

The switchgear, circuit breakers and all associated equipment shall be tested in accordance with relevant standards. All routine tests shall be carried out. Type tests shall also be carried out if not tested previously.

Type and routine test report shall be submitted for the PURCHASER's approval before the equipment is dispatched. Bound copies of test reports shall be furnished along with the switchgear.

All meters and other reference devices used for testing shall have valid calibration from reputed national / international laboratories / institutes as applicable. Inspection by Purchaser/ Engineer will not be carried out unless the Vendor confirms that calibrated equipment are ready for proceeding with the tests

Equipment shall not be dispatched unless the test certificates are duly approved by the PURCHASER/ ENGINEER.

Vendor shall carry out all routine tests as specified in relevant IS/ IEC standards on all major components and furnish copies of test reports for PURCHASER's approval. Wherever required, Vendor shall conduct the necessary type tests in the presence of PURCHASER's representative based on the unit prices available in the bid.

Vendor shall also carry out all routine and functional tests as specified in the relevant IS/IEC on the assembled switchgear panels in the presence of the PURCHASER's representative at work before despatch and furnish copies of test reports for approval. If required stage inspection, will be carried out by the Purchaser.

VENDOR shall furnish copies of routine test report for all bought out items for PURCHASER's approval.

DRAWINGS AND DATA

The following shall be furnished as part of the tender:

General arrangement showing plan, elevation and typical sectional views.

Technical literature on the equipment offered.

Quality Assurance Plan.

MAINTENANCE REQUIREMENTS

Easy access shall be provided for all components in the switchgear for maintenance.

As far as possible the switchgear shall be so designed that no special tools are necessary for installation and maintenance. However, if special tools are required, the Bidder shall include price of one complete set in his bid.

The Bidder shall include supply of Essential spares specified in Data sheet- and also Recommended Spares for three (3) years trouble free operation, in Section-F.

Vendor shall furnish detailed inter panel wiring diagrams, internal wiring diagrams, detailed component layout drawings to enable the purchaser to carry out maintenance work.

DATA TO BE FURNISHED BY THE VENDOR AFTER AWARD OF THE CONTRACT

LIST OF DRAWINGS

The VENDOR shall furnish the following drawings for each panel after placing the order. If a large number of switchgears are involved, the PURCHASER will indicate the priorities.

Overall outline dimensions and general arrangement including plan, front elevation, rear & side elevations, clearances required in front and back, details of bus duct connections, if any.

Switchgear layout plan including floor openings, fixing arrangements and loading details.

Schematic control diagrams to cover controls, protection, interlocks, instruments, space heaters, etc. for each type of module

Detailed internal wiring diagram of each type of module, including terminal block numbers, ferrule numbers and the PURCHASER's external cable connection designations

Itemised bill of material for each switchboard

Interpanel interconnection wiring diagram including terminal numbers and ferrule numbers

Switch development diagrams

Each type of protection relay and circuit breaker release characteristics

Fuse characteristic curves for each type and rating of fuse

(a) The VENDOR shall be entirely responsible for the correctness of the internal wiring diagrams

TEST CERTIFICATES

Type test certificates of all standard component parts, e.g. contactors, breakers, switches, fuses, relays, CTs, VTs, and for the standard factory built assembly shall be submitted by the VENDOR within 3 months from receipt of order.

INSTRUCTION MANUALS

The VENDOR shall furnish specified number of copies of the instruction manual which would contain detailed instructions for all operational and maintenance requirement. The manual shall be furnished at the time of despatch of the equipment and shall include the following aspects :

All final approved scheme drawings and single line diagrams shall be submitted in latest version of AUTOCAD and the same shall be submitted in CD’s

(a) Outline dimension drawings showing relevant cross-sectional views, earthing details and constructional features.

(b) Rated voltages, current, duty-cycle and all other technical information which may be necessary for correct operation of the switchgear.

(c) Catalogue numbers of all components liable to be replaced during the life of the switchgear.

(d) Storage for prolonged duration.

(e) Unpacking.

(f) Handling at site.

(g) Erection.

(h) Pre-commissioning tests.

(i) Operating procedures.

(j) Maintenance procedures.

(k) Precautions to be taken during operation and maintenance work.

1.	LOW VOLTAGE POWER FACTOR CORRECTION	□IS: □ BS: □ IEC 61921
2.	AC CIRCUIT BREAKERS	□ IS 60947-2 □ BS:3871(PI) □ IEC 60947-2
3.	LOW VOLTAGE SWITCHGEAR AND CONTROL GEAR	□ IS:61439 □ BS:5486 □ IEC:61439
4.	AIR BREAK SWITCHES	□ IS:60947-3 □ BSEN:60947-3 □ IEC-60947-3
5.	CURRENT TRANSFORMERS	□ IS:2705 □ BS:7626 □ IEC:60044
6.	VOLTAGE TRANSFORMERS	□ IS:3156 □ BS:7625 □ IEC:60044
7.	DEGREE OF PROTECTION	□ IS:60947(PI) □ BS: □ IEC:60947-1
8.	CODE OF PRACTICE FOR INSTALLATION AND MAINTENANCE OF SWITCHGEAR	□ IS:10118 □ BS: □ IEC:

9.	CODE OF PRACTICE FOR PHOSPHATING IRON AND STEEL	□ IS: 6005 □ BS: 3169 □ IEC:
10.	GUIDE FOR TESTING UNDER CONDITIONS OF ARCING DUE TO INTERNAL FAULT	□ IS: □ BS: □ IEC 61641
11.	TESTING GUIDE	□ ANSI/IEEE C.37.20.7
	EQUIPMENT, ACCESSORIES, COMPONENT PARTS, RAW MATERIALS AND TESTS SHALL BE IN GENERAL CONFORM TO ☐ IS: ☐ BS ☐ IEC:	

5. APFCR PANELS

This specification covers the design, material, principle of operation, manufacture, inspection and testing at the Vendor's works, delivery to site and performance testing of capacitor controller for automatic switching of capacitor banks sequentially as required to give a desired power factor.

The relay shall be numerical type giving signal to contactors/ TSC (thyristor switched capacitors) for switching on/off preset number of capacitor units.

The relay shall have sufficient output contacts to switch on required number of capacitors as required.

CODES & STANDARDS

The codes and standards mentioned in the various specifications and requirements specified in the enquiry document shall be the latest as on the day of execution of the works unless otherwise specified. The revisions in the relevant codes and standards after the date of award of contract shall be informed by the Contractor to the Consultant/ Owner within 30 days of the issue of such revision of the code/ standard. Consultant/ Owner may approve use of the earlier code/ standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed.

BASIC REQUIREMENTS

It would be a digital electronic device for the automatic/manual control of power factor correction capacitors on three phase system. It shall detect the power factor lagging and leading reactive power (kVAr) component above preset levels, and then switch the appropriate number of capacitors 'IN' or 'OUT' to achieve the optimum average power factor without system operating under leading power factor condition.

The digital relay would have low VA burden and final switching of appropriate capacitor banks would be achieved by switching on/off of Contactors/TSC, through initiation of this device.

PRINCIPLE OF OPERATION

On deviations from set power factor, the controller shall release command signals to switch on/switch off capacitor bank stages and maintain the set power factor. The dead band shall be provided in the inductive and capacitive region of the set power to avoid frequent switching operations. The dead band limit shall be adjustable depending upon the switching steps.

The device shall have various programming steps to set different switching combinations to take care of varying load conditions.

STANDARD FEATURES

(a) To measure/monitor power factor and VAr continuously. Status of switching step shall be displayed through LED.

(b) Following adjustment shall be provided.

- Power factor
- Dead band capacitive region with respect to set power factor (pf).
- Inductive region with respect to set pf
- Operating time for programmable switching steps.
- Auto/manual selector switch.
- Manual step control.

(c) All control knobs, LEDs for display and selector switches shall be mounted on the front face of relay casing/panel.

(d) It shall be fully programmable.

(e) There shall be a choice for customer to select operating sequence upto 4 to 5 which will have maximum number of steps of capacitors equal to sixteen (16 Nos). The sequence shall be arithmetic 1,2,3….6,7,8.

(f) Operating time selection of time interval designation between switching stages shall be possible using time selector switches. The device shall take care that any stage which has just been switched out, will only be reconnected by the pulse counter, after 60 secs. has elapsed so that it has safely discharged. This is a requirement for 415V capacitors; for 11kV or 6.6 kV capacitors the time interval for any stage to be switched again shall be 10 minutes (corresponding to the safe discharge time for 11kV or 6.6 kV capacitors).

(g) Loss of voltage element. This would prevent abnormal switching surges on loss of supply. Also, it would control the switching on/off surges.

(h) Dead band features – Relay response sensitivity adjustable using dead band so that hunting is prevented.

Auto/Manual control – This would help testing and commissioning at site as well as ease in operation when either mode fails during service time.

DATA TO BE FURNISHED BY THE VENDOR AFTER THE AWARD OF CONTRACT

Sl,No.	DOCUMENTS	PURPOSE
1.0	Instruction manuals	For Information
2.0	Test Reports	- do -
3.0	Schematic diagram for PF control	- do -

4.0	Essential spares	- do -
5.0	General Arrangement drawing of controller panel showing main dimensions, type of mounting, weight etc.	For Further Engineering

SL. NO.	BRIEF NAME	REFERENCE STANDARDS		
1.0	APPLICABLE STANDARDS			
1.1	Electrical relays for power system protection	□ IS-3231	□ BS	□ IEC-60255
1.2	Environmental tests for electronic & elec. equipment	□ IS-9000	□ BS	□ IEC 60068-2
1.3	Shunt capacitors for power systems	□ IS 13585 & 13925	□ BS	□ IEC-60871 & 60931

ACTIVE HARMONIC FILTER

This specification defines the requirements for active harmonic filter systems in order to fulfill the requirements of IEEE-519-1992 or IEEE-519-2014 for the harmonic current limits. By reducing harmonic current in the network, the active harmonic filter will increase the lifetime of the electrical equipment and increase the customer's electrical energy efficiency.

- General Requirement -
- The active harmonic filter shall be provided by reputable supplier who can demonstrate adequate experience in the power quality and active harmonic filtering sector.
- The supplier's manufacturing process shall be audited in accordance with ISO 9001 quality standard.
- The active harmonic filter shall be connected in parallel with the load to be compensated.
- The active harmonic filter shall be compatible with any supply voltage from 200 V up to 480 V.
- The active harmonic filter shall be compatible with both 50Hz and 60Hz networks.
- The nominal output current of the active harmonic filter modules shall be as per SLD/BOQ. It should be expandable to any range by means of paralleling.
- The configuration of the active harmonic filter shall be selectable to either 3-wire or 4-wire connection in order to filter harmonics from phase conductors and optionally the neutral conductor.
- The active harmonic filter shall not need any external controller other than those built into the unit.
- The active harmonic filter shall measure all three phases of line current in real time and generate the measured harmonics currents in opposite phase by means of a Digital Signal Processor (DSP) based system.

- The active harmonic filter power inverter module shall be neutral point clamped 2-level topology based IGBT technology to provide good and accurate output current. The PWM modulation technology using fixed switching frequency shall be used. The switching frequency shall not be less than 20kHz to minimize audible noise.
- The active harmonic filter shall be capable of measuring the network currents from either the supply side or the load side allowing closed loop or open loop current control.
- The current signal provided by split core current transformers of Class 0.5 accuracy shall be sufficient for proper filter operation and performance.
- There shall be galvanic isolation between the current measuring transformer signals and active harmonic filter control electronics input.
- Ability to cancel all odd harmonics up to 51st order. These harmonics are individually selectable and programmable with on limitation.
- Control method using the FFT (Ulta-fast computation) using digital controller
- The active harmonic filter shall have an operation mode enabling the user to set a target percentage of wanted mitigation of harmonic components
- The active harmonic filter shall be capable of providing fundamental frequency reactive power compensation up to full nominal output. This reactive power can be either capacitive or inductive.
- The active harmonic filter shall be capable of load balancing up to full nominal output current.
- The active harmonic filter shall have an automatic re-start feature enabling recovery of normal operation after a black out of the supply system or after being subjected to a non-severe condition.
- The active filter shall recognize the main voltage rotation and give indication if this is not correct
- The active harmonic filter shall have speed-controlled fans which are controlled via temperature in order to increase component lifetime and decrease heat losses.

Control Circuit

a. Control MCB of rating 10A-FP-10kA-C Curve to provide power supply to the control circuit of the active filter
b. Advanced DSP microprocessor controller which shall monitor the voltage and current in the three phases (Red, Yellow and Blue) to compute the exact power requirement in the three phases, and thus, implement the following features - step-less compensation of leading and lagging power factor, harmonics compensation and load balancing
c. Suitable number and rating of voltage and current sensing circuits
d. Necessary control and firing cards with proper wiring and lugs of required rating shall be provided
e. Suitable number and rating of any other items, e.g. relays, SMPS, etc.
6. The APFC panel shall have the following features, in addition to those already mentioned above:
i. Panel shall be suitable for operation within an ambient temperature between 0 deg C and 45deg C
ii. Panel shall have an audible noise level lesser than 70db iii. Panel shall have a filtering efficiency of at least 97%
iv. Panel shall have a reaction/response time of at least 200 micro-seconds

v. Power factor correction shall always be set at first priority Target PF level shall be programmable at the time of commissioning
vi. Priority selection between the remainder features - harmonics compensation and load balancing - shall be programmable at the time of commissioning In the default mode, harmonics compensation is set at 2nd priority and load balancing is set at 3rd priority
vii. Auto fold-back of the HPFC panel if total current requirement exceeds the rated capacity of the panel
viii. Bus-bars or cables shall be suitably color coded and mounted using appropriate insulator supports Suitable clearances shall be provided for the bus-bars and other live parts of the system as per international standards
ix. All live parts of the system shall be properly shrouded
x. Inspection terminal strip, number ferruling, and other labeling shall be suitably provided
xi. Stickers marked with “DANGER” shall be provided wherever required
xii. Detailed drawings and manuals shall be provided wherever required
xiii. Following protections shall be provided:
a. Over voltage (AC) protection
b. Over voltage (DC) protection
c. Phase sequence protection
d. Over current protection
e. Over temperature protection
f. Protection circuits for the inverter stack and its components
xiv. All components and wiring used in the system shall adhere to the relevant ISI and IEC standards

6. CABLES

This specification covers the requirements of Power Cables up to 33kV, Control, Instrumentation (up to 400 degrees centigrade), Communication and Lighting Cables with general purpose insulation and sheaths. Requirement of special outer sheaths with Heat Resistant (HR), Fire Survival (FS) and Flame Retardant Low Smoke (FRLS) characteristics are also covered in this specification.

CODES AND STANDARDS

The codes and standards mentioned in the various specifications and requirements specified in the enquiry document shall be latest as on the day of award of contract of the works unless otherwise specified. Contractor shall be responsible to inform to the Consultant/ Owner in case of any revisions/re-affirm/amendment in the relevant codes and standards after the date of award of contract within 30 days of the issue of such revision/re-affirm/amendment of the code/ standard. Consultant/ Owner may approve use of the earlier code/ standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed.

GENERAL CONSTRUCTIONAL FEATURES

The following aspects are applicable for all types of cables covered in this specification.

Conductor

(a) Aluminium conductor, circular, compacted stranded, grade H4, Class 2 as per IS mentioned in data sheet for power cables. ‘Ó’ grade aluminium shall be used for solid conductor of the welding cable conductor.

(b) Annealed, stranded Copper Conductor, Class 2 as per relevant IS for control cables. For flexible cable, class shall be 5 or 6 and for CU welding cable, class shall be 6.

Conductor Screen

All cables rated above 3.3/3.3 kV shall be provided with conductor screening. Conductor screening shall be provided over the conductor by applying non-metallic semi-conducting tape or by extrusion of semiconducting compound or a combination of the two.

Insulation

Insulation for cables shall be XLPE for HV power cable (above 1100V grade) and PVC/ XLPE for LV power (1100V grade), control / lighting / instrumentation and communication cable applied by extrusion.

Core Identification

Colour coding shall be acceptable for all cables up to 5 cores. Cables with more than 5 cores shall have printed numerals every 50mm on each core.

Inner Sheath

Inner sheath when specified shall be extruded type PVC and shall be compatible with the insulation provided for the cables as per IS mentioned in data sheet.

Armour

Armouring for the cables shall comprise galvanised steel or hard drawn aluminium, in the form of round wires or strips following IS mentioned in data sheet.

W	-	Galvanised round steel wire
F	-	Galvanised flat steel strip
AW	-	Hard drawn single aluminium wire.
AS	-	Hard drawn single aluminium strip

Insulation Screening

(a) All cables rated above 3.3/3.3 kV shall be provided with insulation screening. The screening shall consist of one or more of the following, as Specified.

(i) Non-metallic part – it shall be applied over the insulation of each core and shall consist of either semiconducting tape or extruded semi conducting compound or a combination of the two.

(ii) Metallic part – it shall consist of either tape, or braid, or concentric serving of wires or a sheath. It shall be non-magnetic and shall be applied over the non-metallic part.

NOTE-The semi-conducting tape and semi-conducting compound shall be suitable for the operating temperature of the cable and compatible with the insulating material.

Outer Sheath

The outer sheath shall be of an extruded layer of PVC (poly vinyl chloride) compound with the specified ambient and operating temperature of the cables. The sheath shall be heat resistant, resistant to water, ultraviolet radiation, fungus, termite and rodent attacks. The colour of the outer sheath shall be black. PVC sheath shall meet the requirements of standards covered under 3.1.5 above.

Requirement of special sheath with Fire Survival (FS) and Flame Retardant Low Smoke (FRLS) characteristics shall be as per clause 5.0. Requirement of Fire Protective Paint on outer sheath of the cable shall be as per Data Sheet.

Cable Drums

Cables shall be supplied in non-returnable wooden or steel drums as applicable. The wood used for construction of the drum shall be properly seasoned and free from defects and wood preservative shall be applied to the entire drum. All ferrous parts shall be treated with a suitable rust preventive coating to avoid rusting during transit or storage. Cable drums shall conform to standard mentioned in datasheet.

The BIDDER shall indicate in the offer, the maximum length for each size of cable, which can be supplied on one drum. The actual length supplied on each drum shall be within tolerance limit of +5 % with an overall ceiling of +5% on total ordered quantity of each size of cable. Negative tolerance is not acceptable. However, before winding the cables on drums, VENDOR shall obtain PURCHASER's approval for the drum lengths so as to minimise the number of joints to the extent possible. Cable ends shall be sealed by non-hygroscopic sealing caps.

Cable drums shall carry following details in printed form:

IS code.

(a) Manufacturer's name and trademark
(b) Type of cable and voltage grade
(c) Year of manufacture
(d) Type of insulation
(e) No. of cores and size of cables
(f)Cable code
(g) Length of cable on drum
(h) Inner Diameter and Outer Diameter of Drum

Cable lengths specified in Data Sheet are approximate only. Actual requirements will be advised to the successful BIDDER at the time of placing the order. Incremental cable lengths in meters shall be embossed on the outer sheath of every 1 metre interval.

Cable drum length shall be intimated to the successful BIDDER two (2) months prior to start of manufacturing date.

DATA TO BE FURNISHED

DATA SHEET

BIDDER shall furnish the information called for in Data Sheet for each type of cables. All BIDs shall be accompanied by descriptive technical catalogues.

REQUIREMENT OF SPECIAL SHEATH FOR FRLS/FS CABLE

When specified in Data Sheet, outer sheath for FRLS/FS cables shall meet the following test requirements related to flame retardance, low smoke emission, low acid and toxic gas emission. The BIDDERs shall have proper test apparatus to conduct all the relevant tests as per the applicable Standards mentioned herein.

Tests for Flame Retardance

a. Oxygen Index

The critical oxygen index value shall be minimum 29 when tested at 27$\pm$2^{o}C as per relevant standard mentioned in data sheet and the temperature index value shall be minimum 250^{o}C at oxygen index of 21 when tested as per relevant standard as mentioned in data sheet.

b. Flammability

(i) Cables shall pass test under fire conditions as per relevant IS standard.

(ii) Cables shall also pass tests as per relevant IS standard.

(iii) Fire survival cables in addition to tests (i) and (ii) above shall pass tests as per relevant IEC.

(iv) Cables shall pass test as per relevant IEC, IEEE, and Swedish chimney test F3 as per SS 424-1475.

Tests for Smoke Generation
The cables shall satisfy the tests conducted to evaluate the percentage obscuration by smoke in an optical system placed in the path of the smoke. The maximum smoke density rating shall not be more than 60% when tested as per standard mentioned in data sheet.
Tests for Acid Gas Generation
The hydrochloric acid generation when tested as per relevant IEC mentioned in datasheet. shall be less than 20% by weight.
Tests for Resistance to Ultraviolet Radiation
This test shall be carried out as per relevant standard. The retention values of tensile strength and ultimate elongation after the tests shall be minimum 60% of tensile strength and ultimate elongation before test.
Tests for Water Absorption
Outer sheathes shall be subjected to tests for water absorption as per IS mentioned in datasheet. When additional characteristics are required, the tests shall be as agreed between PURCHASER and VENDOR before the placement of order.
Anti-rodent and termite repulsion test
SPECIFIC REQUIREMENTS
The various types of cables covered in this specification shall meet the following requirements:
1100V Grade Power Cables
The cables shall be insulated with extruded PVC/ XLPE compound provided with extruded PVC inner sheath, armoured/ unarmoured and outer sheath of extruded black PVC compound as per data sheet.
The construction, performance and testing of the cable shall comply with relevant IS.
1100 V Grade Control Cables
The cables shall be insulated with extruded PVC/ XLPE compound, provided with extruded PVC inner sheath and outer sheath of extruded black PVC compound as per data sheet.
The construction, performance and testing of the cable shall comply with the standards mentioned in data sheet.
XLPE Insulated HV Power Cables

The conductors shall be screened by extruded semi-conducting compound and XLPE insulated applied by extrusion. The cores shall be screened by extruded semi-conducting compound in combination with non-magnetic metallic tape (copper tape preferred). PVC inner sheath over laid up cores shall be extruded and outer sheath over the armour shall be extruded black PVC compound type ST-2. Core identification shall be by printed numerals.

The construction, performance and testing of the cable shall comply with relevant IS.
Telecommunication Cables
The cables shall meet the following requirements:

(a)Conductor: Solid, tinned, annealed copper

(b)Insulation: PVC insulation type-A as per relevant IS
(c)Twisting: The insulated conductors shall be twisted together to form twisted pairs or quads; these shall be stranded in concentric layers to form the cable core. The cable thus formed shall be tightly lapped with outer wrapping tapes.

The interstices of insulated cable core shall be completely filled with viscose compound.

(d)Overall: With 0.075 mm aluminium tape or 0.013 mm melinex screening tape, overlap not less than 30%.

(e)Other details: A suitable non-magnetic rip cord shall be laid details longitudinally under the sheath. The armouring shall be of galvanised steel wires or galvanised single steel strip. The inner PVC sheath shall be of type-A. The outer PVC sheath shall be of Type ST-1.

(f) Voltage tests for: Dielectric withstand between conductors - 500V for 1 minute (rms) and between conductor & sheath -2000V rms/3000 V DC.

<u>450/750 V Grade Light duty unarmoured cables</u>

Cables shall be insulated with extruded PVC type-A. Outer sheath shall be extruded black PVC type as indicated in data sheet. The sheathed cables shall be weatherproof suitable for indoor/outdoor use. Twin and multicore cables shall be laid up and filled with thermoplastic material, bound by plastic tape and provided with outer sheath. Aluminium conductor, circular, compacted stranded, grade H4, Class 2. For copper conductor, conductor shall be annealed, stranded, Class 2 as per relevant IS. For flexible cable, copper conductor class shall be 5 or 6 and for CU welding cable, class shall be 6.

<u>Instrumentation Cables</u>
Cables shall comply with the following requirements:

Conductor : Annealed, tinned copper in solid or stranded circular construction

Insulation : PVC type-A applied by extrusion process.

The insulation shall be strippable manually as well as by mechanical stripping devices without damage to the conductor.

Element identification : As per relevant IEC

Core wrapping : By non-hygroscopic material by taping or by extrusion.

Element screening : By copper tape of minimum 0.04 mm thickness or by copper laminated plastic tape when specified in Data Sheet.

Rip cord : Non-metallic rip cord under the core wrapping

Drain wire : A tinned copper drain wire of minimum 0.5mm^2 cross section in contact with each screen of cabling element.

Cabling elements shall be any one of the following :
A 'Pair' of two insulated conductors twisted together designated by alphabet 'p' printed on a binding tape at 200 mm intervals.
A 'Triad' of three insulated conductors twisted together designated by alphabet 't', printed on a binding tape at 200 mm intervals.
A 'Quad' of four insulated conductors twisted together and designated by alphabet 'q' printed on a binding tape at 200 mm intervals.
A 'Quintuple' of five insulated conductors twisted together or by combination of one quad & one untwisted wire or 2 pairs and one untwisted wire. The quintuple shall be designated by alphabet 'Q' printed on a binding tape at 200 mm interval.
Maximum length of lay in the finished cable shall be 120 mm.
Units
Cables shall be bunched together in units of twenty cabling elements or sub units of five or ten elements, stranded in concentric layers. The units or sub units shall be designated by p1, p2, p3,.., t1, t2, t3..,q1, q2, q3, .., or Q1, Q2, Q3 ..., etc. depending on the combination.

Overall screening and armouring
Cables shall have an overall screen made up of copper/aluminium tape of 0.04 mm thickness or copper/aluminium of 0.008 mm thickness laminated with plastic tape with a minimum overlap of 15%. A drain wire of tinned copper with minimum 0.5 mm^2 cross section shall be provided in continuous contact with the screen. Armouring when specified shall be of galvanised steel strips.
Inner and Outer Sheath
The inner and outer sheaths shall consist of black PVC compound Type ST-1.
Voltage grade - Dielectric between conductors shall withstand for 1 minute the following voltages:

a) Conductor diameter up to 0.6 mm - 1000 V AC or 1500 V DC
b) Conductor diameter above 0.6 mm- 1500 V AC or 2250 V DC

Insulation Resistance
Minimum insulation resistance per km shall be 500 mega Ohm.
Mutual Capacitance
Mutual capacitance of any pair of conductors shall not exceed 120nF/km.
Capacitance Unbalance
The capacitance unbalance between any two pairs shall not exceed 400 pF for 500 metre length of cable.
The construction, performance and testing of cables except as modified above shall generally comply with the relevant standards mentioned in data sheet.

Instrument cable for operating temperature up to 400 deg centigrade.

Conductor : Annealed, bare copper
Conductor Type : Flexible

Insulation : Kepton Tape + Sintered PTFE

Overall Shielding : AL- Myler tape

Drain wire : Annealed tinned copper drain wire of minimum 0.5mm^2 cross section in contact with each screen of cabling element.
Inner Sheath : Wrapped & sintered PTFE tape
Outer Sheath : FG tape (Natural) + FG braiding with varnish (natural)
Overall braided Armour material after outer sheath: Stainless steel wire

Tests and Test Equipment
Cables shall be subjected to routine and acceptance tests in accordance with standards specified. Test methods shall conform to relevant IS. Bidder shall furnish all test certificates for Purchaser's approval. BIDDER shall ensure use of calibrated test equipment having valid calibration test certificates from standard laboratory traceable to National/ International Standards
Construction details including type of material used and thickness of each material for each type of cable in a tabular form and cross section drawings.
Technical catalogues and manuals
Installation and termination instructions.

Test Certificates

Type/Routine test certificates for all types of cables included in the order and special tests on FRLS/FS/ FRLSZH cables in line with applicable standard.
Technical particulars of all cables
QAP for all cables

ITEM	APPLICABLE STANDARDS
Type of conductor	IS 8130 IEC 60228
Conductor Screening	IS 7098 IEC 60502
Insulation	IS 5831 IS 7098 IEC 60502
Armoring	IS 3975
Test and test equipment	IS 10810
Oxygen Index test	ASTM-D-2863
Temperature index value	ASTM-D-2863 / NES 715
Cable drums	IS 10418
Flammability	IS 10810 IEC 60331 IEC 60332 IEEE 383 SS 424-1475
Test for smoke generation	ASTM-D-2843
Test for acid gas generation Tests for Resistance to Ultraviolet Radiation	IEC 60754-1 DIN 53387
Telecommunication cable, Low frequency cables and wires with PVC insulation and sheath - General Tests and measuring	IS 5831 IEC 60189-1 IEC 60189-2

ITEM	APPLICABLE STANDARDS
methods	
Instrumentation cable	IEC 60189-1 IEC 60189-2
Construction, performance and testing of XLPE Insulated HV Power Cables	IS 7098 IEC 60502
Construction, performance and testing of 1100 V Grade PVC Insulated Power and Control Cables	IS 1554 IEC 60502
Construction, performance and testing of 1100 V Grade light duty unarmoured cables	IS 694
Instrument cable for operating temperature up to 400 deg centigrade	JSS 51034
NOTES	
Equipment, Accessories, Components /Parts Raw materials and tests shall in general conform to: IS BS IEC CBIP	

HT Termination Kit

This specification lays down the performance requirements of following types of cable terminations and cable joints for use on electrical system operating at voltages from 3.3kV to 33kV in indoor and outdoor application.
Heat shrinkable type cable terminations and cable joints.

CODES AND STANDARDS

The design, manufacture, testing and performance of HV cable terminations and joints shall comply with all currently applicable standards, codes of practice, regulations and safety codes in the locality where the equipment will be supplied. Nothing in this specification shall be construed to relieve the VENDOR of his responsibility. In case of conflict between these standards and this specification, more stringent of the two requirements shall govern. Some of the currently applicable standards are indicated in Data Sheet
All codes and standards referred to in the specification shall be understood to be the latest version on the date of offer made by the BIDDER unless otherwise indicated.
The VENDOR shall ensure that instruments and gauges to be used for testing and inspection shall have valid calibration and the accuracy can be traced to National and International Standards as applicable.

HEAT SHRINKABLE TYPE SYSTEM

The term shrinkable refers to extruded or moulded polymeric material which are cross linked to develop elastic memory and supplied in an expanded or otherwise deformed size and shape. Subsequent heating in an unconstrained state to a

temperature above the shrink temperature results in the material recovering or shrinking to its original shape.
Stress control and stress grading wherever necessary in the terminations and joints shall be by means of semi-conducting heat shrinkable tubing.
Environmental sealing between the heat shrinkable materials and cable surfaces shall be achieved by using hot melted sealant or adhesives. Where such sealant or adhesives are exposed to high electrical stress, they must be track resistant.

PERFORMANCE REQUIREMENTS

External creepage distance between the high voltage conductors and ground shall be accomplished by utilising heat shrinkable terminations and joints and shall be accomplished by utilising EPDM rubber material for "PUSH-ON" type terminations and joints. These shall be weather resistant.
The termination systems shall have been type tested for the tests listed in the relevant IS / IEC and the type and routine test certificates shall be submitted before dispatch.

AFTER PLACEMENT OF ORDER, THE VENDOR SHALL SUBMIT:

Editable soft copies of final drawings for all the equipment ordered in latest version of Autocad.
Six copies of instruction booklets on laying, jointing and testing of the cables and accessories.
Six copies of descriptive manuals and principal technical data of all equipment ordered.
Six copies of complete test reports.
Guaranteed technical particulars.

	APPLICABLE STANDARDS Power Cables with extruded insulation & their accessories for rated voltage from 1kV up to 30kV	☐ IS ☐ BS ☐ IEC 60502
	Artificial pollution tests on high voltage insulators to be used on A.C systems for salt-fog test	☐ IS ☐ BS ☐ IEC 60507 SEC-3
	High voltage test techniques	☐ IS ☐ BS ☐IEC60060-1
	Joints and termination of polymeric cables for working voltages from 6.6kV up to and including 33kV performance requirements and type tests	☐ IS 13573 ☐ BS ☐ IEC
	(Partial discharge measurements) for partial discharge tests	☐ IS ☐ BS ☐ IEC 60270
	Cross linked polyethylene insulated PVC specified cables (For working voltage from 3.3kV up to and including 33 kV)	☐ IS 7098 ☐ BS ☐ IEC
	Specification for PVC insulated (Heavy duty) electric cable for working voltage from 3.3kV up to and including 11kV	☐ IS 1554 ☐ BS ☐ IEC
	NOTES :	
	Equipment, accessories,	☐ IS ☐ BS

components / parts, raw materials and tests shall in general conform to	☐ IEC

7. CABLE CARRIER SYSTEM

This specification covers the requirements of Cable containments / cable trays for cable installation for efficient and trouble-free operation. Cable Trays shall be hot dip Galvanized and factory fabricated out of G.I. channels, angle iron, tee, bends, sections, flats and perforated sheet for different loads.

CODES AND STANDARDS

The design, material, construction, manufacture, inspection, testing and performance of equipment shall comply with all currently applicable standards, codes of practice, regulations, and safety codes in the locality where the equipment will be supplied & installed. Nothing in this specification shall be construed to relieve the CONTRACTOR of this responsibility.

The codes and standards mentioned in the various specifications and requirements specified in the enquiry document shall be latest as on the day of award of contract of the works unless otherwise specified. Contractor shall be responsible to inform to the Consultant/ Owner in case of any revisions/re-affirm/amendment in the relevant codes and standards after the date of award of contract within 30 days of the issue of such revision/re-affirm/amendment of the code/ standard. Consultant/ Owner may approve use of the earlier code/ standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed.
The VENDOR shall ensure that instruments and gauges to be used for testing and inspection shall have valid calibration and the accuracy can be traced to National and International Standards as applicable.

LAYING OF CABLE ON CABLE TRAYS

The relative position of the cables laid on the cable tray shall be preserved and the cables shall not cross each other. At all changes in direction in horizontal and vertical planes, the
cable shall be bent smooth with a radius as recommended by the manufacturers. All cables shall be laid with minimum one diameter gap and shall be clamped at every meter to the cable tray. Cables shall be tagged for identification with aluminium tag and clamped properly at every 20M. Tags shall be provided at both ends and all changes in directions both sidesof wall and floor crossings. All cable shall be identified by embossing on the tag the size of the cable, place of origin and termination.

All cables passing through holes in floor or walls shall be sealed with fire retardant Sealant
and shall be painted with fire retardant paint up to one meter on all joints, terminations
and both sides of the wall crossings.

LAYING OF CABLE IN GROUND

The width of trench for laying single cable shall be minimum 350 mm. Where more than

one cable is to be laid in horizontal formation, the width of the trench shall be workout by
providing 200 mm gap between the cables, except where otherwise specified. There shall be clearance of 150 mm between the end cable and the side wall of the trench. The minimum depth of the cable trench shall not be less than 750 mm for single layer of cables.
When the cables are laid in more than one tier the depth of the trench shall be increased by 300 mm for each additional tier.

Excavation of trenches: The trenches shall be excavated in reasonably straight lines. Wherever there is a change in direction, suitable curvature shall be provided. Where gradients and changes in depth are unavoidable, these shall be gradual.

The excavated soil shall be stacked firmly by the side of the trench such that it may not fall back into the trench. The bottom of the trench shall be levelled and shall be made free from stone, brick bats etc. The trench shall then be provided with a layer of clean, dry sand cushion of not less than 100 mm in depth. Prior to laying of cables, the cores shall be tested for continuity and insulation resistance. The cable drum shall be properly mounted on jacks, at a suitable location, making sure that the spindle, jack etc. are strong enough to carry the weight of the drum and the spindle is horizontal. Cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains.

The entire drum length shall be laid in one stretch.
However, where this is not possible the remainder of the cable shall be removed by `Flaking'i.e. by making one long loop in the reverse direction. After the cable has been uncoiled and laid into the trench over the rollers, the cable shall be lifted off the rollers beginning from one end by helpers standing about 10 meters apart and laid in a reasonably straight line. Cable laid in trenches in a single tier formation shall have a cover of clean, dry sand of not less than 150 mm. above the base cushion of sand before the protective cover is laid.

In the case of vertical multi-tier formation after the first cable has been laid, a sand cushion
of 300 mm shall be provided over the initial bed before the second tier is laid. Finally the
cables shall be protected by second class bricks before back filling the trench. The buried
depth of uppermost layer of cable shall not be less than 750mm.

Back Filling: The trenches shall be back filled with excavated earth free from stones or
other sharp-edged debris and shall be rammed and watered, if necessary, in successive
layers not exceeding 300 mm. Unless otherwise specified, a crown of earth not less than
50 mm in the centre and tapering towards the sides of the trench shall be left to allow for
subsidence.

CABLES INSIDE THE BUILDING

Cables inside buildings shall be laid on the cable trays. All cables passing through walls

shall run through GI Pipes sleeves of adequate diameter 50 mm apart maintaining the relative position over the entire length. All Cables running inside building shall be unarmoured cables and cables outside building shall be armoured cables.

ROUTE MARKER

Route marker shall be provided along straight runs of the cables not exceeding 30 meters
also for change in the direction of the cable route and underground joints.
Route marker shall be of cast iron painted with aluminium paint. The size of marker shall be100 mm dia with “Cable” and voltage grade inscribed on it.

CABLE TRAYS

Cable trays shall be of Mild Steel painted/ Galvanised/ Fibre Reinforced Plastic and of ladder / perforated / solid type, complete with all necessary coupler plates, elbows, tees, bends, reducers, stiffeners and other accessories and hardware as detailed in the relevant drawings. For Indoor application trays shall be painted/galvanised and for outdoor application it shall be galvanised. All hardware (i.e. bolts, nuts, screws, washers, etc.) shall be factory fabricated out of CRCA sheet with standard accessories like tee, bends, couplers etc. for different loads and number and size of cables as given below :
Cable trays shall be galvanized as per Specification given under sss

- 1500 mm wide
    - Runners 25 x 100 x 25 x 3 mm
    - Rungs 2# 20 x 40 x 20 x 3 mm 250 mm C/C
    - Suspenders 2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x40 x 5mm GI angle.

- 1200 mm wide
    - Runners 25 x 100 x 25 x 3 mm
    - Rungs 2# 20 x 40 x 20 x 3 mm 250 mm C/C
    - Suspenders 2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x40 x 5mm GI angle.

- 1000 mm wide
    - Runners 25 x 100 x 25 x 3 mm
    - Rungs 2# 20 x 40 x 20 x 3 mm 250 mm C/C
    - Suspenders 2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x40 x 5mm GI angle.

- 750 mm wide
    - Runners 20 x 75 x 20 x 2.5 mm
    - Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C
    - Suspenders 2 Nos. 32 x 32 x 5 mm GI angle 1800 mm C/C with base support of 40x40 x 5mm GI angle.

- 600 mm wide
    - Runners 20 x 75 x 20 x 2.5 mm
    - Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C
    - Suspenders 2 Nos. 32 x 32 x 5 mm GI angle 1800 mm C/C with base support of 40x40 x 5mm GI angle.

- 450 mm wide

- Runners 20 x 75 x 20 x 2.5 mm
- Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C
- Suspenders 2 Nos. 12/16mm threaded Rod with Slotted GI Angles

Note: Suitable length of 10 mm dia GI rod suspenders at 1800 mm interval shall be included in the item for perforated type cable tray.

Alternative to fabricated support of cable tray, Steel wire rope hangers shall be used to
suspend the cable trays. This hanger shall consist of a pre-formed wire rope sling with a
range of end fixings to fit various substrates and service fixings. The end fixings and wire
must be of the same manufacturer with several options available. The system shall be
secured and tensioned with a hanger self-locking grip at the other end. Once the grip is
locked for safety purpose, unlocking shall only be done by using a separate setting key and shall not be an integral part of the self-locking grip. Only wires and/or supports supplie and/or approved shall be used with the system.

SPECIFICATION OF HOT DIP GALVANIZING PROCESS

(for Mild Steel Used For Earthing, Cable Trays Or Junction Boxes For Electrical Installation.)

General Requirements
I. Quality of Zinc
Zinc to be used shall conform to minimum Zn 98 grade as per requirement of IS: 209-
1992.

II. Coating Requirement
Minimum weight of zinc coating for mild steel flats with thickness upto 6 mm in accordance with IS:6745-1972 shall be 400 g/sqm.

The weight of coating expressed in grams per square metre shall be calculated by
dividing the total weight of Zinc by total area (both sides) of the coated surface.
The Zinc coating shall be uniform, smooth and free from imperfections as flux, ash
and dross inclusions, bare patches black spots, pimples, lumpiness, runs, rust stains
bulky white deposits, blisters. Mild steel flats / wires shall undergo a process of degreasing pickling in acid, cold rinsing and then galvanizing.

INSTALLATION OF CABLE TRAYS

Cable trays shall be installed generally at the elevations shown in respective cable tray layout drawings. If any major modifications in the drawings are envisaged in the field, these should be carried out after getting approval from design office.
Before laying the trays, contractor shall submit the shop drawing & take the approval from client/Project Manager.

It shall be the responsibility of the electrical contractor to mark up all the field modifications on the latest issues of the drawings and return two copies of all such " as constructed " drawings to client/Project Manager's design office.
The type and size of tray to be used shall be as mentioned in the individual layout drawings.

Cable trays shall be welded to the mounting/carrier structures. Trays shall be supported with suitable angle/hitech rod supports.
Each continuous laid out length of cable tray shall be earthed at minimum two places by GI flats of minimum size 25x6 mm (unless otherwise noted) to the Employer's earthing system. The distance between earthing points shall not exceed 10 meters.

The following shall be checked before laying the cables on trays.

- Check for proper identification nos. of the trays.
- Check for continuity of cable trays over the entire route.
- Check that all sharp corners, burrs, and waste materials have been removed from the tray.
- Obtain clearances from piping contractor / engineer that no piping will be taken in the way of cable trays.
- Check for earth continuity & earth connection of cable trays.

Cable tray installation work shall comply with all currently applicable statutes, regulations, and safety codes in the locality/country where the installation is to be carried out.

8. VARIABLE FREQUENCY DRIVES- VFD

SCOPE

This specification covers the requirements of Variable Frequency Drive for efficient and trouble-free operation.

CODES AND STANDARDS

The design, material, construction, manufacture, inspection, testing and performance of equipment shall comply with all currently applicable standards, codes of practice, regulations, and safety codes in the locality where the equipment will be supplied & installed. Nothing in this specification shall be construed to relieve the CONTRACTOR of this responsibility.

The codes and standards mentioned in the various specifications and requirements specified in the enquiry document shall be latest as on the day of award of contract of the works unless otherwise specified. Contractor shall be responsible to inform to the Consultant/ Owner in case of any revisions/re-affirm/amendment in the relevant codes and standards after the date of award of contract within 30 days of the issue of such revision/re-affirm/amendment of the code/ standard. Consultant/ Owner may approve use of the earlier code/ standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed.

The VENDOR shall ensure that instruments and gauges to be used for testing and inspection shall have valid calibration and the accuracy can be traced to National and International Standards as applicable.

DESCRIPTION

This specification is to cover a complete heavy duty industrial type Variable Frequency Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use with induction (asynchronous) motors, permanent magnet motors, Synchronous reluctance motor (SynRM) and permanent magnet-assisted synchronous reluctance motor (PMa-SynRM/EC Titanium).

The drive manufacturer shall supply the drive and all necessary options as specified. All drives installed on this project shall be from the same manufacturer and have a common user interface (control panel). The manufacturer shall have been engaged in the production of this type of equipment for a minimum of 30 years. Drives that are manufactured by a third party and “brand labeled” shall not be acceptable. Drive manufacturers who do not build their own power boards and assemblies, or do not have full control of the power board manufacturing and quality control, shall be considered as a “brand labeled” drive.

This specification is intended to supplement a drive schedule. The drive schedule identifies the optimized BOM for the project and includes quantity, size, voltage, enclosure rating, options, and harmonic mitigation requirements of the drives. IEEE 519-2014 is an electrical system standard for harmonic mitigation and not intended to be applied to an individual piece of equipment. Drives are only one of many sources of harmonics, thus verification of system IEEE 519-2014 compliance is beyond the VFD manufacturer’s scope. The EOR (Engineer of Record) is responsible for conducting an electrical system study and verifying the drive schedule has specified proper harmonic mitigation for the drives.

QUALITY ASSURANCE

Referenced Standards and Guidelines:

- Institute of Electrical and Electronic Engineers (IEEE)
  - IEEE 519-2014, IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems.
- Underwriters Laboratories (as appropriate)
  - UL 508A
  - UL 61800-5-1
- National Electric Code (NEC)
  - NEC 430.120, Adjustable-Speed Drive Systems
- CSA Group
  - CSA C22.2 No. 274
- International Building Code (IBC)
  - IBC 2018 Seismic – referencing ASCE 7-16 and ICC AC-156
- IEC 61800-5-1 & IEC 61800 -3.

Qualifications:

- Drives shall be UL labeled as a complete assembly. The base VFD shall be UL listed for 100 kA SCCR when installed in accordance with the manufacturer's guidelines.
- CE Mark – The base drive shall conform to the European Union Electromagnetic Compatibility directive, a requirement for CE marking. The base drive shall meet product standard EN 61800-3 for the First Environment restricted distribution (Category C2).
- The base drive shall be seismically certified and labeled as such in accordance with the 2018 International Building Code (IBC):
- Seismic importance factor of 1.5, and minimum 2.5 SDS rating is required.
- Ratings shall be based upon actual shake test data as defined by ICC AC-156, via all three axis of motion.
- The base drive shall be SEMI-F47 certified. The drive must tolerate voltage sags to 50% for up to 0.2 seconds, sags to 70% for up to 0.5 seconds, and sags to 80% for up to one second.

TECHNICAL REQUIREMENTS

The drive package as specified herein and defined on the drive schedule shall be enclosed in a UL Type enclosure (enclosures with only NEMA ratings are not acceptable), completely assembled and tested by the manufacturer to ISO9001 standards.

The drive shall provide full rated output from a line of +10% to -15% of nominal voltage. The drive shall continue to operate without faulting from a line of +25% to -35% of nominal voltage.

- Drives shall be capable of continuous full load operation under the following environmental operating conditions:
  - Ambient temperature -15 to 40° C (5 to 104° F).
  - Altitude 0 to 1000 m (0 to 3,300 ft) above sea level.
  - Humidity 5 to 95%, non-condensing.

- All drives shall utilize the same Advanced Control Panel (keypad) user interface.
  Plain English text
  - The display shall be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable).

- Safety interlock and run permissive status shall be displayed using predetermined application specific nomenclature, such as: Damper end switch, smoke alarm, vibration trip, and overpressure.
- Safety interlock, run permissive, Supervisory, external fault status, drive name, drive fault contact info and override shall have the option of additional customized project specific terms, such as: AHU-1 End Switch, Office Smoke Alarm, CT-2 Vibration.

The control panel shall include at minimum the followings controls:

- Four navigation keys (Up, Down, Left, Right) and two soft keys to simplify operation and programming.
- Hand-Off-Auto selections and manual speed control without having to navigate to a parameter.

Fault Reset and Help keys. The Help key shall include assistance for programming and troubleshooting.

- Multiple Home View screens shall be capable of displaying up to 21 points of information. Customizable modules shall include bar charts, graphs, meters, and data lists. Displays shall provide real time graphical trending of output power, frequency, and current within selectable intervals of 15/30/60 minutes and 24 hours.
- The control panel shall display the following items on a single screen; output frequency, output current, reference signal, drive name, time, and operating mode (Hand vs Auto, Run vs Stop). Bi-color (red/green) status LED shall be included. Drive (equipment) name shall be customizable.
- There shall be a built-in time clock in the control panel. The clock shall have a battery backup with 10 years minimum life span. Daylight savings time shall be selectable.
- I/O Summary display with a single screen shall indicate and provide:
- The status/values of all analog inputs, analog outputs, digital inputs, and relay outputs. Drives that require access to internal or live components to measure these values, are not acceptable.
- The programmed function of all analog inputs, analog outputs, digital inputs, and relay outputs.
- The ability to force individual digital I/O high or low and individual analog I/O to desired value, for increased personal protection during drive commissioning and troubleshooting. Drives that require access to internal or live components to perform these functions, are not acceptable.
- The drive shall automatically backup parameters to the control panel. In addition to the automatic backup, the drive shall allow two additional unique backup parameter sets to be stored. Backup files shall include a time and date stamp. In the event of a drive failure, the control panel of the original drive can be installed on the replacement drive, and parameters from that control panel can be downloaded into the replacement drive.
- The control panel shall display local technical support contact information as part of drive fault status.
- The control panel shall be removable, capable of remote mounting.
- The control panel shall have the ability to store screen shots, which are downloadable via USB.
- The drive shall generate a QR code, which contains drive identification data, information on the latest events, and values of status and counter parameters.

- The LCD screen shall be backlit with the ability to adjust the screen brightness and contrast, with inverted contrast mode. A user-selectable timer shall dim the display and save power when not in use.
- The control panel shall include assistants specifically designed to facilitate start-up. Assistants shall include: First Start Assistant, Basic Operation, Basic Control, and PID Assistant.
- Primary settings for HVAC shall provide quick set-up without the use of alpha-numerical parameters, for commissioning the drive and customer interfaces to reduce programming time.
- The drive shall be able to operate with the control panel removed.
- The drive shall be able to support a Bluetooth Advanced Control Panel. The Bluetooth control panel shall be FCC and QDL (Qualified Design Listing) certified.
    - A free app (iOS and Android) shall replicate the control panel on a mobile device or tablet. The control panel's programming and control functionality shall function on the device. Customizing text, such as AHU-1 End Switch, shall be supported by the device's keyboard.
    - Bluetooth connectivity shall allow uploading, downloading, and emailing of parameter sets.
    - Bluetooth connectivity shall include two pairing modes: Always discoverable with a fixed passcode, and manual discovery with a unique generated passcode every pairing.
    - Bluetooth connectivity shall be capable of being switched.

- All drives shall have the following hardware features/characteristics as standard:
    - Two (2) programmable analog inputs shall accept current or voltage signals. Current or Voltage selection configured via control panel. Drives that require access to internal components to perform these functions, are not acceptable.
    - Two (2) programmable analog outputs. At least one of the analog outputs shall be adjustable for current or voltage signal, configured via control panel. Drives that require access to internal components to perform these functions, are not acceptable.
    - Six (6) programmable digital inputs. All digital inputs shall be programmable to support both active high and active low logic, and shall include adjustable on/off time delays. The digital input shall be capable of accepting both 24 VDC and 24 VAC.
    - Three (3) programmable Form-C relay outputs. The relay outputs shall include programmable on/off time delays. The relays shall be rated for a continuous current rating of 2 Amps. Maximum switching voltage of 250 VAC / 30 VDC. Open collector and Form-A relays are not acceptable. Drives that have less than (3) Form-C relay outputs shall provide an option card to provide additional relay outputs.
    - Drive terminal blocks shall be color coded for easy identification of function.
    - The drive shall include an isolated USB port for interface between the drive and a laptop. A non-isolated USB port is not acceptable.
    - An auxiliary power supply rated at 24 VDC, 250 mA shall be included.

- At a minimum, the drives shall have internal impedance equivalent to 5% to reduce the harmonics to the power line. 5% impedance may be from dual (positive and negative DC link) chokes, or AC line reactor. Drives with only one DC link choke shall add an AC line choke integral to the drive enclosure. Reference the drive schedule to determine if additional harmonic mitigation is required for the system to comply with IEEE 519-2014 and Local regulations.
- The drives which are selected as per the application requirements shall have THD / Harmonics less than 5%. The drives if selected have harmonics more than 5 % suitable harmonic mitigation techniques with use of active harmonic filters to be implemented.
- Variable Frequency drives shall have inbuilt active components such as harmonic filters or power factor correction devices at input side of VFD which can control current & voltage harmonics as per IEEE 519 standards. Harmonic distortion levels should be within range of 3-5% across varying loads operations, ensuring optimal performance of the variable speed drive system.
- The VFD which is proposed should preferably have IGBT and LCL circuits / AHF for compensation of harmonics below 5% at VFD unit level.
- The drive shall have cooling fans that are designed for field replacement. The primary cooling fan shall operate only when required and be variable speed for increased longevity and lower noise levels. Drives whose primary cooling fans are not variable speed, shall include a spare cooling fan.
- The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 135% overload for 2 seconds every minute. The minimum current rating shall meet or exceed the values in the NEC/UL table 430.250 for 4-pole motors.
- The input current rating of the drive shall not be greater than the output current rating. Per NFPA 70 430.122, drives with higher input current ratings may require the upstream wiring, protection devices, and source transformers to be upsized.
- Circuit boards shall be coated per IEC 60721-3-3; Chemical gasses Class 3C2 and Solid particles Class 3S2.
- Earth (ground) fault detection shall function in both modulating (running) and non-modulating modes.
- Coordinated AC transient surge protection system consisting of 4 MOVs (phase-to-phase and phase-to-ground), a capacitor clamp, and internal chokes. The MOVs shall comply with UL 1449 4th Edition. Drives that do not include coordinated AC transient surge protection shall include an external TVSS/SPD (Transient Voltage Surge Suppressor/Surge Protection Device).
- The drive shall include a robust DC bus to provide short term power-loss ride through. The DC bus Joule to drive kVA ratio shall be 4.5 J/kVA or higher. An inertia-based ride through function should help maintain the DC bus voltage during power loss events. Drives with control power ride through only, are not acceptable.

- All drives shall have the following software features as standard:
  Fault Logger that stores the last 16 faults in non-volatile memory.

- The most recent 5 faults save at least 9 data points, including but not limited to: Time/date, frequency, DC bus voltage, motor current, DI status, temperature, and status words.
- The date and time of each fault and fault reset attempt shall be stored in the Fault Logger.

An Event Logger that stores the last 16 warnings or events that occurred, in non-volatile memory.

- Events shall include, but not limited to: Warning messages, checksum mismatch, run permissive open, start interlock open, automatic reset of a fault, power applied, auto start command, auto stop command, modulating started, and modulating stopped.

- VFDs shall be heavy duty industrial type and shall be incorporated within the MCC
  structure. All AFE-VFDs rated above 150kW must be dedicated floor standing panel, withdrawable type (type- IP42) assembled by the OEM at their factory.

ACTIVE HARMONIC FILTER

- AHF shall be phase rotation insensitive. AHF shall detect phase rotation and align output accordingly.
- AHF heat losses shall not exceed more than 3 percent of the unit kVAR rating.
- AHF amperage output ratings shall be AS PER MOTOR REQUIRED RATING.
- Up to 10 units of any size combination shall be able to be paralleled to inject current according to the information received from one set of supply current transformers (CTs) located at the source of supply for loads and all active harmonic filters.
- Control logic shall be closed loop logic.
- Multiple active harmonic filters may be installed in parallel. The units will function independently. If one unit is stopped or faulted, the remaining units will continue to operate normally.
- All units operating in parallel shall have a common digital series communications connection between all units operating in parallel.
- When operating in parallel, the HMI on any of the paralleled units can be used to set system parameters for total system operation and to look and adjust parameters for any of the single paralleled units.
- Single master controller architecture is not acceptable. AHF units shall support multi-master arrangements. AHF that turns off all units when one is taken offline in the parallel arrangement is not acceptable.
- AHF that shut off any nonlinear loads (i.e. VSD) when AHF faults or is remove from operation is not acceptable.
- All floor standing units shall provide incoming bus bar terminations for both top and bottom entry. At least two cables per phase may be landed for 200 and 300 ampere rated sizes.
- AHF floor standing units shall include a door-interlocked circuit breaker rated at 200,000 AIC (amperes of interrupt capacity) at rated voltages up to 480 VAC.

- All assemblies shall include an open chassis (IP00) with back plate, side walls, top plate, and front cover for user and operator safety. The open chassis (IP00) shall have open access to power terminals, CT terminations, and other user interface location from the bottom. There shall be no access to any internal power devices.
- An energy saving feature shall be provided to permit stopping AHF when load goes below a desired operating set point (10% factory setting but field adjustable) and turn on at some higher set point (15% factory setting but field adjustable).
- Safety features include a dead front design when opening the enclosure door on floor standing units. Extreme measures must be taken to bypass this safety dead front design. To perform service, the enclosure door should never be opened without locking out the upstream feeder breaker.
- Incoming power shall be connected to the input circuit breaker within a power cable entry plenum. Once cable installation is complete and plenum covers are re-installed, there shall be no access to incoming cabling.
- A USB /RS 485 port shall be provided in the AHF to connect AHF from a laptop computer may examine past performance and review all parameter set points and the event log. This may be used for commissioning or service.
- AHF shall monitor the total current of the loads under review utilizing two CT mounted on the supply AC lines for all three phase loads and all AHF. If phase-to-neutral loads are connected (four wire system), three CT shall be required.
- AHF shall analyze the content of the supply current for harmonics from the 2nd to the 50th harmonic orders and shall determine the reactive current content representing displacement and true power factor and mains current balancing.
- AHF shall inject cancellation for every harmonic order from 2nd to 50th order. AHF with designs to inject less than all harmonic orders is unacceptable.
- AHF shall include an option to achieve optimized true PF correction. Optimized true PF correction is designed to prevent correction when the system true PF is better (closer to unity) than the programmed PF set point. Any AHF that reduces the system PF to attain a reduced set point is unacceptable.
- AHF shall be designed with a current limiting function to protect the IGBT and other power section devices.
- When the current limit level is attained on any harmonic order, a message shall be displayed indicating the output capacity is operating at maximum capacity.
- Operation shall continue indefinitely at this reduced level without trip or degradation of AHF.
- AHF shall have automatic restart capability upon power loss return and fault resets.
- Upon occurrence of the fault trip limit, AHF shall stop output current production and lock out restart until the fault is manually cleared.
- AHF shall monitor the incoming air temperature and invoke a hard trip of the unit at 124°F (51°C).
- AHF shall be compatible with SPD, EMC filters, SCR (thyristor) snubber circuits, and switched mode power supplies (SMPS).

INSTALLATION

- The responsible party shall install the drive in accordance with the recommendations of the drive manufacturer as outlined in the drive installation manual.
- Power wiring shall be completed by the responsible party. All wiring shall be installed in accordance with the recommendations of the drive manufacturer as outlined in the installation manual.
- Installation shall be in accordance with national, state and local building and electrical codes as may be in force in the installation area

9. FANS / LIGHT FIXTURES & ACCESSORIES

This specification covers the design, material, specification, manufacture, testing, inspection and delivery to site of lighting fixtures (luminaire) with lamps and their associated accessories. This specification does not cover requirements of lighting suitable for aerodromes, hospitals, road traffic signals and mines.

CODES & STANDARDS

The codes and standards mentioned in the various specifications and requirements specified in the enquiry document shall be latest as on the day of execution of the works unless otherwise specified. The revisions in the relevant codes and standards after the date of award of contract shall be informed by the Contractor to the Consultant/ Owner within 30 days of the issue of such revision of the code/ standard. Consultant/ Owner may approve use of the earlier code/ standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed. In case of conflicts between the standards and this specification, the more stringent of the two shall govern.

LIGHTING FIXTURES (LUMINAIRE) – GENERAL REQUIREMENTS

Luminaire shall be designed for continuous trouble-free operation under atmospheric conditions as specified in Sections B & C of project information without reduction in lamp life or without deterioration of materials and internal wiring. Outdoor fittings shall be weather-proof and water-proof type.

For each type of luminaire the BIDDER shall furnish the utilisation factor tables to indicate the proportion of the light emitted by the bare lamps which falls on the working plane.

All luminaire shall be supplied complete with lamps suitable for operation on a supply voltage and the variation in supply voltage and frequency indicated in Data Sheet.

Luminaire shall meet all the power quality and safety requirements as required by relevant IS. All luminaire shall also be compatible with power quality existing at site.

Fluorescent type, incandescent type, mercury vapour, sodium vapour, LED and metal halide type luminaire shall be complete with accessories like lamps, ballasts, Driver, power factor improvement capacitors, starters, etc. These shall be mounted as far as possible in the luminaire housing only. If these cannot be accommodated integral with the luminaire then a separate metal enclosed control gear box shall be included to accommodate the control accessories together with a terminal block suitable for loop-in, loop-out connections. Outdoor type fixtures shall be provided with outdoor type weather-proof box with IP 55 or better.

Each luminaire shall have a terminal block suitable for loop-in, loop-out and T-off connection by 1100 V, 1 core, PVC insulated copper / aluminium conductor wires upto 4 sq.mm in size. In outdoor, corrosive and hazardous areas the termination at the luminaire shall be suitable for 1100 V, PVC insulated, copper / aluminium conductor, armoured cables of size upto 6 sq.mm conductor. Terminals shall be of
stud or clamp type. The internal wiring shall be completed by the MANUFACTURER by means of stranded copper wire of minimum 1 sq.mm size and terminated on the terminal block. Terminal blocks shall be mounted with minimum two fixing screws.
Mounting facility and conduit knock-outs for the luminaire shall be provided.

All hardware used in the luminaire shall be suitably plated or anodised and passivated for use in chemical, industrial and power plants.

Entire luminaire, including lamps and accessories, shall be from the green labelled range. Unless otherwise specifically asked, these shall be RoHS compliant. These shall comply with E-waste (Management) Rules and shall meet the EPR (Extended Producer Responsibility).

EARTHING

Each luminaire and control gear box shall be provided with an earthing terminal suitable for connection to the PURCHASER's earthing conductor of 12 SWG GI wire unless otherwise specified in Data Sheet. All metal or metal enclosed parts of the luminaire / control gear box shall be bonded and connected to the earthing terminal so as to ensure satisfactory earthing continuity.

PAINTING / FINISH

All surfaces of the luminaire / control gear box housing accessories shall be thoroughly cleaned and degreased. It shall be free from scale, rust, sharp edges and burrs.

The luminaire housing shall be stove-enamelled / epoxy stove-enamelled/vitreous enamelled or anodised as indicated under various types of fittings. Aluminium paint on flame proof fittings is prohibited.

The finish of the luminaire shall be such that no bright spots are produced either by direct light source or by reflection.

GENERAL REQUIREMENT FOR LED LIGHT FIXTURES

All LED luminaire shall be provided with toughened glass and shall have thickness of sufficient strength and high efficiency prismatic diffuser under the LED chamber to protect the LED and luminaire.

Suitable reflector / lenses may also be provided to increase the illumination uniformity and distribution for LED.

The fixture shall be designed so as to have lumen maintenance of at least 70% at the end of minimum 50000 hours (L70) at design temperature of 35 degree C.

Adequate heat sink with proper thermal management shall be provided such that LED soldering point temperature shall not go beyond 75 degree centigrade.

Minimum view angle of the LED shall not be less than 120 degree.

Power factor of complete fitting shall be more than 0.95 at full load 240V and THD<8%.

The LED luminaire shall be free of glare. Colour rendering index (CRI) shall be ≥ 75. System luminous efficacy for indoor area shall be ≥80.

The luminaire shall be provided with inbuilt surge protection of not less than 4 kV to prevent damage to the driver in case of sudden voltage surge.

Lumen maintenance report as per LM 80 guidelines shall be produced for the LEDs used. The test report shall contain description of the source tested/Ambient Condition (Airflow, Temperature etc.)/Electrical Condition/Lumen Maintenance Data/Observation of failure (Lumen depreciation monitored every 1000 hours)/LED Monitoring Interval/Chromaticity shift over time. The LED chips shall have system luminous efficacy of 100 lm/W or more and LED fixture shall have system efficacy of 70 lm/W or more.

Bidder shall submit LM 79 (Electrical & Solid State measurement of solid state lighting products/fixtures). The test report shall contain Total lumen output of the fixture/luminaire intensity distribution/electrical power/luminous efficacy/colour characteristic of the fixture i.e. CCT & CRI.

Each luminaire shall be provided with an earthing terminal suitable for connection to the PURCHASER's earthing conductor of 12 SWG GI wire unless otherwise specified.

<u>Well glass luminaire:</u>

Well glass luminaire shall be robust construction, cast aluminium / vitreous enamelled housing, clear heat and shock resistant glass cover fixed with EPDM gaskets for sealing. For mechanical protection to the glass cover, MS wire – guard with vitreous enamelled finish shall be provided. Additional heavy gauge vitreous enamel anodized aluminium reflector shall be provided. Luminaire for indoor use shall be with degree of protection IP 54.

When used semi-outdoors the luminaire shall be with minimum degree of protection IP 65 and is generally used in steam generator area, platforms etc.

When used in coal dust and hazardous areas classified under zone 2 Groups IIA, IIB, IIC the luminaire shall be increased safety, intrinsically safe, dust proof, dust tight and vapour proof with degree of protection with IP65 or better and mercury vapour lamps.

(a) The housing shall be cast aluminium (LM6) or cast iron / stove enamelled with porcelain lamp holder, stove enamel reflector, heat resistant toughened glass cover complete with wire guard, EPDM gaskets, suspension hook or strap, side 2 way cable entry, earthing terminal, etc.
(b) The luminaire shall have relevant CIMFR or other statutory authority certification for use in zone 2 areas.

LED LUMINAIRE

Low/Medium/High bay LED Luminaire housing shall be die cast aluminium and anodized aluminium reflector with polyester powder coat finish or polyester white paint finish. Diffuser shall be made of Polycarbonate material. Luminaire shall have heat sink for better thermal dissipation

Bulkhead LED Luminaire housing shall be die cast aluminium with front cover of poly carbonate diffuser.

General purpose flood light luminaire:

Flood light luminaire shall be of weather proof construction with die-cast aluminium housing, anodised aluminium mirror polished reflector, heat resistant, toughened glass cover and necessary EPDM gaskets to prevent ingress of dust, moisture and insect.

The housing shall be supported on a cast iron / aluminium base and capable of being swivelled in both horizontal and vertical directions and locked in any desired position.

For focussing purposes, knobs shall be provided along with sector plate indicating the angle in degrees between 0 and 90 deg. in vertical direction.

When mercury vapour, sodium vapour or metal halide lamps are specified, the same shall be mounted in a separate sheet metal enclosed / cast aluminium weatherproof control gear box.

Flame proof flood light luminaire shall be with die cast aluminium housing, stove enamelled, having degree of protection with IP65 or better and used in hazardous areas classified under zone 1 and 2 areas where gas groups IIA and IIB are specified.

The luminaire shall be complete with stove enamelled anodized aluminium reflector, porcelain lamp holder, heat resistant toughened glass cover, cast iron mounting base, cable gland, earthing terminal etc.

The luminaire shall have relevant CIMFR or other statutory authority certification for use in zone 1 or 2 areas.

The Flood light LED luminaire shall be housed in die cast aluminium and

corrosion resistant powder finish and shall have toughened class diffuser with integral driver.

Induction floodlight luminaire shall be with dimmable controlgear & dimming system based on time switch.

OUTDOOR LANTERN LUMINAIRE

POST TOP LANTERN

Post top lantern luminaire shall be generally outdoor weatherproof type for illumination of walkways, gate posts, gardens etc.

The luminaire shall have cast aluminium spigot finished with corrosion proof paint for mounting, opal acrylic or high-density polyethylene (HDP) diffuser bowl, complete with integral mounted control gear, neoprene gaskets, earthing terminal, etc.

The Lantern LED luminaire shall housed in die cast aluminium and powder coated finish.

LUMINAIRE FOR SPECIAL APPLICATION

AVIATION OBSTRUCTION/WARNING LUMINAIRE

Aviation Obstruction Light shall be LED type luminaire (low, medium, high intensity) with long life. The luminaire and related system shall conform to ICAO guidelines.

This luminaire shall be with weatherproof, die cast aluminium body with shock resistant clear glass dome for better illumination. The luminaire and driver shall be suitable for outdoor application. The degree of protection shall be IP65 or better.

AOL shall be suitable for lamp exchange period of over 15years, with maintained intensity.

Automatic Bypass system shall be provided, in the luminaire, for series of LEDs of each luminaire.

AOL shall be complete with all accessories, hardware, fixing arrangement, internal wiring, termination box and bottom cable gland/conduit entry.

The system shall be integrated with Astronomical Time Switch and Photocell.

The means for attaching the luminaire shall be designed to suit the weight of the luminaire and strength to withstand wind speeds as applicable to particular area as per relevant IS.

Low Intensity type luminaire shall be suitable for mounting on structures / buildings upto 45 metres height.

Low intensity (minimum 10 candela in red, minimum 90 candela luminous intensity - total 360deg integrated) red coloured clustered LED type aviation obstruction/warning lights (AOL) The AOL shall be steady glowing (without any

flashing). AOL shall have min. 10Cd maintained intensity over a period of >15years.

Medium Intensity type luminaire shall be suitable for mounting on structures / buildings upto 200 metres height.

This system shall consist of a beacon with medium intensity red coloured fixed/flashing OR white coloured flashing LED lamps.

High Intensity type luminaire shall be suitable for mounting on structures / buildings of height 200 metres and above.

This system shall consist of a beacon with LED lamps emitting high intensity white light and synchroniser flasher unit.

ENVIRONMENTAL LIGHTING LUMINAIRE

Bollard Luminaire

(a) Bollard luminaire shall be outdoor, weather proof type for illumination of lawns, gardens, pathways, etc.

(b) The luminaire shall be of die cast aluminium housing, clear acrylic cover, louvers for directing light downwards and bottom cable entry.

(c) The luminaire shall be suitable for LED.

PORTABLE EMERGENCY LIGHT LUMINAIRE

(a) Emergency light shall be indoor type for providing emergency light during failure of normal AC supply.

(b) The luminaire shall be with CRCA sheet steel enclosure, complete with metallised mirror reflector, leak proof re-chargeable battery, rated for two hour discharge, battery, charger, charger-on lamp, push button switches, automatic changeover switch / relay, two metre length cord with plug, mounting pads and other accessories required for satisfactory operation of the luminaire.

(c) The luminaire shall be suitable for connection to 240 V, 50 Hz single phase supply. On failure of normal AC supply the luminaire shall pick-up automatically and on restoration of AC supply the luminaire shall switch off automatically.

(d) The luminaire shall be suitable for required incandescent lamp and fluorescent lamp.

CLEAN ROOM LUMINAIRE

(a) Clean room luminaire shall be suitable for the application. These shall be easy to clean. These shall be Bottom opening / Top-Opening depending on the project specific installation practice. The surface finish & Material of construction shall avoid any microbial growth such as bacterial/Viral/Fungal.

ACCESSORIES FOR LUMINAIRE

REFLECTORS

The reflectors shall be made of CRCA sheet steel / aluminium / silvered glass/ chromium plated sheet copper as indicated for above mentioned luminaire.

Aluminium used for reflectors shall be anodized / epoxy stove enamelled / mirror polished. The finish for the reflector shall be as indicated for above mentioned fittings and or in Data Sheet.

Aluminium paint on the reflectors of flame proof lighting fittings is prohibited.

Reflectors shall be free from scratches or blisters and shall have a smooth and glossy surface having an optimum light reflecting coefficient such as to ensure the overall light output specified by the MANUFACTURER.

Reflectors shall be readily removable from the housing for cleaning and maintenance without disturbing the lamps and without the use of tools. They shall be securely fixed to the housing by means of positive fastening device of captive type.

TESTS AND TEST REPORTS

Type tests, acceptance tests and routine tests for the lighting fixtures and accessories covered by this specification shall be carried out as per the relevant standard for the respective fixtures and their accessories.

The MANUFACTURER's type and routine test certificates shall be submitted for tests conducted as per relevant standards for the fixtures and accessories. The BIDDER shall submit with his proposal copies of available test certificates of the luminaire offered.

DRAWINGS AND DATA

As part of proposal, the BIDDER shall furnish relevant descriptive and illustrative literature on lighting fixtures and accessories and the following drawings / data for the respective lighting fixtures.

Dimensioned drawings with manufacturer's catalogue numbers.

Lumen maintenance report as per cl.no.3.10.9

Information called for in Data Sheet for each group of luminaire.

In addition to the above bidder to refer the control switch gears & accessories specification also for this section.

LIGHTING AUTOMATION

The Lighting Management System(LMS) and associated equipment including

HMI, photocells, timers, astronomical time clocks, etc., shall comply with the latest applicable IEC / IS standards. The control system shall be designed and manufactured to comply with the CE Standard.

The lighting Automation control system shall include but not be limited to the following:

- Floor controller in electrical risers
- Wired Ceiling mounted sensors;
- Wired Photocells;
- Wired ELV switches;
- Ethernet Cable between Ethernet Modules and already existing LAN network.
- Twisted pair cable between floor controllers, and other items, accessories, hardware, software, etc., as required for a complete stand-alone lighting control and monitoring system.
- The lighting control system shall be capable of working with an array of differing lamp sources with following

- Logical Grouping / patching requirements
- Scene-setting requirements
- Daylight Tracking Requirements
- System Graphic Topology
- Required IP Router
- Touch Switches
- AREA / LINE COUPLER Dali Gateway
- Dali controller Tunable White

Software Control and Monitoring Functions

These software functions will be executed by Building Management Systems which needs to have all the feature mentioned.

Detailed engineering of the system shall be carried out by the vendor.

Central Automatic Control Functions

Central automatic commands are to be generated by a calendar software program. The calendar program enables different switching and scene regimes to be allocated for different times of the day or year and programming of weekend and special event planning. Timing software shall include as standard an astronomical time clock.

The system shall be capable of providing a load shedding facility such that each luminary circuit can be designated an essential (operable during loss of mains) or nonessential (held off).

Scene’s reflecting time of day and daylight in zones can be automatically controlled via the central commands.

The system shall be capable of providing corridor linking linked to occupation of adjoining spaces and is held on while associated areas are in use.

The system shall provide complete daylight linking to enable energy savings to be achieved when adequate daylight is provided.

The lighting control system shall record the numbers of hours run by each switchable group of lighting; this information will be used for monitoring lamp life and producing planned maintenance schedules.

A global input from a number of photoelectric cells forming part of the general lighting shall be used to operate the general lighting installations, the external lighting installations.

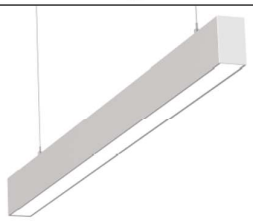
The layout of the buildings shall be shown on the workstation graphics in plan form and shall show the major components of the general lighting system. Navigation buttons/icons shall allow the lighting control zones of the center to be displayed at larger scales and give control of individual lighting circuits.
The system shall be capable of producing planned maintenance schedules. The system shall provide a management tool for monitoring status and historical performance of the sub-project and load center.

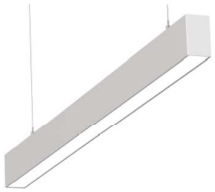
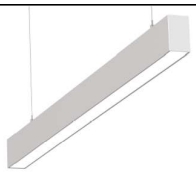
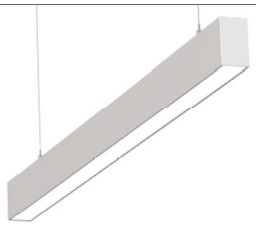
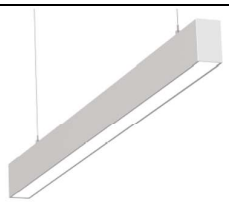
Integration capability:

This Lighting Management System should be capable of integrating with Building Management System on Bacnet / IP of KNX IP Interface.

Note : Listed out the Light fittings reference images and type – Specification of all fixtures shall be followed as per BOQ . Base rates for some decorative fixture given below same should be followed during Bidding.

Description As per BOQ	Reference Image
(TYPE1 LIGHT FIXTURE)	
(TYPE2 LIGHT FIXTURE)	
(TYPE3 LIGHT FIXTURE)	
(TYPE4 LIGHT FIXTURE)	
(TYPE5 LIGHT FIXTURE)	
(TYPE6 LIGHT FIXTURE)	

TYPE7 LIGHT FIXTURE)	
(TYPE8 LIGHT FIXTURE)	
(TYPE9 LIGHT FIXTURE)	
INTERIOR LIGHT FIXTURES	
(TYPE10 LIGHT FIXTURE)	
(TYPE11 LIGHT FIXTURE)	
(TYPE12 LIGHT FIXTURE)	

(TYPE13 LIGHT FIXTURE)	
(TYPE14 LIGHT FIXTURE)	
TYPE15 LIGHT FIXTURE)	
(TYPE16 LIGHT FIXTURE)	
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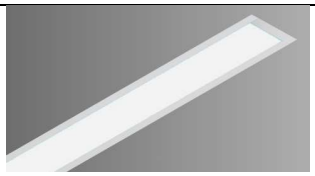
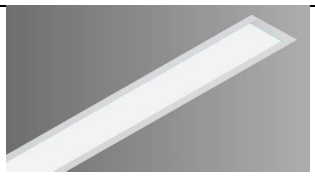
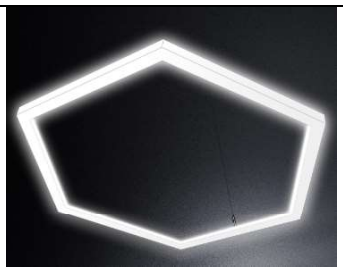
(TYPE18 LIGHT FIXTURE)	

(TYPE19 LIGHT FIXTURE)	
(TYPE20 LIGHT FIXTURE)	
(TYPE21 LIGHT FIXTURE)	
DECORATIVE LIGHT FIXTURE TYPE -1 (TYPE22 LIGHT FIXTURE)	
DECORATIVE LIGHT FIXTURE TYPE -2 (TYPE23 LIGHT FIXTURE)	
DECORATIVE LIGHT FIXTURE TYPE -3 (TYPE24 LIGHT FIXTURE)	

DECORATIVE CHANDELIER LIGHT FIXTURE TYPE -4 (TYPE25 LIGHT FIXTURE) *(Basic rates needs to be considered - Rs. 30000)*	
DECORATIVE CHANDELIER LIGHT FIXTURE TYPE -5 TYPE26 LIGHT FIXTURE) *(Basic rates needs to be considered - Rs. 18000)*	
DECORATIVE CHANDELIER LIGHT FIXTURE TYPE - 6 (TYPE27 LIGHT FIXTURE) *(Basic rates needs to be considered - Rs. 15000)*	
DECORATIVE CHANDELIER LIGHT FIXTURE TYPE - 7 (TYPE28 LIGHT FIXTURE) *(Basic rates needs to be considered - Rs. 28000)*	
DECORATIVE HEXAGONAL SUSPENDED LIGHT FIXTURE TYPE - 8 (TYPE29 LIGHT FIXTURE) *(Basic rates needs to be considered - Rs. 25000)*	

10. SWITCHES, SOCKETS & ACCESSORIES

This specification covers the design, material, manufacture, testing, inspection, and delivery to site the Indoor and Outdoor lighting system equipment. The indoor equipment includes lighting distribution boards, panels (Single phase/Three phase), switches, power receptacle units, lighting wires, junction box, conduits and its accessories, ceiling fans etc, the outdoor equipment includes outdoor lighting distribution boards/panels, lighting poles (Street light/Flood light/High mast), LT power cables, etc. Separate specification when enclosed, cover the requirements of lighting system installation works.

CODES & STANDARDS

The items of supply shall conform to the latest applicable electrical rules, all currently applicable standards codes of practice indicated in Data Sheet, regulations, and safety codes of the locality where the equipment are to be installed. In case of conflict between these standards and specification, the more stringent of the two shall govern. Nothing in this specification shall be construed to relieve the CONTRACTOR of his responsibility. Where no standards are available, the supply items shall be backed by test result, shall be of good quality and workmanship and any supply items which are bought out by the VENDOR shall be procured from approved manufacturers acceptable to the PURCHASER/ENGINEER.

The codes and standards mentioned in the various specifications and requirements specified in the enquiry document shall be latest as on the day of execution of the works unless otherwise specified. The revisions in the relevant codes and standards after the date of award of contract shall be informed by the Contractor to the Consultant/ Owner within 30 days of the issue of such revision of the code/ standard. Consultant/ Owner may approve use of the earlier code/ standard if the revisions do not materially affect the Statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed.

The CONTRACTOR shall ensure that instruments and gauges to be used for testing and inspection of critical parameters as identified in the specification have valid calibration and the accuracy can be traced to National/International standards, as applicable.

LIGHT CONTROL SWITCHES

Light control switches of ratings and types, i.e. decorative/industrial/flame proof, shall be supplied as indicated in project layout drawings/price schedule. The switches shall be suitable for use on 240 V, 1 phase, 50 Hz supply.

Switches shall be of flush type for mounting behind an insulated plate or incorporated with a switch or switch box/suitable enclosure. The switch box/ enclosure may be recessed into or mounted on wall as per the requirements of project layouts.

The size of enclosure boxes shall be chosen to accommodate the number of

switches to be installed at the particular location. The enclosures shall be made of 1.2 mm thick CRCA sheet steel, stove enamelled/galvanised. The enclosure box shall be covered with perspex/insulating cover. An enclosure intended for surface mounting shall not have holes or gaps in its sides other than those expressly provided for cable entry.

Flame proof switch shall be of rotary type construction, enclosed in a flame proof enclosure and rated for 15 Amps. As a standard feature, unless otherwise specified, switch shall have two bottom entries, one of which shall be provided with a flame proof stopper plug.

RECEPTACLE UNITS

Receptacle units shall consist of socket outlet with associated switch, neon indicating lamp and plug. The socket outlet and switch or MCB shall be flush mounted within a stove enamelled/ galvanised 1.2 mm thick CRCA sheet steel enclosure with perspex/insulating cover. The box may be recessed into or mounted on a wall as per requirements of project layouts.

The outdoor type receptacles shall be housed in a 2 mm thick CRCA sheet steel epoxy painted enclosure with gasketed, hinged door having locking arrangement. The enclosure shall be with rain canopy and removable gland plate entry from bottom. Composite receptacle with switch modules housed in a box shall be with degree of protection IP 66.

The receptacle units shall be suitable for 240 V, 1 phase, 50Hz/415V, 3 phase, 50 Hz supply as indicated in project layout drawings/price schedule.

Single phase receptacles shall be associated with a switch/MCB of same current rating and the receptacle shall become live only when the associated switch/MCB is in “ON” position.

Three phase receptacles shall be associated with a TPN switch housed in the same enclosure. The receptacle shall become live only when the associated switch is in “ON” position and it shall not be possible to withdraw the plug with the switch in “ON” position.

The plugs shall be provided with cord grips to prevent strain and damage to conductors/wires at connection and entry points.

The types and current ratings of receptacle units shall be as indicated in the Project layout drawing/price schedule and they shall conform to the applicable standards indicated in Data Sheet.

FLAMEPROOF EQUIPMENT

The enclosure of all flameproof equipment for use in hazardous areas where gases/vapours of Group I, IIA, IIB, IIC are present, shall be of cast iron/cast aluminium, stove enamel finished. Chemical corrosion resistant epoxy finish shall be provided, if specified in Data Sheet. The construction shall comply with relevant applicable standards mentioned in Data Sheet.

If the enclosures are additionally required to be weatherproof, neoprene gaskets shall be provided to make the enclosure dust and weather proof providing a degree of protection of IP 55.

All ferrous parts, exposed to atmosphere shall be suitably plated/galvanised.

All internal wiring shall be connected to terminal blocks provided in terminal enclosure on incoming side.

Flameproof cable gland entries shall be provided suitable for the PURCHASER's specified cable sizes. The number of required cable entries for junction/terminal boxes as required for branching, terminating of cables for lighting distribution shall be provided. All unused cable entries shall be closed by flameproof plugs.

Flameproof receptacle unit (socket with associated switch/MCB and plug) shall have interlocking feature such that plug cannot be inserted or taken out with switch/MCB in "ON" position.

Two external earthing terminals shall be provided on the enclosure to suit the PURCHASER's specified conductor. Additionally, one internal earthing terminal shall be provided in junction/terminal boxes.

Adequate mounting lugs with necessary hardware shall be provided for mounting the equipment on wall/structure.

These enclosures shall have inscription warning against opening the enclosure unless the circuit is isolated. Equipment rating and ON/OFF positions of switches/MCBs shall also be designated.

The BIDDER shall indicate that the enclosures have been tested and certified by relevant Statutory authorities for use in hazardous areas.

CEILING FANS / WALL MOUNTED FANS

Ceiling/Wall mounted fans shall be suitable for operation on 240 V, 1 phase, 50 Hz supply and shall be complete with standard mounting accessories such as suspension rods, top and bottom caps etc for ceiling fans and easy accessibility for wall mounted fans. The fans shall be supplied with appropriate speed regulators.

The fans shall generally conform to the applicable standards indicated in Data Sheet-. Details regarding blade sweep and suspension requirements shall be as per Project layout drawing/price schedule.

LIGHTING WIRES

The wires for wiring in lighting system shall be 1100 V, 1 core, PVC insulated, unarmoured with stranded copper conductors, unless otherwise specified in Data Sheet. The wires shall conform to the applicable standards specified in Data Sheet- .

The minimum area of conductors shall be 2.5 sq.mm for light fittings and 5A receptacles and 4 sq.mm for receptacles rated 15 A.

The wires shall be coded white for phase/positive of DC and black for neutral/

negative of DC.

The approximate quantities of wires shall be indicated by the PURCHASER in Data Sheet only when the same are not covered in the CONTRACTOR's "Point Wiring" work under lighting system installation work.

CONDUITS

Rigid steel/non-metallic conduits and their associated fittings shall conform to applicable standards in Data Sheet- . The minimum size of conduit shall be 20 mm for surface installation and 25 mm diameter for concealed installation.

Steel conduits shall be seamed by welding and hot dip galvanised unless otherwise specified. They shall be supplied in standard lengths of 5 m.

Supply of conduits shall include all associated fittings like couplers, bends and tees as required for lighting installation work. In case of building with expansion joints, it shall also include junction boxes with flexible connectors for expansion joints.

The approximate quantities of conduits shall be indicated by the PURCHASER only when conduits are not covered in the CONTRACTOR's "Point Wiring" work under lighting system installation works.

JUNCTION BOXES

Junction boxes with terminals shall be supplied for branching and terminating lighting cables when required for outdoor areas, 3 phase receptacles etc.

The junction boxes shall be dust and vermin proof and shall be fabricated from 1.2 mm to 2 mm CRCA sheet steel depending on the size of the junction box and shall be complete with removable cover plate with gaskets, two earthing terminals each with nut, bolt and washer. Boxes shall be additionally weather proof when specified.

The boxes shall have provision for wall, column, pole or structure mounting and shall be provided with cable/conduit entry knock outs, terminal blocks, HRC fuses, as indicated in the Project drawing.

The terminal blocks, with specified number of terminals, shall be mounted securely on brackets welded to the back sheet of the box. The terminals shall be minimum 650 V grade, one piece construction complete with terminals, insulation barriers, galvanised nuts, bolts and washers and provided with identification strips of PVC. The terminals shall be made of copper alloy and shall be of box clamp type.

The boxes shall be hot dip galvanised/painted with one shop coat of red oxide zinc chromate primer followed by a finishing coat of paint as specified.

SPARE PARTS

Unit prices of the items listed in Data Sheet shall be quoted together with catalogue numbers.

The VENDOR may recommend additional spare items and quote the unit prices

of the respective items.

TESTS AND TEST REPORTS

Type tests, acceptance tests and routine tests for all supply equipment/ component parts covered by this specification shall be carried out as per the relevant standards for the respective equipment and their accessories.

The certified copies of test certificates/reports of the above-mentioned tests shall be submitted to the PURCHASER before dispatch of equipment. BIDDER shall submit with his proposal copies of available type test certificates of the equipment/component parts offered.

DRAWINGS AND DATA

The BIDDER shall furnish relevant technical/ descriptive literature of all quoted items and the general arrangement drawing showing dimensioned views for Lighting Distribution boards and lighting panels and junction boxes. Data Sheet completely filled in shall also be furnished.

FOR REVIEW/APPROVAL

Distribution board/Panel general arrangement dimensioned drawings showing plan elevation and side view, outline dimensions, floor openings, floor/wall/ structure fixing arrangements, earthing terminals and weights etc

Bill of material listing component/equipment designation, make, type, ratings, quantity of the various components mounted on the boards/ panels.

Schematic wiring diagram of the distribution boards/ panels, showing the terminal numbers and the terminals for the PURCHASER's external connections.

Dimensional drawing of flood lights tower giving all design particulars, GA drawing of High Mast.

FOR INFORMATION

Inside view of distribution boards / panels showing mounting and wiring arrangement of various component equipment.

Descriptive/technical catalogues of air break switches, MCCB, miniature circuit breakers, residual current circuit breakers, metering instruments, light control switches, receptacle units, flameproof enclosures, conduits, junction boxes and ceiling/wall mounted fans.

Dimensioned drawing of flood lights tower/High mast giving all design particulars shall be submitted for approval before fabrication of the tower/High mast.

11. WIRING

For WIRES please refer to the respective local state PWD specifications. In the absence of information from PWD specification , the following specifications shall be followed as given below.

The specification covers design, manufacturing, supply, installation, testing and

commissioning of internal wiring / conduit wiring for modular switch sockets , Lighting fixtures and lighting control equipment.

CODES AND STANDARDS

The codes and standards mentioned in the various specifications and requirements specified in the enquiry document shall be latest as on the day of award of contract of the works unless otherwise specified. Contractor shall be responsible to inform to the Consultant/ Owner in case of any revisions/re-affirm/amendment in the relevant codes and standards after the date of award of contract within 30 days of the issue of such revision/re-affirm/amendment of the code/ standard. Consultant/ Owner may approve use of the earlier code/ standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed.

SYSTEM OF WIRING

The system of wiring shall consist of PVC insulated copper stranded conductor flexible
FRLS (Fire Retardant Low smoke) wires in metallic / non metallic (Rigid heavy Duty ISI -
marked fire retarded PVC Conduits of minimum 2mm Wall thickness and Sizes starting from20 mm diameter) conduits and shall be concealed or surface mounted above false ceiling as called for.

GENERAL

Prior to laying and fixing of conduits, the contractor shall mark the conduit route, carefully examine the working drawings prepared by him and approved route, sufficiency of number and sizes of conduits, location of junction boxes, sizes and location of switch boxes and other relevant details. Any discrepancy found shall be brought to the notice of the Owner's site representative. Any modifications suggested by the contractor should get written approval before the actual laying of conduits is commenced.

In laying of conduits, it is important that not more than two right angle bends are provided for each circuit without a pull box. No junction box shall be provided in the entire length of conduit run for drawing of wires. Only switch outlets, lighting fixture outlets, equipment power outlets and socket outlets shall be considered for drawing of wires. Wiring for short extensions to outlets in hung ceiling or to vibrating equipments like motors etc, shall be installed in flexible conduits with necessary glands of same material at both the ends. No flexible extension.
by the Consultant indicating the layout, satisfy himself about the non-interference in the

METAL CONDUITS & ACCESSORIES.

- Conduits and Accessories shall conform to latest edition of Indian Standards IS-9537 part 1 & 2.16/14 (16 gauge up to 32mm diameter & 14 gauge above 32 mm diameter) gauge screwed Glor MS painted conduits as specified in the design basis shall be used.

- Joints between conduits and accessories shall be securely made by standard accessories, as per IS-2667, IS-3837 andIS-5133 to ensure earth continuity.

- All conduit accessories shall be threaded type only.Only approved make of conduits and accessories shall be used.

- Conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer.

- Note.: Whatever materials required to be billed by the Contractor should come on site with proper Challan Numbers and quantity mentioned in each such Challan.

- All jointing shall be subject to the approval of the Owner's site representative. The threads and sockets shall be free from grease and oil. End termination of conduit on GI boxes shall be by means of hexagon check nuts & spring washer on both sides of the conduit. The joints in conduits shall be free of burrs to avoid damage to insulation of conductors while pulling them through the conduits. Rubberised bushes shall be used in the conduit entry and exit from DBs, switch boxes etc, so that wires are protected from damage to insulation of the incoming and outgoing wires.

- All conduits shall be as per Schedule of quantities .

- For all exposed (areas without false ceiling) wiring shall be with -GI conduit, & above the false ceiling areas the wiring shall be in- MS conduits shall be used.

- Flexible conduits shall be made of heavy gauge MS strip galvanized after making the spiral. Both edges of the strip to have interlocking to avoid opening up. Flexible conduit shall be heat resistant, lead coated steel, water leak, fire and rust proof. The flexible conduit shall be heat resistant on continuous temperature up to 150 deg. C and intermittent temperature up to 200 deg. C. The flexible conduit shall be corrosion resistant as per IS-3480 & BS-731.

PVC CONDUITS & ACCESSORIES.

PVC Conduit
Conduits and accessories shall conform to latest edition of IS-9537 part 3 and shall be heavy duty with minimum wall thickness of 2.0 mm rigid tubes which are unscrewed without coupling and with plain ends. All PVC conduits used shall be Fire Retardant, ISI-marked and shall not be less than 20 mm diameter. Heavy duty FR PVC conduit shall be used for all concealed / embedded installation.

PVC Conduit Accessories
Accessories used for conduit shall be of an approved brand and type complying to relevant IS code. All accessories used shall be of standard white or black colour, identical to conduit used .Plain conduits shall be joined by slip type of couplers with manufacturer's standard sealing cement.

All conduit entries to outlet boxes, trunking and switchgear are to be made with adaptors
female thread and screwed male bushes. PVC-switch and socket boxes with round knockouts are to be used. The colours of these boxes and the conduits shall be the same.
Standard PVC circular junction boxes are to be used with conduits for intersection, Tee junction, angle-junction and terminal. For the drawing-in of cables, standard circular through boxes shall be used.
Samples of accessories shall be submitted for approval prior to installation. All jointing of PVC conduits shall be by means of adhesive jointing. Adequate expansion joints shall be allowed to take up the expansion of PVC conduits.

BENDS

Where necessary, bends or diversions may be achieved by means of bends and / or circular cast iron boxes with inspection cover and with adequate and suitable inlet and outlet screwed joints. In case of recessed system each junction box shall be provided with a cover properly secured and flush with the finished wall surface. No bends shall have radius less than 7.5 cms or three times the outside diameter of the conduits. For metallic conduits, bends of defined radius shall be made by compactly filling fine sand inside the conduit length, to avoid non-uniform shape, once the bend is done. Proper jigs shall be used to ensure that the Enamelling /Galvanising of the Conduit is not damaged.

FIXING OF CONDUITS

All conduits shall be installed so as to avoid exposure to steam, hot water or any other process pipes. After the conduits, junction boxes, outlet boxes and switch boxes are installed in position, their outlets shall be properly plugged or covered so that water, mortar, rodents and insects, insects or any other foreign matter does not enter into the conduit system.

Surface conduits shall be fixed by means of heavy gauge GI saddles secured at intervals not more than 1000 mm and on either side of couplers or bends or similar fitting saddles shall be fixed at a distance of 300 mm from centre of each fitting. For conduit fixing suitable PVC/Nylon fasteners shall be used.

Recessed conduiting shall be done by making chase in the masonry by chase cutter; the
conduit shall be fixed in the chase by means of GI hooks not more than 600 mm apart. Afterfixing of conduit the chase shall be filled with cement mortar after fixing of chicken mesh and brought to the original finish level of the surface to the entire satisfaction of Owner.

SWITCH OUTLETS , JUNCTION BOX OUTLETS & INSPECTION BOX

All outlet boxes for switches, sockets and other receptacles shall be rust proof and shall be of 1.6 mm thick mild steel sheets with HOT dipped galvanizing (or as specified in SOQ),having smooth external and internal surfaces to true finish. All outlet boxes for receiving plug sockets and switches shall be fabricated to approved sizes. All boxes shall have adequate number of knock out holes of required diameter and earthing terminal screws. Outlet boxes shall generally be of 50mm depth subject to maximum depth of 65 mm.

DRAWING OF CONDUCTORS

The drawing and jointing of PVC insulated copper conductor wires shall be executed with due regard to the following precautions. While drawing wires through conduits, care shall be taken to avoid scratches and kinks which may cause breakage of conductors.

There shall be no sharp bends. Wire reel stands to be used for pulling of wires to avoid kinks. Care shall be exercised while drawing the wires from reels, by taking appropriate measures to ensure that wires are not spread on ground, causing dust and dirt accumulation on the new wires.

Maximum permissible number of 1100 volt grade PVC insulated FRLS wires that may be
drawn into metallic Conduits are given below:

Size of wires Nominal Cross section Area (Sq. mm.)	Maximum number of wires within conduit size(mm)				
	20	25	32	40	50
1.5	5	10	14	--	--
2.5	5	8	12	--	--
4	3	7	10	--	--
6	2	5	8	--	--
10	--	3	5	6	--
16	--	2	3	6	6
25	--	--	2	4	6
35	--	--	--	3	5

Maximum permissible number of 1100 volt grade PVC insulated FRLS wires that may be drawn into rigid non-metallic or FR PVC Heavy duty Conduits are given below :

Size of wires Nominal Cross section Area (Sq. mm.)	Maximum number of wires within conduit size(mm)				
	20	25	32	40	50
1.5	7	12	16	--	--
2.5	5	10	14	--	--
4	4	8	12	--	--
6	3	6	8	--	--
10	--	4	5	6	--
16	--	3	3	6	6
25	--	--	2	4	6
35	--	--	--	3	5

Insulation shall be removed by insulation stripper only. Few Strands of wires shall not be cut/reduced for convenience in connecting into terminals. At each terminal of wire, lugs to be mounted using appropriate crimping devices. The terminals shall have sufficient cross-sectional area to take all strands and it's connecting brass screws shall have flats ends. All looped joints shall be connected through terminal block/connectors. The pressure applied to tighten terminal screws shall be just adequate, neither too much nor too less. All light points shall be terminated through a connector. Conductors having nominal cross-sectional areas exceeding 10 sq.mm shall always be provided with cable sockets. At all

bolted terminals brass flat washer of large area and approved steel spring washer shall be used. Brass nuts and bolts with brass washers shall be used for all connections.

Only licensed wiremen (Before doing the work or before appointing him on site contractor has to submit his wiring licence to Owner) and cable jointers shall be employed to do jointing work. Before entrusting cable jointing work to any technician, or before appointing Cable Jointers or Wiremen on Site, Contractor has to submit such Technicians' / Wireman's / Cable Jointer's licence to Owner.All wires and cables shall be embossed with the manufacturer's label with ISI mark and shall be brought to site in original packing. For all internal wiring. PVC insulated wires of 1100 volts grade (LSZH) shall be used.

The sub-circuit wiring for point shall be carried out in loop system and no joints shall be allowed in the length of the conductors. No wire shall be drawn into any conduit until all defective work of conduit installation of any nature that may cause injury to wire is completed. Care shall be taken while pulling out the wires so that no damage occurs to conduits/wire itself, the conduits shall be thoroughly cleaned of moisture, dust , dirt or any other obstruction.
The minimum size of PVC insulated copper conductor wires for all sub-circuit wiring for light points shall be minimum 2.5 sq.mm copper. Separate neutral to be pulled for each circuit.

MAINS & SUBMAINS

Mains and sub-mains cable or wires where called for shall be of the rated capacity and approved make. Every main and sub main wires shall be drawn into an independent adequate size of conduit. Earthing shall be in conformity with relevant IS codes and calculations shall be submitted for verification. An independent earth wire of the proper ratingshall be provided for every single phase sub-main. For every 3 -phase sub-main, 2 Nos.earth wires of proper rating shall be provided along with the sub-main.

The earth wires shallbe drawn along with circuit wires through conduit. Where mains and sub-mains cables are connected to switchgear, sufficient extra lengths of cable shall be provided to facilitate easy connections and maintenance. Powder-coated 1.6 mm thick sheet steel covering (also called trunking) shall be provided to cover the group of conduits and cables entering and exiting the Wall mounted/Floor mounted Sub DBs, DBs, and FDBs, so that the Installation looks neat .The colour of such sheet steel covering (trunking) shall be matching with the colour of
the SDBs, DBs and FDBs.

Balancing of circuits in three phase installation shall be as planned by the ELECTRICAL contractor in the shop drawings and shall be checked by the owner \ owner's representative before the commencement of wiring and shall be strictly adhered to.

MEASUREMENT OF POINT WIRING

Unless specified otherwise, measurement for point wiring for lighting circuits shall be on the basis of primary and secondary point. As mentioned in Schedule of Quantities. All work & materials necessary for wiring a point circuit of any length from the Final Distribution Board to switch board shall include the circuit wiring except where identified.

Point wiring shall be measured in units of number. or set as describe in schedule of
quantities. It is including all wiring, back box, earthing wires, conduits, conduit supporting structural members including spacers, clamps etc, bushes and other fittings as well as flanges (with gaskets, nuts, and bolts for jointing), unions, bends, elbows, tees, concentric and / or eccentric reducers, inspection pieces, expansion loops etc (as required for completing installation.).The above accessories shall be measured as part of circuit cum point wiring as specified in schedule of quantities.

12. AUXILIARY POWER SUPPLY

The specification covers design, manufacturing, supply, installation, testing and commissioning of auxillary supply for substation equipments .

CODES AND STANDARDS

The codes and standards mentioned in the various specifications and requirements specified in the enquiry document shall be latest as on the day of award of contract of the works unless otherwise specified. Contractor shall be responsible to inform to the Consultant/ Owner in case of any revisions/re-affirm/amendment in the relevant codes and standards after the date of award of contract within 30 days of the issue of such revision/re-affirm/amendment of the code/ standard. Consultant/ Owner may approve use of the earlier code/ standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed.

GENERAL

This specification covers the requirements for 110 V, partial recombination type Nickel-Cadmium alkaline batteries with chargers.

Ni - Cd batteries shall comply with latest version of IEC62259.

The batteries covered in this specification are for indoor use. For out-door application suitable enclosure shall be provided.

BATTERY SIZING

The nominal voltage of a single cell shall be 1.2 V. Battery capacity shall be adequate to cater for continuous load (annunciation, indicating lamps etc.) as well the maximum momentary load that may arise due to tripping of all HT breakers connected to bus.
The supplier shall carry out battery sizing calculations based on the load cycle specified in line with IEEE 1115.

Following factors shall be considered while carrying-out battery sizing calculations.

- Ageing factor – 1.25
- Design margin –1.0
- State of charge –0.9

The number of cells shall be determined as per load cycle and the battery system.
Voltage level & adequate no of spare cells.

CONSTRUCTION

The cells shall have prismatic, spill-proof and valve-regulated partial recombination
type of construction with partial recombination feature. The cells shall be flooded type containing sufficient reserve electrolyte. Battery shall be equipped with nickel plated inter-cell connectors and terminals. The cells shall be housed in high-strength impact resistant & alkali-resistant containers and shall be transparent / translucent to facilitate checking of electrolyte level. Container and Lid shall be welded and shall not cause leakage of electrolyte/gases during operation even in case of normal mechanical /electrical impacts. The containers shall be strong enough, so that excessive bulging of container does not occur during service. Cells shall be supplied in filled & charged state.
Battery shall have provision for water top up to ensure electrolyte level does not fall
below recommended level.

Electrodes
+ ve and –ve electrodes shall be made by encapsulating/impregnating active material
in order to ensure that the battery is able to perform reliably over its life. +ve and –ve
electrodes shall be separated by micro porous separators. The structure of electrodes
shall be elastic enough to absorb mechanical stresses & volume changes during charge \ discharge cycle.

Connectors
Nickel plated copper inter cell connectors shall be used for connecting up adjacent
cells and rows. Bolts, nuts and washers shall be nickel-plated steel/stainless steel. All terminals and cell inter-connectors shall be fully insulated or have insulation shrouds.

Terminals
Separate terminals shall be provided on the end cell for connecting load through DCDB and for connecting charger leads. All terminals shall be of suitably sized nickel-plated steel. Suitable nickel-plated copper lugs shall be provided by the for connecting up the load wiring.

Battery Racks
Suitable corrosion resistant battery racks and cable supports shall be provided. Metallic racks shall be properly earthed. The bottom tier of stand shall have a ground clearance of 150mm minimum above the floor. Racks shall be made of alkali resistant powder coated steel or stainless steel or FRP to ensure corrosion resistance.

Temperature Range
Battery must be capable of continuous operation in temperatures range of -15 oC to+50oC for prolonged periods. No Air-conditioning shall be provided where batteries are to be installed.

BATTERY CHARGER UNIT FOR 110V NI-CAD BATTERY

General
The battery charger shall be two Float cum Boost type Thyristor controlled. The charger shall have selector switch for Auto Float – Boost / Manual Float / Manual Boost Mode of operation. During Auto Float – Boost Mode, Automatic Changeover
shall take place from Float Mode to Boost mode and Vice-Versa. This means that when the Batteries are fully charged the charging shall automatically change from Boost charge to trickle charge. One battery charging set shall be provided with two
identical charging units each capable of functioning as float cum boost charger as well as supplying the DC load. Transformer neutral and enclosure earthing of Battery chargers shall have separate dedicated earthing conductor and shall be connected to main earthing grid.
.
Construction Feature
Float cum Boost charger and DC Distribution Board shall be housed in sheet steel
cubicle (IP 42 rating) with panels of 1.6 mm thickness, louvers for ventilation glands
plate will be provided for cable entry from bottom. The cubicle shall be painted in Siemens grey shade RAL-7032. The battery charger is divided into two compartments. The upper compartment houses the battery charger with all the necessary controls. The lower compartment is suitable for housing the batteries.
Separate charge bus and load bus shall be provided. Normally both the chargers, the battery and the load shall be connected to the load bus, the charger being on float mode. During boost charging, charger shall be connected to the charge bus with the battery. During this period, it shall be ensured that the other charger is healthy and connected to the load bus through contactor changeover arrangement. In case, the contactor fails, audio visual alarm shall be generated and subsequently the healthy charger shall feed the total load.

Performance
The D.C output voltage of Float / Boost charger shall be stabilized within + 5% for AC input variation of 230 V + 10%, frequency variation of 50 Hz + 5% and DC load
variation of 0-100%. The voltage regulation shall be achieved by a constant voltage
regulator having fast response SCR control. The ripple content will be within 3% of
DC output nominal voltage. Battery chargers shall be design for operating ambient
temperature of 0˚C- 50˚C.

There shall be provision to select Auto Float / Manual Float / Manual Boost modes.
During Auto Float Mode the battery charging shall automatically changeover from Boost Mode to Float Mode and Vice Versa. During Manual Float / Boost modes it shall be possible to set the output volts by separate potentiometers.
The battery charger shall have automatic output current limiting feature.
In case of main AC power failure with the battery on float charge mode, the battery

shall be automatically connected to the load bus for feeding of all loads. When power supply is resumed, then the charger, pre-selected as boost charger, shall start boost charging the battery until the desired battery voltage is reached. During this period, the load bus shall be isolated from the charge bus and the other charger shall feed the load.
In case of main AC power failure during boost charging of the battery, the battery shall be automatically connected to the load bus by a DC contactor. During the time
of closure of the auto changeover contactor, the continuity of power supply shall be
maintained from the tap cell of the battery through suitable diodes.
During the period of boost charging, if the float charger fails, then the boost charger
shall get connected to the load bus automatically though the dropper diodes to feed
the load. Normally, the dropper diodes shall remain by passed by suitable normally closed DC dropper diode bypass contactor. During the time of opening /Closing of the auto changeover contactors, the continuity of power supply shall be maintained from the tap cell of the battery through suitable diode. Boost charger shall be designed to cater DC continuous load as well as desired constant current for charging the battery simultaneously. The voltage at the load terminals shall be kept within specified limit through proper selection of dropper diodes.

During the period of boost charging, if the boost charger fails, then the mode of operation of the float charger shall automatically change from float to boost and charger shall start boost charging the battery as well as go on feeding the load through dropper diodes.
Facility shall be provided to manually connect the battery to the charge bus and switch on the selected boost charger when the battery voltage falls below a preset level and charge the battery at a constant recommended starting current upto
recommended cell voltage level.
The Charger shall be suitable for supplying the normal (100%) constant load and at
the same time maintain the battery to which it is connected in a full charged condition
while floating across the load and charger.

DC Distribution Board
It shall be provided in the charging cubicle, it will comprises of the following:
Incoming : Bidder to specify
Outgoing : 10 Nos. 16 A DP MCB
(Bidder to be submit the sizing calculation of battery chargers as per load profile and finalise DB configuration depend on the same.)

Test
All equipment and components thereof shall be to factory tests as per relevant IS standards. The following tests shall be conducted.
a. Dielectric Test.
b. Voltage regulation check from 0 to 100% load with ±10% input voltage variation

c. Ripple content measurement
d. Heat Run Test on current limiting values.
e. Routine Tests on component parts.

VRLA SMF BATTERY CHARGER FOR SUBSTATION

General

The battery charger shall be Float cum Boost type Thyristor controlled. The charger shall have selector switch for Auto Float – Boost / Manual Float / Manual Boost Mode of operation. During Auto Float – Boost Mode, Automatic Changeover shall take place from Float Mode to Boost mode and Vice-Versa. This means that when the Batteries are fully charged the charging shall automatically change from Boost charge to trickle charge.

Performance

The D.C output voltage of Float / Boost charger shall be stabilized within + 2% for AC input variation of 230 V + 10%, frequency variation of 50 Hz + 5% and DC load variation of 0-100%. The voltage regulation shall be achieved by a constant voltage. regulator having fast response SCR control. The ripple content will be within 3% of DC output nominal voltage.

There shall be provision to select Auto Float / Manual Float / Manual Boost modes.

During Auto Float Mode the battery charging shall automatically changeover from Boost Mode to Float Mode and Vice Versa. During Manual Float / Boost modes it shall be possible to set the output volts by separate potentiometers.

The battery charger shall have automatic output current limiting feature.

Construction Feature

Float cum Boost charger and DC Distribution Board shall be housed in sheet steel cubicle with panels of 1.6 mm thickness, louvers for ventilation glands plate will be provided for cable entry from bottom. The cubicle shall be painted in Siemens grey shade RAL-7032. The battery charger is divided into two compartments. The upper compartment houses the battery charger with all the necessary controls. The lower compartment is suitable for housing the batteries.

Rating (for 24 V Battery Charger)

AC Input : 230 V + 10% AC 50 Hz single phase.
DC Output : To float cum boost charge of 24 V with suitable AH batteries and also supply a continuous load.
Current Rating : 30.0 Amps
Float Mode : 27.0 V nominal (Adjustable) between 24-28.0 V.
Boost Mode : 28.2 V nominal (Adjustable) between 24-29.0 V.
Voltage Regulation : + 2% for AC input variation of 230 V + 10%.

Frequency Variation of 50 Hz + 5% and DC load
variation 0-100%
Ripple : Less than 1%

DC Distribution Board
It shall be provided in the charging cubicle, it will comprises of the following:
Incoming : 1 No. 63 A DP MCB
Outgoing : 10 Nos. 16 A DP MCB

VRLA BATTERY CHARGER FOR SUBSTATION

General
This specification covers the requirements for 24 V, VRLA type batteries with chargers. The latest state of the art Valve Regulated Sealed Maintenance Free Lead Acid Batteries with suitable discharge rating. The batteries covered in this specification are for indoor use. For out-door application suitable enclosure shall be provided.

Battery Sizing
Battery capacity shall be adequate to cater for actual burden of relay and metering
load & momentary load that may arise due to tripping of all breakers connected to bus.

The battery system design shall be provided with necessary devices to prevent deep discharge beyond recommended limits to prevent the batteries discharging beyond end cell voltage specified by the battery maker.

Following factors shall be considered while carrying-out battery sizing calculations.
a) Ageing factor – 1.25
b) Design margin –1.0
c) State of charge –0.9
The number of cells shall be determined as per load cycle and the battery system.
Voltage level & adequate no of spare cells.

Construction
Separators provided in the batteries shall be fibre boron on silicate glass mat. It shall be spill proof and vibration proof. The container of VRLA type battery shall be flame retardant.
Insulation of inter cell connectors for batteries shall be FRLS type and also the battery
terminals shall have FRLS shroud (anti-static type).
All batteries shall be clearly identified and identification numbers marked on the batteries and a schematic diagram.

Connectors
The connections from battery to battery shall be by using heavy duty copper bus bar
strips and terminal post shall be of brass of least electrical resistance. All terminals
and cell inter-connectors shall be fully insulated or have insulation shrouds.

Terminals
Separate terminals shall be provided on the end cell for connecting load through DCDB and for connecting charger leads. All terminals shall be of suitably sized.

Battery Racks
Suitable corrosion resistant battery racks and cable supports shall be provided. Metallic racks shall be properly earthed. The bottom tier of stand shall have a ground clearance of 150mm minimum above the floor. Racks shall be made of alkali resistant powder coated steel or stainless steel or FRP to ensure corrosion resistance.

Temperature Range
Battery must be capable of continuous operation in temperatures range of -15 oC to+50oC for prolonged periods. No Air-conditioning shall be provided where batteries are to be installed.

SAFETY EQUIPMENT

Danger Plate
Danger plate shall be provided on HV and MV equipment. MV danger notice plate shall be 200 mm x 150 mm made of mild steel atleast 2 mm thick with vitreous enamelled white on both side and with inscription in red colour on front side.

Fire Extinguishers
Portable CO2 conforming to IS:2878-1976, and dry chemical conforming to IS:2171-1967 shall be provided in the Sub-station.
For outdoor duty power transformers, stand alone type CO2 fire extinguisher \ sand buckets etc shall be provided.

Insulating Mats for Electrical Purpose
Insulating Mats shall be in compliance with IS-15652-2006 /IEC 61111-2002-06.
The insulating mats shall be made of Elastomer (a generic term that includes rubber, latex and elastomer compounds that may be natural or synthetic or a mixture of both) for use as floor covering for the protection of workers on AC and DC installation with the system voltage up to 66 KV AC and 240 volts DC.

Mats shall be resistant to acid and oil and low temperatures and shall be identified by the respective class symbol.
Thickness of mats for different classes, physical properties, dielectric properties and all other specification shall be as per IS:15652-2006.be free from blisters, pin holes, cracks, embedded foreign matters and other defects.
First Aid Box

First Aid box shall be provided with all necessary medicine, bandage, scissor etc.

13. EARTHING & LIGHTNING PROTECTION

This specification covers the requirements of installation, testing and commissioning of earthing systems. The work shall be carried out in accordance with this specification, relevant project layout drawings, typical drawings and installation notes enclosed with the specification.

CODES AND STANDARDS

The codes and standards mentioned in the various specifications and requirements specified in the enquiry document shall be latest as on the day of award of contract of the works unless otherwise specified. Contractor shall be responsible to inform to the Consultant/ Owner in case of any revisions/re-affirm/amendment in the relevant codes and standards after the date of award of contract within 30 days of the issue of such revision/re-affirm/amendment of the code/ standard. Consultant/ Owner may approve use of the earlier code/ standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed.

GENERAL

The system shall be TNS with four wire supply system (R,Y,B,N and. E) . All the non-current carrying metal parts of electrical installation and all metal conduits trunking, cable sheaths, switchgear, distribution panels, light fittings and all other parts made of metal shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system.

All metal work such as pipelines, ducts, cable trays, stair case railing etc shall be bonded to earth. All earthing shall be in conformity with IS: 3043 1987, and the basic system of earthing shall be TNS. Earthing for electronic equipment shall follow IEEE 1100 recommendations.

EARTH CONDUCTORS

Earthing conductors shall be of copper for equipment neutral earthing, IT equipment earthing, Server / Hub rack earthing, Isolation transformer neutral earthing etc. as per BOQ. GI conductor shall be used for general body earthing as mentioned in the design basis. Conductor shall be protected against mechanical injury and corrosion.

SIZING OF EARTH CONDUCTORS

Sizing of earth conductor for HV equipment and main LV panels etc. shall be based on actual fault current calculated. Separate earthing grids shall be provided for body earthing, neutral earthing of transformers & electronic \ IT equipment for every group of building. Earthing grids for all building groups shall be connected together at ground floor for equipotential bonding & to minimize overall resistance of earthing path.

Earthing grids of electronic \ IT equipment shall be separate & shall not be connected to general earthing grids. Electronic \ IT equipment earthing grids for all building blocks shall be interconnected for equipotential bonding & to minimize overall resistance of earthing path .For lighting & power circuits cross sectional area of earthing conductor shall not be smaller than half of the largest current carrying conductor subject to an upper limit of 80 Sq.mm. If the area of the largest current carrying conductor or bus bar exceeds 160 sq.mm then two or more earthing conductors shall be used in parallel, to provide at least half the cross sectional area of the current carrying conductor or bus bars. All fixtures, outlet boxes, junctiboxes and power circuits up to 15 amps shall be earthed with PVC insulated copper wire.

CONNECTION OF EARTH CONDUCTORS

All joints in tapes shall be with four rivets and shall be brazed in case of copper and by welding or bolting in case of GI. Wires shall be connected with crimping lugs; all bolts shall have spring washers. Sub- mains earthing conductors shall run from the main distribution panel to the sub distribution panel. Final distribution panel earthing conductors shall run from sub-distribution panel.

Circuit earthing conductor shall run from the exposed metal of equipment and shall be connected to any point on the main earthing conductor, or its distribution panel. Metal conduits, cable sheathing and armouring shall be earthed at the ends adjacent to distribution panel at which they originate, or otherwise at the commencement of the run by an earthing conductor in effective electrical contact with cable sheathing. Where equipment is connected by flexible cord, all exposed metal parts of the equipment shall be earthed by means of an earthing conductor enclosed with the current carrying conductors within the flexible cord. Switches, accessories, lighting fitting etc. which are rigidly secured in effective electrical contact with a run of metallic conduit shall not be considered as a part of the earthing conductor for earthing purposes, even though the run of metallic conduit is earthed. The installation shall be complete in all respects for efficient and trouble-free service. All work shall be carried out in a first-class quality and neat workmanship.

Grounding conductors shall be handled carefully to avoid kinking and cutting of the conductors during their installation. All exposed ground conductors run shall be taken in a neat manner horizontal, vertical and parallel to the building walls or columns and shall not be laid haphazardly. All connections to the grounding grid shall be made with earthing strip welded to grid and bolted at equipment ends.

Neutral conductor, sprinkler pipes, or pipes conveying gas, water or inflammable liquid,
structural steel work, metallic enclosures, metallic conduits and lightning protection system
conductors shall not be used as a means of earthing an installation or even as a link in an earthing system. The electrical resistance measured between earth connection at the main LT panel and any other point on the completed installation shall be low enough to permit the passage of current necessary to operate or circuit breakers and shall not exceed 1 ohm.

All switches carrying medium voltage shall be connected with earth by two separate and distinct connections. The earthing conductors inside the building wherever exposed shall be properly protected from mechanical injury by running the same in G I pipe of adequate size.

The overlapping in strips at joints where required shall be minimum 75 mm. The joints shall be riveted and brazed in case of copper and by welding / bolting in case of GI in an approved manner. Sweated lugs of adequate capacity and size shall be used for termination of all conductor wires above 6 sq.mm size. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substances and properly tinned. Equipotential bonding of all metallic structures shall be done.

The following must always be ensured in earthing system.

There shall be separate and distinct grid for the electronic IT equipments UPS neutral, Rack earthing, Isolation transformers etc.

Separate grid shall be created for generator neutrals, transformer neutrals, lightning protection system earth pits etc. Separate grid shall be provided for body earthing of all electrical equipment. These earth grids shall be interconnected at the ground level to form a common grid.

Extraneous conductive parts such as gas pipes, other service pipes and ducting risers and pipes of fire protection equipment and exposed metallic parts of the building structure.

Earth resistivity test to be done by ELECTRICAL contractor to establish correct values and use the same for calculating overall earth resistance.

Resistance to Earth The resistance of earthing system shall not exceed 1 ohm.

HOT DIP GALVANISING PROCESS

Quality of Zinc
Zinc to be used shall conform to minimum Zn 98 grade as per requirement of IS:209-1992.

Coating Requirement
Minimum weight of zinc coating for mild steel flats with thickness upto 6 mm in accordance with IS:6745-1972 shall be 400 g/sqm.
The weight of coating expressed in grams per square metre shall be calculated by
dividing the total weight of Zinc by total area (both sides) of the coated surface.
The Zinc coating shall be uniform, smooth and free from imperfections as flux, ash
and dross inclusions, bare patches black spots, pimples, lumpiness, runs, rust stains bulky white deposits, blisters.
Mild steel flats / wires shall undergo a process of degreasing pickling in acid, cold rinsing and then galvanizing. Jointing of earthing tape shall be by welding. All joints
and cut ends shall be properly painted with aluminium paint.

CONVENTIONAL COPPER EARTH ELECTRODE

Earthing electrode shall be 600 x 600 x 3.15 mm thick tined copper plate electrode, with 2 Nos 50 x 6 mm copper strips from earth plate electrode to inspection chamber, 50 mm dia medium class GI pipe, CI funnel with 20 gauge GI wire mesh, masonry chamber 1000 x 500 mm with concrete base as per IS3043 with C I heavy duty / chequered plate manhole cover with frame painted with bitumastic paint and packing with mixture of charcoal and common salt around plate electrode including digging of pit upto permanent moisture level and as per soil condition but not less than 3 meters and back filling as required.

CONVENTIONAL GI EARTH ELECTRODE

Earthing electrode shall be 600 x 600 x 6.3 mm thick GI plate electrode, with 2 nos. 50 X 6 mm GI strips from earth plate electrode to inspection chamber, 50 mm dia medium class GI pipe, CI funnel with 20 gauge GI wire mesh, masonry chamber 1000 X 500 mm with concrete base as per IS3043 with CI manhole cover with frame painted with bitumastic paint and packing with mixture of charcoal and common salt around plate electrode including digging of pit upto permanent moisture level but not less than 3 meters and back filling as required.

CHEMICAL EARTH ELECTRODE

In maintenance free earthing copper bonded earthing rod electrode shall be of 14.35 mm in diameter and 3 meter length. The rod shall be placed in a 150 mm dia an augured hole in the ground and then surrounded by ground enhancement material in either a dry form or pre mixed in a slurry. Once set, ground enhancement material becomes hard and as such holds positively to the rod as well as surrounding ground.

Earth rod offered shall have passed the test required of BS7430/ ANSI/ UL467 and confirm to the adhesion of the copper coating to the steel core (Design feature that prevents the ingress of moister and subsequently the integrity of the rod. Minimum 0.25 mm thickness of copper shall be deposited over the steel core as per BS 7430/ UL 467. Average life of the ground rod shall be 30 years in most soil.

Ground enhancement material shall be as per IEEE-80 clause 14.5d with a resistivity of less than 0.12 ohm-meter. The ground enhancement material shall be permanent and not leach any chemicals in to the ground. The pH value of the ground enhancement material shall be 6.9 to 7.2 of 100 gm/ lit @ 20 deg.C.

Minimum 30 Kg of ground enhancement material shall provided for each earth electrode.
Inspection chamber shall be of 400 x 500 mm with concrete base CI manhole cover with
frame painted with bitumastic paint. 2 Nos. of 50 x 6 mm cross section & 300 mm long copper strip to be clamped with copper claded rod electrode have sufficient nos (But not less than 4 Nos.) of 10 mm GI nuts & bolts for connection to the equipment / interconnection to the other pits to form equi-potential bonding.

14. UNINTERRPUTED POWER SUPPLY (UPS)

SCOPE

This specification covers the requirements of Uninterruptible Power Supply (UPS) to critical AC load systems, which have stringent requirements, imposed on voltage and frequency regulation, harmonic content, and transient recovery.

CODES AND STANDARDS

The design, material, construction, manufacture, performance, inspection and testing of UPS shall comply with all latest versions of standards, statutes, regulations, and safety codes in the locality where the equipment is proposed to

be installed. Nothing in this Specification shall be construed to relieve the VENDOR of this responsibility.

Some of the currently applicable standards are indicated in Data Sheet. In case of conflict between these standards and this specification, more stringent of the two requirements shall govern.

All codes and standards referred to in the specification shall be understood to be the latest version on the date of offer made by the bidder unless otherwise indicated.

SYSTEM REQUIREMENTS

The UPS system shall be true online static type and the components of UPS shall isolate power line transients, frequency, and voltage variations. The UPS shall provide no-break power supply to the critical loads under normal conditions, during outages in the input power and during failure / mal operation of the main components of the UPS by switching the alternate supply. The UPS to operate at minimum Power factor of 0.95 under fully loaded condition.

Static UPS systems shall be parallel redundant as specified in Datasheet.

Parallel redundant operation with bypass to regulated supply

UPS system shall be working in Parallel Redundant configuration having two sets of 100% rectifiers, batteries,static transfer switch and inverters and shall share the load. Under normal conditions, when AC mains power is available, both the rectifiers shall operate independently and supply DC power for float / boost charging the batteries and simultaneously to inverters. In case of failure in any one rectifier,. the faulty rectifer unit shall automatically get disconnected and the entire load shall be fed from the other UPS. Each rectifier shall be designed for feeding inverter load and float / boost charging of the battery to its rated capacity within 10 hours.

Normally both inverters will be synchronized with each other and with bypass supply. The two inverters shall operate in parallel and share the load equally. When a disturbance / fault occurs in any one of the inverters, the faulty unit shall automatically get disconnected and the entire load shall be fed from the other inverter. In case, both inverters develop a fault, the complete load shall be transferred to bypass supply through static transfer switches and retransfer of load from bypass to inverter supply shall be automatic/manual.

Servo Controlled Voltage Stabiliser (SCVS) shall be provided for bypass as stated in datasheet

A manually operated make before break changeover switch/MCCB shall be provided to bypass the UPS power circuits (inverters and stati switches) for maintenance and repair purposes.

N+1 Configuration

In this configuration, one number of UPS unit shall be provided as standby. At any point of time one UPS shall act as standby to other main UPS units. Under normal operating condition, all UPS i.e., N+1 shall be operating in parallel with partial loading. On an event of failure of anyone UPS, the remaining UPS will automatically increase the loading and take care of the failed UPS loads. Bidders shall supply all required paralleling accessories along with the UPS. Requirement and configuration of bypass shall be as indicated in Datasheet.

DESIGN REQUIREMENTS

All UPS components, i.e.., rectifier, inverter, static switch, by-pass switch, isolation transformer associated controls shall be mounted in floor mounted, sheet steel panel. In case of 3ph output UPS, it shall be transformer less design. The panels shall be designed for continuous operation for the ambient conditions defined in Data sheet. The battery shall be separately installed in a battery room. In case fans are required for cooling, N+1 Redundancy shall be provided to ensure rated output of the UPS.

Battery

The battery backup time, number and type of batteries shall be as specified in Data Sheet. The BIDDER shall choose the required voltage of the battery. The AH capacity of battery shall be chosen by BIDDER, based on the battery backup time / duty cycle, and minimum ambient temp. specified in Data Sheet, and the guaranteed DC/AC efficiency of the UPS system offered.
BIDDER shall furnish calculation for sizing of the battery based on the requirements specified in Data Sheet.

Rectifier

The rectifier shall essentially be IGBT type for all ratings of three phase UPS. For single phase UPS full controlled full wave type thyristors rectifier shall be used. The thyristor type rectifier shall be 6 pulse/12 pulse design with input isolation transformer. For Redundant UPS design the two rectifier input isolation transformers shall have vector grouping and connections to ensure 12 pulse operation seen from the source side. The rectifier shall be provided with soft start feature. The rectifier shall have features for temperature compensation charging of the batteries

The rectifier shall be capable of supplying the inverter full load, in addition to charging the fully discharged batteries in 8 to 10 hours or as recommended by battery manufacturer and then maintain the battery on trickle charge mode. The rectifiers shall automatically share the load during parallel operation in case of common battery, as specified in Data Sheet.

Inverters

The inverter shall be of IGBT type. The same shall be of PWM (Pulse Width Modulation) type. The inverter system shall be complete with necessary filters to limit the harmonic distortions to the load. The system shall have features to prevent deep discharge of battery.

Static Switch

The static switch shall comprise thyristors connected in anti-parallel configuration, enabling loads on each branch circuit to be connected to the inverter of the other branch circuit or to the stand-by regulated AC supply.

The current rating of the static switch shall be not less than the continuous full load rating of the branch circuit and short time rating of 1000% for 10 milliseconds.

Automatic initiation of the transfer from a faulty branch circuit to either a healthy branch circuit or the stand-by regulated source shall be accomplished during following conditions:

(a) Inverter failure.

(b) Loss of inverter AC output.

(c) Load over current (in case of non-redundant UPS with static bypass to regulated supply).

Regulated Stand-by AC Supply

Regulated stand-by AC supply shall be derived from stand-by source through a 3 ph servo-controlled voltage stabiliser (SCVS) and a 3 ph/3ph-1ph Delta-Vee connected adequately rated isolation transformer.

The voltage regulation and transient response shall be as specified in Data Sheet.

Circuit Protection

The following devices shall be provided to protect the UPS system:

(a) AC input circuit breaker to Rectifier unit.

(b) AC input circuit breaker to supply stand-by transformer / voltage stabiliser.

(c) DC circuit breaker for battery output.

(d) Fast acting semiconductor fuses.

INDICATIONS & ANNUNCIATION

The UPS system shall be provided with necessary meters, mimic diagram, local indication / alarm conditions.

High resolution digital display unit shall be provided for continuous monitoring of the UPS operation. The control system shall operate on Windows or equivalent platform. The following operating conditions shall be annunciated.

Alarm Indication:

(a) System fault
(b) Rectifier charger failure
(c) Inverter failure/ faulty
(d) Battery under voltage
(e) End of Battery Discharge
(f) UPS over temperature
(g) Overload
(h) Static transfer to stand-by
(i) Transfer inhibited
(j) Overload shutdown
(k) Emergency shutdown
(l) Battery circuit breaker / switch open
(m) AC Main failure
(n) AC stand-by source mains failure
(o) AC stand-by frequency out of range
(p) Manual bypass ON
(q) Fan failure
(r) Asynchronous condition
(s) Control power failure

Status Indication on Mimic:

(a) Mains on
(b) Rectifier on
(c) Battery on load
(d) Inverter on
(e) AC Stand-by source on
(f) Inverter on –load
(g) Manual by-pass on
(h) Load on static bypass.

Display of measurements:

(a) Inverter output phase-to-phase voltages
(b) Inverter output currents
(c) Inverter output frequency
(d) Voltage across battery terminals
(e) Rectifier input phase-to-phase voltages
(f) Rectifier input currents
(g) Active and apparent power
(h) Power factor
(i) DC voltage & Current
(j) CREST Factor

Remote Interface

Bidder shall consider the UPS integration with remote DCS/PLC/SCADA/BMS for monitoring of all annunciations, alarm, and metering parameters. UPS shall have RS485 port with Modbus compatibility to communicate to remote system. The Modbus card shall be either an isolated port or terminal block. The terminal block shall allow conventional twisted pair cabling for daisy chaining.

HARMONICS

Necessary input and output filters shall be provided, or the Rectifier and Inverter design shall be such that the harmonics injected back to the source and to the load shall be within limits specified in IEEE-519 at the point of coupling of the UPS to the system. The fault level of the system at the point of common coupling shall be as specified in data sheet

AC DISTRIBUTION BOARD (ACDB)

ACDB shall be supplied along with the UPS if mentioned in Datasheet.

SYSTEM EARTHING

The VENDOR shall clearly bring out the earthing philosophy to be adopted for the UPS electronics, protective earthing (PE) and neutral earthing. The requirement of separate clean earth independent of the plant electrical system earth shall be clearly brought out. All metallic non-current carrying parts of the Panel shall be bonded together and connected to the earth bus made of GI/Cu.

TESTS ON UPS

Routine tests on the complete UPS system shall be carried out as per relevant standards for each major sub-system in the UPS, viz., Rectifier, Inverters, batteries, stand-by supply etc. Factory testing at various loads such as 25%, 50%, 75% and 100% with non-linear loads at the output of UPS.

Type and routine tests certificates for all components used in the UPS system shall be furnished. Tests for components shall be as per relevant standard specifications.

BIDDER shall furnish the quality assurance plan for the equipment offered. The quality assurance plan shall include bought out components and assemblies used in the UPS system.

System tests shall be performed on the completely assembled UPS system. System tests shall include frequency regulations, Voltage regulation, current limiting feature and harmonic content tests in addition to the tests to prove the functional requirements such as synchronisation with range of adjustments, transfer of static switches for conditions of loss of square wave, overload and under voltage conditions.

Endurance test on static switches shall be performed for not less than 10 transfer / retransfer cycles at full load.

Heat run test shall be carried out on each branch of UPS including bypass (if provided) and on overall UPS system at rated load under relevant ambient conditions for a period of 8 hours. This test shall be conducted as a routine test on all UPS being supplied.

SPARES

BIDDER shall include list of spares with quantities as recommended for three years trouble free operation.

DATA TO BE FURNISHED BY VENDOR AFTER AWARD OF CONTRACT

Drawing / Document for Approval:

Detailed schematic diagram of the UPS system showing all components.

Bill of Material indicating rating & type designation of components.

General Arrangement drawing showing overall dimensions, foundation fixing details,
location of various devices, mimic diagram, list of protections, annunciation, and meters,
cable openings, etc.

Battery Sizing Calculation

Battery room Layout

Battery Drawings/documents as specified in battery Specification.

Drawings / Documents for information

Type test reports on components chosen.

Quality assurance plan.

Instruction manuals

15. INSTALLATION SPECIFICATION

This specification details the guidelines for work associated with installation, testing and commissioning of various electrical equipment including switchyard equipment. The work shall, however, at all times be carried out strictly as per the instructions of the OWNER/ENGINEER/MANUFACTURER and as per approved drawings where relevant. The scope of work shall be as indicated in Price Schedule.

CODES AND STANDARDS

The electrical equipment installation work shall conform to the latest applicable regulations, currently applicable standards, codes of practice indicated in Data Sheet, regulations and safety codes of the locality where the installation is to be carried out. Nothing in this specification shall be construed to relieve the

CONTRACTOR of his responsibility. In case of conflict between these standards and this specification, more stringent of the two requirements shall govern.

All codes and standards referred to in the specification shall be understood to be the latest version on the date of offer made by the Bidder unless otherwise indicated.

The CONTRACTOR shall ensure that instruments and gauges to be used for testing and inspection shall have valid calibration and the accuracy can be traced to National and International Standards as applicable.

GENERAL SCOPE

The installation work shall include receipt, unloading at site, shifting from place of unloading/storage to place of installation, assemble all parts of the equipment, erect, test and commission the same

The work shall be carried out strictly as per the instructions and layout drawings of the OWNER/ENGINEER/MANUFACTURER. In case of any doubt/misunderstanding as to correct interpretation of the drawings or instructions, necessary clarifications shall be obtained from the OWNER/ENGINEER. The CONTRACTOR shall be held responsible for any damage to the equipment consequent to not following the instructions correctly. MANUFACTURER's equipment manuals will be furnished to the CONTRACTOR who shall return the same after completion of work.

The CONTRACTOR shall furnish all tools, ladders, scaffolding, welding equipment, rigging materials, testing equipment, test kits etc. required for complete installation, testing and commissioning of the items included in the contract work.

The OWNER may engage specialist engineers from the equipment MANUFACTURERS to supervise the installation, testing and commissioning of their equipment. The CONTRACTOR shall extend full cooperation to these engineers and carry out the works as per their instructions. The CONTRACTOR's work shall include minor rewiring/modifications as may be necessitated during commissioning. Providing such assistance shall be deemed to be included in the CONTRACTOR's basic scope.

The CONTRACTOR shall cooperate through the OWNER/ENGINEER with other CONTRACTORS at site, in all matters of common interest, so as not to obstruct operation of others and to ensure the safety of all personnel and works at the site. In case of any conflict OWNER / ENGINEER's decision will be final and binding.

It will be the CONTRACTOR'S responsibility to assist the OWNER to obtain approval from local statutory authorities including Electrical Inspector, wherever applicable, for carrying out any work and / or for installation carried out which comes under the purview of such Authorities. The scope will include submission of necessary documents duly filled in, obtaining preliminary approval of drawings, obtaining permission to start erection, arranging for visit of statutory authority after completion of erection work and obtaining permission to charge.

It is the responsibility of the CONTRACTOR to provide watch & ward and security for the equipment/component parts covered in this contract. Any loss of equipment/component parts, after take over by the CONTRACTOR, till the installation is handed over to the OWNER, shall be made good by the CONTRACTOR.

The CONTRACTOR shall be responsible for cleaning all equipment under erection, under storage, the work area and the project site at regular intervals to the satisfaction of the OWNER/ENGINEER. In case the cleaning is not to the OWNER's satisfaction, he will have the right to carry out the cleaning operations and any expenditure incurred by the OWNER in this regard will be to the CONTRACTOR's account.

In order to avoid hazards to personnel moving around the equipment such as switchgear etc. which is kept charged after installation, before commissioning, such equipment shall be suitably cordoned off to prevent anyone accidentally going near it.

The CONTRACTOR shall carry out touch-up painting on any equipment, if the finish paint on the equipment is soiled or marred during installation/handling. The paint including primer thinner & shade of the paint to match with OWNER's specification, shall be deemed to be included in the scope of the CONTRACTOR

The CONTRACTOR shall ensure workmanship of good quality and shall assign qualified supervisors/engineers and competent labour who are skilled having valid licence/authorisation/work permit, careful and experienced in carrying out similar works. The OWNER/ENGINEER shall reserve the right to reject non-competent person employed by the CONTRACTOR, if the workmanship is not found satisfactory. Wherever required the CONTRACTOR shall include loaning of skilled/unskilled personnel for work by OWNER/other agencies, on Man-hour/Manday rates, for normal & overtime work to meet the project schedule.

It shall be the responsibility of the CONTRACTOR to obtain necessary Licence/ Authorisation/permit for work for his personnel from the Licensing Board of the locality/state where the work is to be carried out. The persons deputed by the CONTRACTOR's firm should also hold valid permits issued or recognised by the Licensing Board of the locality/state where the work is to be carried out.

INSTALLATION WORK SCOPE

TEMPORARY LIGHTING ARRANGEMENT FOR THE WORK AREA

The CONTRACTOR shall on his own arrange for the temporary lighting arrangement for the work area to carry out the installation work in the plant premises.

CONSTRUCTION POWER

Construction power including power for testing and temporary lighting will be made available at one point & suitable number of outlets to cater to all the requirements shall be derived by the CONTRACTOR. All safety requirements for distribution of power like provision of protective devices for over current, earth fault, earth leakage and equipment earthing shall be considered. CONTRACTOR will be charged for the power consumed as per the rates indicated in contract. Construction power equipment is deemed to be included in the scope of installation CONTRACTOR. Only the power required for load test of the equipment will be made available to the CONTRACTOR free of cost. CONTRACTOR shall inform the requirement of construction power in kVA/ MVA to the OWNER during bidding stage/ well in advance so that same can be arranged by the OWNER prior to commencement of construction work. If it is mentioned in project specific requirements that construction power has to be arranged by CONTRACTOR then CONTRACTOR shall arrange for the same through local EB or DG sets.

The CONTRACTOR shall install, test and commission the equipment furnished by the OWNER. The quantities, approximate sizes and weights of the equipment shall be as indicated in Schedule of Prices.

Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented. Tolerances shall be as established in the MANUFACTURER's drawings or as stipulated by the OWNER/ENGINEER. No equipment shall be permanently bolted down to foundation or structure until the alignment has been checked and found acceptable by the OWNER/ENGINEER.

Care shall be exercised in handling to avoid distortion to stationary structures, the marring of finish or damaging of delicate instruments or other electrical parts. Adjustment shall be made as necessary to the stationary structures for plumb and level, for the sake of appearance or to avoid twisting of frames, binding of hinged members etc.

The CONTRACTOR shall move all equipment into the respective buildings through the regular doors or floor/wall openings provided specifically for lifting/moving the equipment. Wherever the OWNER's crane is made available for lifting heavy equipment and materials, the CONTRACTOR shall move the equipment from storage site to the crane, attach to the crane hook to the point(s) provided specifically for handling and install in final location. The CONTRACTOR shall submit time schedule to the OWNER, of the requirements for use of cranes. The CONTRACTOR shall make his own arrangement for lifting of the equipment when the OWNER's crane or cranes are not available. Operation of the OWNER's crane shall be by OWNER's personnel only. No part of the structure shall be utilised to lift or erect any equipment without prior permission of the OWNER/ ENGINEER.

Foundation work for all transformers, switchgears, motors, control panels/desks, neutral grounding equipment, cable trenches etc. will be carried out by the civil CONTRACTOR. However minor modifications to foundations, wherever found necessary for proper installation, shall be carried out by the CONTRACTOR. Base frames for switchgear/control panel when called for in Price Schedule shall be fabricated by the CONTRACTOR.

All external cabling including end connections and earthing will be carried out separately under cabling and earthing works respectively.

CONTRACTOR shall arrange for periodic inspection of the material/equipment in his custody until taken over by OWNER. CONTRACTOR shall also keep a check on the deliveries/stored equipment/material covered under his scope of erection. The CONTRACTOR shall advise OWNER well in advance regarding possible hold-up in his work due to expected delays in delivery of free issue of materials.

The CONTRACTOR shall include the following in his scope, whenever applicable.

Supply & installation of danger/warning plates, labels, insulation rubber sheets/gloves, insulation mats, first aid chart & box, sand bucket with steel stand, fire extinguishers, artificial respirator, approved single line diagram framed in glass cover etc., quantities shall be as indicated in Price Schedule.

Danger/warning plate having text written in English, Hindi and applicable vernacular language shall be provided on all electrical equipment for voltages 415V and above. The boards shall have the skull and cross bones, danger sign,

together with the inscription, inscribed in white letters on red background. Electrical installation CONTRACTOR shall mount these boards at site on any of the equipment which are not provided with danger/warning plates. The danger/warning plates shall comply with the standards mentioned in Data Sheet and applicable regulations

Site fabrication of items to meet specific situations e.g. Junction boxes, wire mesh enclosures, etc. of different sizes, as called for in Price Schedule of the specification.

Chipping and punching holes/openings in concrete floors/walls and brick walls and finishing them good and providing channels and embedments wherever required.

EQUIPMENT INSTALLATION

TRANSFORMERS

Site inspection, storage, installation, testing and commissioning of transformers shall be in accordance with the specified code of practices, MANUFACTURER's instructions and the commissioning check list enclosed with the specification.

The CONTRACTOR shall (a) assemble the transformers with all fittings such as bushings, cooler banks, radiators, conservators, valves, pipings, cable boxes, marshalling boxes, OLTC, cooling fans/pumps etc. (b) arrange for oil filtration before filling, (c) Provide wedges/clamps to rigidly station all transformers on rails, (d) connect up the transformer's terminals and (e) lay and terminate the cables/conduits between all the accessories mounted on the transformer tank/cooler and the transformer marshalling kiosk.

Care shall be taken during handling of insulating oil to prevent ingress of moisture or foreign matter. In the testing, circulating, filtering or otherwise handling of oil, rubber hoses shall not be used. Circulation and filtering of oil, heating of oil by regulated short-circuit current during drying runs and sampling and testing of oil shall be in accordance with the MANUFACTURER's instructions/specified Code of Practice.

SWITCHGEARS, MCCs, PCCs, PDBs, CONTROL & RELAY PANELS

All the AC/DC Switchgears, HV/LV switchgear, MCCs, PCCs, PDBs and control and relay panels/desks, lighting distribution boards etc. shall be installed in accordance with specified Code of Practice, drawings furnished and the MANUFACTURER's instructions and respective commissioning check lists enclosed with the specification. The switchgear/panels shall be installed on finished surfaces or concrete or steel sills. These panels may be bolted on to the foundation pockets or welded to base frame members as detailed in the drawings to be furnished to the CONTRACTOR. The CONTRACTOR shall be required to install and align any channel sills which form part of the foundations. Proper aligning, joining of various vertical shipping sections, busbar connections, inter panel wiring etc. will be the responsibility of the CONTRACTOR. In joining shipping sections of the switchgear/panels/control centres together, adjacent housing or panel sections provided shall be bolted together after alignment has been completed. Power bus enclosures, ground and control splices of conventional nature shall be cleaned and bolted together, being drawn up with torque wrench of proper size or by other approved means.

The CONTRACTOR shall take utmost care in handling instruments, relays and other delicate mechanisms. Wherever the instruments and relays are supplied separately, they shall be mounted only after the associated control panels/desks

have been erected and aligned. The blocking materials/mechanism employed for the safe transit of the instruments and relays shall be removed after ensuring that the panels/desks have been completely installed and no further movement of the same would be necessary. Any damage to relays and instruments shall be immediately reported to the OWNER/ENGINEER.

BUSDUCT

Whenever called for, busducts (segregated/ non-segregated or isolated as the case may be) supplied by others, will have to be erected by the CONTRACTOR in accordance with specified code of practice, manufacturer's instructions and the drawings furnished by the VENDOR/OWNER. Indoor portion of the busduct may be supported from the floor or ceiling beams and outdoor portion of the busduct shall be supported from ground below on suitable foundation (which is by civil CONTRACTOR). Wall frame assembly shall also be installed as per VENDOR drawings, wherever called for.

MOTORS

Unless otherwise specified, the motors will be installed by the driven equipment VENDOR. However, the CONTRACTOR under this specification shall undertake pre-commissioning checks and testing of the motors. The installation/commissioning shall be as per the applicable code of practice, MANUFACTURER's instructions and commissioning check list for motors enclosed with the specification.

D C SYSTEM

Installation and testing of D C system i.e. Battery and battery chargers shall be carried out in strict compliance with the MANUFACTURER's instructions and commissioning check list enclosed with the specification. Each cell shall be inspected for breakage and condition of cover seals as soon as it is received at site. Each cell shall be filled with electrolyte in accordance with the MANUFACTURER's instructions. Battery shall be set up on racks as soon as possible after receipt, utilising lifting devices supplied by the MANUFACTURER. The cells shall not be lifted by the terminals. Contact surfaces of battery terminals and intercell connectors shall be cleaned, coated with acid resistant grease and assembled. Each connection shall be properly tightened. Each cell shall be tested with hydrometer and thermometer and results logged. Freshening charge, if required, shall be added. When handed over to the OWNER, the battery shall be fully charged and electrolyte shall be at full level and of specified specific gravity.

NEUTRAL GROUNDING EQUIPMENT

The CONTRACTOR shall install, test and commission the neutral grounding equipment (NGR, NGT etc.) as per MANUFACTURER's instructions/relevant codes and standards and commissioning check list enclosed with the specification.

MISCELLANEOUS ITEMS

Whenever applicable, communication equipment, space heater panels, local starters, capacitors and every other electrical equipment within the plant premises shall be installed, tested and commissioned as per respective equipment VENDOR's instructions, relevant code of practice and the drawings furnished by OWNER/VENDOR. Suitable brackets, angle/channel section for wall mounted equipment shall be provided by the CONTRACTOR.

TESTING AND COMMISSIONING

All checks and tests as per the MANUFACTURER's drawings/manuals, relevant code of installation and the enclosed commissioning check lists for various types of equipment e.g. transformers, circuit breakers, isolators, lightning arresters, insulators, CVTs, wave traps, CTs, VTs, reactors, motors, relays, meters etc. shall be carried out by the CONTRACTOR as part of the installation work.

The OWNER may ask for such additional tests as in his opinion are necessary to determine that the works comply with the specification, MANUFACTURER guarantees/instructions or the applicable code of installation. The CONTRACTOR shall carry out such additional tests also.

The CONTRACTOR shall perform operating/functional tests on all switchgears and panels to verify operation of switchgear/panels and correctness of the interconnections between various items of the equipment. This shall be done by applying normal AC or DC voltage to the circuits and operating the equipment for functional checks of all control circuits, e.g. closing, tripping, control interlock, supervision and alarm circuits. All connections in the switchgear shall be tested from point to point for possible ground or short-circuit.

All site connections and shortings and interpanel wiring etc. required to be carried out at site on terminals of any electrical equipment in the plant shall be carried out by the CONTRACTOR at no additional cost.

Insulation resistance tests shall be carried out by meggers of following ratings:

(a)	Control circuits up to 220V	- by 500V megger
(b)	Power circuits, busbars, connections up to 11 kV	- by 1000V megger
(c)	Power circuits, busbars connections above 11 kV & up to 33 kV	- by 2500V motor operated megger
(d)	Power circuits, busbars, connections above 33 kV	- by 5000V motor operated megger

The CONTRACTOR shall make available the following Testing and Commissioning equipment for testing and commissioning of various equipment in the plant :

(a) 500V and 1000V hand operated meggers.

(b) 5000V/2500V motor operated meggers.

(c) Earth resistivity testing equipment.

(d) Phase sequence indicators.

(e) Frequency meters.

(f) Micrometers

(g) High potential testing sets suitable for testing cables up to 33 kV grade complete with transformer, rectifier stack, instruments and control.

(h) Miscellaneous instruments/accessories like clip-on ammeters, voltmeters, wattmeters, multimeters, power factor-meters, time-interval meters, single-phase and three-phase variacs, portable transformers, switches etc.

(i) Continuity testers.

(j) Primary injection equipment.

(k) Secondary injection testing kit.

(l) Insulating oil breakdown test set with accessories.

(m) Equipment for measuring the thermal resistivity of the soil.

(n) Transformer oil filtration equipment.

(o) Relay test kits.

(p) Breaker timing device for Circuit breaker opening/closing time measurement.

(q) CT & VT testing apparatus.

(r) Low resistance measuring instrument.

(s) Partial discharge measuring equipment.

The OWNER's authorised representative shall be present during every test as called for by the OWNER. The CONTRACTOR shall record all test values and furnish the required copies of the test data to the OWNER. Electrical circuits and equipment shall be energised or used at normal operating voltage only after such reports have been accepted as satisfactory by the OWNER.

SAFETY PROCEDURE

Contractor shall have safety plan and procedure complying with the relevant standards which must be followed strictly including engagement of certified safety officers/ supervisors to control and monitor safety aspects during execution of the work. They shall also follow OWNER/ ENGINEER's requirement of safety as applicable.

Contractor shall carry out safety training program regularly at site for his personnel and workmen before any execution work is taken up.

It is the responsibility of the CONTRACTOR to arrange safety shoes, helmets, safety goggles, welding protectors, safety belts, flash proof dress, grounding equipment etc as required.

1.0 APPLICABLE STANDARDS (CABLING SYSTEMS)	1.	CODE OF PRACTICE FOR FIRE SAFETY OF BLDGS.	□ IS: 1646
	2.	GUIDE FOR SAFETY PROCEDURES AND PRACTICES IN ELECTRICAL WORK	□ IS:5216
	3.	ACCESSORIES FOR RIGID STEEL CONDUITS	□ IS:3837 □ BS:4568
	4.	FITTINGS FOR RIGID STEEL CONDUITS	□ IS:14768 □ IEC:61035
	5.	FITTINGS FOR RIGID NON-METALLIC CONDUITS	□ IS:3419 □ BS:4607
	6.	ADAPTORS FOR FLEXIBLE STEEL CONDUITS	□ IS:4649 □ BS:731
	7.	CODE OF PRACTICE FOR STRUCTURAL STEEL	□ IS:800 □ BS:5950
2.0 APPLICABLE STANDARDS (LIGHTING SYSTEMS)	1.	CODE OF PRACTICE FOR ELECTRICAL WIRING INSTALLATION	□ IS:732 □ IEC/TC:64
	2.	CODE OF PRACTICE FOR INTERIOR ILLUMINATION	□ IS:3646 □ DIN:5035
	3.	CODE OF PRACTICE FOR STREET LIGHTING INSTALLATION	□ IS:1944 □ BSCP:1004 □CIEPUB12
	4.	GUIDE FOR SELECTION OF ELECTRICAL EQUIPMENT FOR HAZARDOUS AREAS	□ IS:5571 □IEC:60079
	5.	CODE OF PRACTICE FOR INDUSTRIAL LIGHTING	□ IS:6665 □ IES: TECH REP 2
	6.	CODE OF PRACTICE FOR FIRE SAFETY OF BLDGS.	□ IS:1646

2.0 APPLICABLE SANDARDS (LIGHTING SYSTEMS	7.	BOXES FOR ENCLOSURES OF ELECTRICAL ACCESSORIES	□ IS:14772 □ IEC: 60670
	8.	FLAME-PROOF ENCLOSURES OF ELECTRICAL APPARATUS	□ IS/IEC:60079
	9.	GUIDE FOR SAFETY PROCEDURES AND PRACTICES IN ELECTRICAL WORK	□ IS:5216
	10.	CEILING ROSES	
	11.	ACCESSORIES FOR RIGID STEEL CONDUITS FOR ELECTRICAL WIRING	□ IS:371 □ BS:67
	12.	FITTINGS FOR RIGID STEEL CONDUITS FOR ELECTRICAL WIRING	□ IS:3837 □ BS:4568
	13.	PVC INSULATED CABLES CABLE VOLTAGES UPTO AND INCLUDING 450/750V	□ IS:14768 □ IEC:61035
	14.	PVC INSULATED HEAVY DUTY ELECTRIC CABLES	□ IS:694 □ IEC:60227 □ BS:6500
			□ IS:1554 □ IEC:PUB 502 □ BS:6346
3.0 APPLICABLE SANDARDS (EARTHING AND LIGHTNING PROTECTION SYSTEM)	1.	CODE OF PRACTICE FOR EARTHING	□ IS:3043 □ IEC:PUB 364 □ BS:84
	2.	PROTECTION OF BUILDING AND ALLIED STRUCTURES AGAINST LIGHTNING	□ IEEE:142
	3.	CODE OF PRACTICE FOR ELECTRICAL INSTALLATIONS	□ IS: □ IEC:62305
	4.	HOT DIP GALVANISING ON IRON AND STEEL	□ IS:732 □ IEC/TC:64
			□ IS:2629 □ BS:729

3.0 APPLICABLE SANDARDS (EARTHING AND LIGHTNING PROTECTION SYSTEM)	5.	CODES FOR WELDING	□ IS:816 □ BS:1856 □ DIN:4100
	6.	GALVANISED ROUND STEEL WIRE	□ IS:3975
	7.	COPPER CONDUCTORS	□ IS:12444 □ BS:6360
	8.	METHODS OF TESTING UNIFORMITY OF COATING OF ZINC COATED ARTICLES	□ IS:2633 □ BS:729 □ ASTM:239
4.0 APPLICABLE SANDARDS (EQUIPMENT INSTALLATION)	1.	INSTALLATION AND MAINTENANCE OF TRANSFORMERS	□ IS:10028
	2.	CODE OF PRACTICE FOR MAINTENANCE AND SUPERVISION OF MINERAL INSULATING OIL IN EQUIPMENT	□ IS:1866 □ BS:5730 □ IEC:60422
	3.	INSTALLATION AND MAINTENANCE OF SWITCHGEAR	□ IS:10118
	4.	INSTALLATION AND MAINTENANCE OF INDUCTION MOTORS	□ IS:900
	5.	GUIDE FOR SAFETY PROCEDURES AND PRACTICES IN ELECTRICAL WORK	□ IS:5216
	6.	HOT DIP GALVANISING	□ IS:2629 □ BS:729
	7.	CODES FOR WELDING	□ IS:816 □ BS:1856 □ DIN:4100
	8.	ELECTRICAL WIRING INSTALLATIONS VOLTAGES >650V	□ IS:732 □ IEC/TC:64
	9.	FIRE SAFETY OF BUILDINGS (GENERAL) - ELECTRICAL INSTALLATIONS	□ IS:1646

4.0 APPLICABLE SANDARDS (EQUIPMENT INSTALLATION)	10.	DANGER PLATES	□ IS:2551
	11.	NEW INSULATING OILS	□ IS:335 □ IEC:60296 □ BS:148
	12.	INDIAN ELECTRICITY ACT 1910, (AS AMENDED)	
	13.	ELECTRICITY SUPPLY ACT 1948, (AS AMENDED)	
	14.	INDIAN ELECTRICITY RULES 1956 (AS AMENDED)	
5.0 NOTES	1	ELECTRICAL INSTALLATION WORK SHALL CONFORM TO (IF ADDITIONAL STANDARDS REQUIRED)	□ IS: □ BS: □ IEC:

CODES AND STANDARDS

The electrical installation work shall comply with the latest applicable Standards, Regulations and Safety Codes of the locality where the installation is carried out. Nothing in this specification shall be construed to relieve the CONTRACTOR of this responsibility.

The codes and standards mentioned in the various specifications and requirements specified in the enquiry document shall be latest as on the day of award of contract of the works unless otherwise specified. Contractor shall be responsible to inform to the Consultant/ Owner in case of any revisions/re-affirm/amendment in the relevant codes and standards after the date of award of contract within 30 days of the issue of such revision/re-affirm/amendment of the code/ standard. Consultant/ Owner may approve use of the earlier code/ standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed.

GENERAL SCOPE

The CONTRACTOR shall take over the equipment to be erected from the OWNER'S storage yard/stores/sheds/railway siding, transport the equipment's where required in actual position, erect, assemble all parts of the equipment and test and commission the same. As and when required CONTRACTOR shall have his own storage for equipment brought to site by him

The CONTRACTOR shall furnish all tools, welding equipment, rigging materials, scaffolding, platforms, ladders, testing equipment, test connections, kits, etc. required for complete installation, testing and commissioning of the items included in the contract work.

The OWNER may engage specialist engineers from the equipment MANUFACTURERS to supervise the installation, testing and commissioning of their equipment. The CONTRACTOR shall extend full co-operation to these engineers and carry out the works as per their instructions. The CONTRACTOR's work shall include minor rewiring/modifications as may be necessitated during

commissioning. Providing such assistance shall be deemed to be included in the CONTRACTOR's basic scope. Whenever required the CONTRACTOR shall include loaning of skilled and unskilled personnel for work by OWNER/other agencies, on Man-hour/Man-day rates, for normal and overtime work to meet the project schedule.

The CONTRACTOR shall be co-operative through the OWNER/ENGINEER with other contractors at site, in all matters of common interest, so as not to obstruct operation of others and to ensure the safety of all personnel and works covered under this specification. In case of any conflict, OWNER's decision will be final.

It will be the CONTRACTOR'S responsibility to obtain approval/clearance from local statutory authorities including Electrical Inspector, wherever applicable for conducting of any work or for installation carried out which comes under the purview of such authorities.

The work shall be carried out strictly as per the instructions and layout drawings of the OWNER/ENGINEER/MANUFACTURER. In case of any doubt/misunderstanding as to correct interpretation of the drawings or instructions, necessary clarifications shall be obtained from the OWNER/ENGINEER. The CONTRACTOR shall be held responsible for any damage to the equipment consequent to not following the MANUFACTURER's instructions correctly. All necessary drawings, MANUFACTURER's equipment manuals will be furnished to the CONTRACTOR who shall return the same after completion of work.

The CONTRACTOR shall be responsible if any installation materials are lost or damaged during installation. All damages and thefts of equipment/component parts, after take over by the CONTRACTOR, till the installation is taken over by OWNER shall be made good by the CONTRACTOR.

The CONTRACTOR shall have a separate cleaning gang to clean all equipment under erection as well as the work area and the project site at regular intervals as deemed fit by the OWNER/ENGINEER to the satisfaction of the OWNER/ENGINEER. In case the cleaning is not to the OWNER'S satisfaction, he will have the right to carry out the cleaning operations and any expenditure incurred by the OWNER in this regard will be to the CONTRACTOR's account.

In order to avoid hazards to personnel moving around the equipment such as switchgear etc., which is kept charged after installation, before commissioning, such equipment shall be suitably cordoned off to avoid accidental operation of the equipment or accidental contact with any of the Live parts.

The CONTRACTOR shall carry out touch-up painting on any equipment indicated by the OWNER/ENGINEER, if the finish paint on the equipment is soiled or marred during installation handling. The paint including primer, thinner & shade of the paint to match with OWNER's specification will be supplied by the CONTRACTOR

The CONTRACTOR shall include the following in his scope whenever applicable.

Supply and installation of danger warning plates, labels, insulation mats, fire extinguishers, first aid chart, etc.

Site fabrication of items to meet specific situations e.g. cable trays, junction boxes, wire mesh enclosures etc.

Chipping and punching holes/openings in concrete floors/walls and brick walls and finishing them good and providing channels and embedment's wherever

required. Provision of chequered plates to close floor openings left around switchgears/panels etc. together with supply of materials.

The CONTRACTOR shall ensure workmanship of good quality and shall assign qualified supervisors/engineers and competent labour who is skilled, careful and experienced in carrying out similar works. The OWNER/ENGINEER shall reserve the right to reject non-competent persons employed by the CONTRACTOR, if the workmanship is not of good order.

It shall be the responsibility of the CONTRACTOR to obtain necessary Licence/Authorisation/Permit for work (before commencement of work and permission to charge) from the Licensing Boards of the Locality/State where the work is to be carried out. The persons deputed by the CONTRACTOR's firm should also hold valid permits issued or recognised by the Licensing Board of the Locality/State where the work is to be carried out.

EQUIPMENT INSTALLATION WORK

The CONTRACTOR shall arrange for the temporary lighting arrangement for the work area to carry out the installation work in the plant premises.

Construction power including power for testing and temporary lighting will be made available at one point if specifically agreed between OWNER AND CONTRACTOR . Otherwise it will be the CONTRACTORS responsibility to arrange for such power. Suitable number of outlets to cater to all the requirements shall be derived by the CONTRACTOR. Provision of necessary protective devices shall be included in scope of CONTRACTOR.

The CONTRACTOR shall install, test and commission the equipment furnished by the OWNER. The quantities, approximate sizes and weights of the equipment shall be as indicated in schedule of prices section-F.

Equipment shall be installed in a neat workmanlike manner with proper care during handling to avoid any distortion or damages to delicate instruments.

Foundation work for all equipment will be carried out by the civil contractor. However minor civil works wherever found necessary for proper installation shall be carried out by the CONTRACTOR under this specification. Base frames for switchgear/MCC/control panel when calle for in section F shall be fabricated by the CONTRACTOR.

Care shall be exercised in handling to avoid distortion to stationary structures, the marring of finish or damaging of delicate instruments or other electrical parts. Adjustment shall be made as necessary to the stationary structures for plumb and level, for the sake of appearance or to avoid twisting of frames, binding of hinged members etc.

The CONTRACTOR shall move all equipment into the respective buildings through the regular doors or floor/wall openings provided specifically for lifting/moving the equipment. Wherever the OWNER’s crane is made available for lifting heavy equipment and materials, the CONTRACTORshall move the equipment from storage site to the crane, attach to the crane hook to the point(s) provided specifically for handling and install in final location. The CONTRACTOR shall submit time schedule to the OWNER, of the requirements for use of cranes.

The CONTRACTOR shall make his own arrangement for lifting of the equipment when the OWNER's crane or cranes are not available. Operation of the OWNER's crane shall be by OWNER's personnel only and it will be made available to the erection contractor on chargeable basis for their scope of work. No part of the structure shall be utilised to lift or erect any equipment without prior permission of the OWNER/ ENGINEER.

CONTRACTOR shall arrange for periodic inspection of the material/equipment in his custody until taken over by OWNER. CONTRACTOR shall also keep a check on the deliveries/stored equipment/material covered under his scope of erection. The CONTRACTOR shall advise OWNER well in advance regarding possible hold-up in his work due to expected delays in delivery of free issue of materials.

Installation, testing and commissioning of all equipment shall be in accordance with the specified codes of practice and Manufacturer's instructions and respective commissioning check lists enclosed with this specification.

Transformers

As and when applicable, CONTRACTOR shall (a) assemble the transformer with all the fittings such as radiators, bushings, cooler banks, conservator, valves, piping's, marshalling boxes etc. (b) arrange for oil filtration before oil filling (c) providing wedges/clamps for rigidly stationing transformers on rail (d) connect up the transformer's terminals (e) lay and terminate the OWNER's cables.

Due care shall be taken by CONTRACTOR to avoid any ingress of moisture or foreign matter during handling of insulation oil.

When lifting a transformer by the lifting lugs or shackles provided for the purpose, simultaneous use should be made of all such lugs and shackles in order to avoid any unbalance while lifting. The lifting chain should never interfere, with any part of the transformer. Before lifting complete transformer, it should be ensured that all cover bolts are tightened fully. In case where it is necessary to use jacks for lifting, jacking shall not be under valve or cooling tubes. For transporting transformers from stores to site, the transformers shall be loaded on a suitable capacity truck or trailer. The transformers shall be properly supported by steel ropes and stoppers on the trailer to avoid tilting of the transformers in transit due to jerks and vibrations. At no instance a transformer shall be kept on bare ground. Where it is not possible to unload the transformer directly on a foundation, these shall be unloaded on a properly built wooden sleeper platform. A transformer shall never be left without putting stoppers to the wheels.

Except large power transformers, all the lighting and small distribution transformers shall be placed on the prepared concrete bed. Large power transformers shall be placed after grouting channels or rails, over concrete foundations. The transformers shall be levelled, aligned and checked for free movement on the rails. Stoppers shall be clamped to the transformers immediately to prevent any movement. All the accessories where supplied loose, like radiators, cooling fans, valves, conservator tanks, explosion-vent pipe, bushings and other devices should be cleaned and tested before fixing on the transformer. All the connections for C.T.s, bushings and other wiring shall be checked for tightness and correctness before replacing the lid or tightening all the bolts.

For LT Dry type transformer, the CONTRACTOR shall transport the transformers from store/railway siding to site and place them on their foundations, assemble

different parts and accessories, fabricate and erect all the supporting structures for detachable cable boxes, complete all conduit erection and wiring connections.

Where assemblies are supplied in more than one section/package, CONTRACTOR shall make all necessary mechanical and electrical connections. All insulators and bushings shall be protected against any damage due to negligence or carelessness of CONTRACTOR during installation. Insulators/Bushings, chipped/cracked due to negligence or carelessness of the CONTRACTOR shall be replaced by CONTRACTOR at his own expense.

Switchgear, Control/Relay Panels

The switchgear shall be handled with care, avoiding impact to the equipment; by the skilled manpower under the guidance of a competent supervisor. Dragging of the panels shall be avoided and use of a crane and trailer shall be made for the handling purposes while transporting to various sites. The switchboard shall be properly supported on the truck or trailer by means of ropes to avoid any chances of damage or tilting due to heavy vibration. The switchboards should be lifted by making use of lifting eyebolts only, fully tightened after ensuring that panel supports, nuts and bolts are all intact and tightened. When panels are to be lifted in packed conditions, utmost care shall be taken to avoid any damage to insulators, bushings, metering and protective equipment. The panels shall preferably be kept inside the packing cases till foundations are ready.

Base channels shall be grouted, levelled, in cement concrete pad for low voltage switchgear panels and other cubicle panels. A level benchmark shall be given by the OWNER as reference level, and further all levels shall be checked and kept with theodolite by the CONTRACTOR. Pedestal type panels and MCCs shall be erected by grouting base channels by bolts. A proper bonding surface should be made by chipping the floor while making cement concreting. All foundations, grouted bolts shall be cured for a minimum period of 48 hours.

The switchboard panels should be taken out from the packed cases and moved one by one to the proper place. All the panels should be assembled, aligned, levelled and it should be ensured that panel to panel coupling bolts, bus bar links fit properly without any strain on any part. It should also be checked up that lowering, lifting, racking in and out operation of the breaker and all other motions are free from any obstruction. The fixing bolts should be grouted only after satisfying all these requirements. The panels shall be checked for correct vertical position using pendulum weight and spirit levels. L.T. switchgear panels can be tack welded at suitable intervals for each shipping section.

After completion of the panel erection, all the cubicles switches, starters, C.T. and P.T. chambers, bus bars chamber should be cleaned and checked for tightness of all the components. All loosely supplied items shall be fitted up. All the wiring connections should also be checked with drawings and tightened. Metering and protective C.Ts, alarm, indications and protective relays should be fitted up. Phase sequence & polarity of

PTs and CTs should be checked. Contact resistance of all bus bar joints and contactors should be checked up. Every part or insulator should be checked for any possible damage. All the starters, switches, contacts should be cleaned with C.T.C. Silver tipped contacts should be checked for easy and free movement. Hinges of panel doors should be lightly lubricated to give free and noiseless movement. All openings shall be kept completely closed to avoid ingress of any foreign particles inside the panel.

Switchgear and control/relay panels/desks shall be installed on finished surfaces or concrete or steel sills. Proper aligning, joining of various vertical shipping sections, bus bar connections, inter panel wiring etc. will be the responsibility of CONTRACTOR.

The CONTRACTOR shall take utmost care in handling instruments, relays and other delicate mechanisms. Wherever the instruments and relays are supplied separately, they shall be installed only after erection of switchgear/relay panels is complete.

Bus ducts

If specified in scope of work, bus ducts supplied by others will have to be erected by the CONTRACTOR. The CONTRACTOR shall provide suitable support structure for bus ducts. Indoor portion of the bus duct may be supported from the floor or ceiling beams and outdoor portion of the bus duct shall be supported from ground below on suitable foundation (foundation by civil CONTRACTOR). Wherever called for, the wall frame assembly shall also be made good as per bus duct Vendor drawings.

The bus duct will be supplied in parts and all the parts shall be assembled and the bus bar connections shall be made at site. The insulator in bus ducts shall be inspected for any possible damage during transit and the defective ones shall be replaced. The insulators shall be cleaned with carbon tetrachloride. Contact surface of bus bars, bus-bar bolts and nuts shall be thoroughly cleaned with petrol and wiped. Petroleum jelly shall then be applied and bolted connection made. The bus duct enclosure shall be checked for earth continuity and then earthed at two places. The bus duct shall be duly supported between switchgear and transformer. The opening in the wall where the bus duct enters the switchgear room shall be completely sealed to avoid rainwater entry. Expansion joints, flexible connections, wall frame assembly, seal off bushings etc. supplied by the manufacturer of the bus duct shall be properly connected. The bus duct levelling shall be checked with spirit level and pendulum weight. Location of flexible joints shall be marked for identification.

Motors

Unless otherwise specified all the motors will be installed by other agencies. However, pre-commissioning checks and testing of the motors will be by the CONTRACTOR.

Insulation resistance of the motors shall be measured between the winding of the machine and its frame by means of a 500/1000V megger in case of LT motors. A minimum value of 1 mega-ohm for 415V motors shall be considered a safe value.

Insulation resistance of MV motors shall be by 2500V megger and its value shall not be less than 20 mega-ohms at 60 deg. C

Battery and Chargers

Battery shall be set up on the racks. Contact surfaces of battery terminals and inter cell connectors shall be cleaned and coated with protective grease and assembled. Each cell shall be inspected for breakage and condition of cover seals as soon as it is received at site. Each cell shall be filled with electrolyte in accordance with the MANUFACTURER's instructions. The cells shall not be lifted by the terminals. Each cell shall be tested with hydrometer and thermometer and results logged. Freshening charge, if required, shall be added. The battery shall

be fully charged and electrolyte shall be at full level and of specified specific gravity at the time of handing over to the OWNER.

Welding Receptacles

The welding receptacles shall be erected on steel structures/concrete as per the drawings. In isolated places a separate support shall be fabricated and installed.

Erection of welding receptacle shall be done by fixing the socket with screws using rawl plug or by anchor fasteners. IR/HV test values shall be taken. Interlocks if any and switch operation shall be checked. Power cable shall be terminated properly and the receptacles shall be grounded at two separate points.

240/24V Transformer and Flame proof sockets (24V)

The 240/24V transformers shall be an integral part of 24V flameproof hand lamp socket. Necessary supporting structures shall be fabricated out of mild steel and the same shall be painted. Only galvanized steel bolts, nuts & washers shall be used. Power cable shall be properly terminated and switch operation and mechanical/electrical interlock shall be checked.

Socket shall be properly grounded.

Miscellaneous Items

Communication equipment, space heater and ventilation distribution boards, local starters, capacitors, exhaust fans with starters and with louvers assembly and any other electrical equipment within the plant premises shall be installed, tested and commissioned as per respective VENDOR's instructions and the drawings furnished by OWNER.

Suitable brackets, angle/channel section for support of wall mounted equipment shall be provided by the CONTRACTOR

CABLING SYSTEM INSTALLATION WORK

Scope of Supply:

Following items as required shall be supplied by the CONTRACTOR. Required types and quantities shall be as specified in schedule of prices,

Galvanised steel cable trays (ladder and perforated types), cable tray covers and vertical raceway covers.

Cable glands, lugs and trefoil clamps.

GI rigid and flexible conduits/pipes

Cable termination kits.

Miscellaneous items like junction boxes/marshalling boxes, push button stations, power receptacles, space heater and ventilation distribution boards.

Mounting / supporting structure for cable trays

Cable Trays and Accessories

The cable trays shall be complete with all necessary coupler plates, elbows, tees, bends, reducers, stiffeners and other accessories and hardware. All hardware (i.e. bolts, nuts, screws. washers, etc.) shall be hot dip galvanised.

Cable Glands & Lugs

Cable glands shall be of robust construction and of double compression type. Cable lugs shall be of tinned copper, solder less crimping type suitable for aluminium or copper conductors.

Conduits and Pipes

The CONTRACTOR shall supply galvanised steel/coated conduits, GS pipes and flexible conduits as required for the cabling work. Conduits shall be seamed by welding and shall be hot dip galvanised both inside and outside. Pipes shall be of heavy duty type and hot dip galvanised both inside and outside. Flexible conduits shall be made with bright, cold rolled, annealed and galvanised mild steel strips.

Power Receptacles

The power receptacles shall be industrial heavy duty type with switches for 3-phase, AC supply with 3 pin and earth connections. The receptacles shall have ratings of 32 Amps and 63 Amps. The socket and switch shall have suitable interlock facility for safety. The receptacles shall be provided with matching plugs. Each unit shall be complete with gasket, cable glands, cable lugs and earthing terminals with washers and nuts.

Junction Boxes/Marshalling Boxes

Junction boxes/marshalling boxes shall be hot-dip galvanised, weather proof with IP 55 degree of protection. The terminals shall be suitable for terminating 2 numbers 2.5 mm^2 conductors on each side. All terminal blocks shall be rated for 1100V, 15A unless otherwise specified. All the terminals shall be complete with insulated barriers, terminal studs, washers, nuts, etc.

Local Push Button Stations

The local push button/control stations shall be installed near the motors to be controlled. Individual channel supports shall be used for each of the push button stations. These shall be installed as per approved erection detail drawing. Control station for hazardous areas shall be certified and approved by regulatory authorities.

The local push button stations shall be metal enclosed, weather-proof, dust and vermin proof, suitable for mounting on wall or steel structures. The enclosure shall be die cast aluminium or sheet steel of 2 mm thickness and provide a degree of protection of not less than IP: 55. The enclosure shall be painted with one coat of epoxy primer and two coats of light grey epoxy paint.

The open/close/start push buttons shall be of momentary contact push to actuate type and stop push buttons shall be stay put type with mushroom knob. The stop push button shall be of lockable type in 'OFF' position. All push buttons shall be fitted with two (2) normally open and two (2) normally closed contacts rated for 415V, 10A.

The following types of push button stations shall be supplied.

Type-A: With three push buttons for control of reversible motors.

Type-B: With two push buttons for control of non-reversible motors.

Type-C: With one push button for 'stop' operation.

Space heater and Ventilation Distribution Boards

Space heater/ventilation distribution boards shall be sheet steel enclosed indoor, dust and vermin proof and wall mounting type. The enclosure shall be of 2.0 mm thick cold rolled sheet steel and provide degree of protection of not less than IP: 52. All doors, removable covers and plates shall be with neoprene gaskets all around. The boards shall be complete with cable glands, lugs, removable gland plates, two nos. earthing terminals and other necessary accessories.

The space heater boards and ventilation distribution boards shall have one (1) No. 3-phase incoming feeder. The space heater board shall have specified no. of single phase out going feeders whereas ventilation distribution boards shall have both 3 phase as well as single phase outgoing feeders as specified in section-C.

Wherever 4 wire supply is not available, 4 wire supply shall be derived using 415/ 433 Volts transformers. Distribution boards with transformers shall be suitable for floor mounting. The transformers shall be of dry type and shall have the following technical parameters (unless otherwise specified in Section-C).

(a) KVA rating : 100 KVA/50 KVA

(b) Voltage rating : 415/433 V

(c) P.U. Impedance : 5%

(d) Off circuit taps : ± 2.5 %

(e) Vector group : DYn1

Scope of installation work

The cabling system installation work shall include unloading, storing, installation, fixing, jointing/termination, testing and commissioning of complete cabling system items and any other work/items necessary for completing the job.

Major civil works are excluded from the scope of this specification. These include construction of cable trenches, cable tunnels, duct banks etc. Normally the required embedment plates will be provided by others at the time of civil construction. Wherever the embedment plates are not provided by others, the ELECTRICAL CONTRACTOR shall provide the embedment plates by using anchor fasteners. However, minor civil works such as making holes/grooves in floor slab/wall and patching up in an approved

manner any holes made in the walls/floors by the CONTRACTOR, embedment of short lengths of conduits, plates in floors, walls etc. if not already done by Civil Contractor shall be deemed to be included in the scope of ELECTRICAL CONTRACTOR.

Following are the itemised scope of cabling installation work.

Cable laying and installation

The CONTRACTOR shall install, test and commission power and control cables which will be furnished by the PURCHASER. The quantities, sizes and types of cables shall be as indicated in SOR.

The cables shall be laid in built-up trenches, directly buried in ground , on cable trays, vertical raceways, clamped on structures/walls/ceiling, pulled through pipes and conduits etc. as shown in the typical/project drawings. Unit rates quoted for installation of cables shall be same irrespective of route and method of laying. The scope of cable installation shall include laying, pulling of cables, proper dressing of cables on cable trays, racks, vertical raceways and supply and installation of saddles, spacers and nylon cord for tying as required.

The cost of excavation & back filling and supplying brick covers for medium and low voltage cables and pre cast concrete covers/half round RCC pipe covers for high voltage cables, route/joint markers, supply of sand shall be included in the rate of directly buried cables on cubic metre basis.

Cable Termination

All cables shall be connected at both ends. The CONTRACTOR shall quote unit prices for termination of cable at one end, for each type/size of cable. The scope of work shall include making the requisite holes in the gland plate, fixing the glands, terminating the cables in the glands, mounting of core balance CT if required, earthing the cable armour, crimping the cable lugs on each core, neatly clamping the cables in cable alleys/wiring troughs and connecting to the terminals. The cable and core identification tags shall be supplied and installed by the CONTRACTOR.

Cable termination for HT cables shall be generally as described in (a) above and shall include heat shrinkable tubing system of cable termination.

Cost of supplying cable glands, cable lugs, and cable termination kits shall be included under unit rates for cable termination.

Cable Tray and Tray Covers Installation

Installation details for cable trays shall be as shown in 'Cabling Notes and Details". All cable racks, vertical raceways and supporting steel shall be installed at the locations shown in the various layout drawings. The sizes of ladder/perforated cable trays to be supplied and installed shall be 150, 300, 450, 600 and 750 mm wide.

The rate quoted for installation shall include all hardware, welding materials, touch-up paint and other consumables. No separate rates shall be admissible for accessories like elbows, tees, reducers, etc. These shall be included in the straight run measurements. However, the cable tray installation rates shall not include the rates for steel supports which are covered under a separate item.

The CONTRACTOR shall also include earthing of the cable trays at distance not exceeding 10Mtrs. length by means of G.S. Flat. The size of the GS flat shall be as shown in project drawings.

Installation rates shall be same for horizontal or vertical run/disposition of cable trays. Unit rates for dismantling cable trays/steel work shall be same as that for installation unless defined separately in BOQ/PO, if the case arises. Prices for installation of site fabricated trays shall be same as that of pre-fabricated trays.

All vertical raceways/trays and outdoor trays (topmost layer) shall be covered by 16 gauge painted/galvanised MS sheet covers. For outdoor applications whenever the cables are directly exposed to Sun rays, they shall be provided with sun shields to protect the cables from direct heating by Sun rays. The estimated lengths and widths of these covers are indicated in BOQ. The scope of work shall

include the installation of these covers including necessary screws when required for fixing to vertical raceways/trays.

Cable Trays/Vertical Raceways Mounting Arrangements and Cable Carrier Structures

The CONTRACTOR shall fabricate, install and paint the following as per relevant enclosed drawings/general notes:

Mounting arrangements for cable trays. Any cable trays junction bends which are non-standard shall be fabricated as racks to suit installation drawings.

Vertical cable raceways and steel accessories (angles and plates) required to seal the floor openings in the case of indoor raceways.

Cable carrier structures (racks) for cable trenches and tunnels.

Supporting steel for junction/marshalling boxes, push-button stations, vertical structures for clamping trefoil cables, etc., as required.

The steel members shall be welded to the floor beams, columns, plates embedded in R.C. floors or grouted in brick walls as the case may be to obtain the required supporting arrangements as detailed in relevant drawings. The cable racks and supports shall be painted after installation with one coat of red lead primer, one coat of oil primer followed by two coats of aluminium paint.

The above mounting structures/cable racks shall be fabricated from standard structural steel members (channels, plates, angles and flats) as indicated in enclosed project drawings. The estimated quantity of steel are furnished in section-F and the rate for the same shall be quoted separately on per tonne basis. The unit rates quoted for installation shall include fabrication of support, erection, welding, grouting, painting including supply and installation of all hardware to make the installation complete in all respects.

Conduits/Pipes Installation

The CONTRACTOR shall install all conduits/pipes required for the cabling work as per enclosed project drawings/notes. The sizes and quantities shall be as indicated in BOQ.

Conduits/pipes shall be laid buried in ground, laid along the walls/structural members, along floors and ceilings. Conduit and pipe sleeves which are required to be embedded in walls, roof slabs, floors, trench and tunnel walls, under roads and tracks etc. will in

general be furnished in place wherever necessary by the PURCHASER for the portion of civil work completed until the time, the CONTRACTOR for cabling work reaches site. However, in places where such pipe sleeves have not been provided by the PURCHASER, the CONTRACTOR shall install conduit/pipe sleeves in place wherever necessary by breaking walls/floors as required by the ENGINEER to PURCHASER's satisfaction. All conduits/pipes shall have their ends closed by caps until cables are pulled.

Water-proof sealing shall be done for all outdoor to indoor conduit/pipe inserts by means of bell mouth termination pieces and bitumen based cold set water-proof compound. Fire-proof sealing shall be done for pipe inserts in floor slabs, in walls of pressurised rooms and hazardous area, wherever indicated in project drawings. The water-proof/fire-proof sealing of pipe inserts shall be as per the typical drawings enclosed. The supply and installation rates of the necessary water-

proof/fire-proof sealing compounds shall be separately indicated by the CONTRACTOR if asked for in BOQ

The scope of installation of conduits/pipes shall include supply and installation of all accessories like tees, elbows, pull-boxes, conduit end plugs, bell-mouths, GI wire for cable pulling, GI saddles, spacers, screws, nuts and bolts. The scope for directly buried pipes/conduits shall include excavation and back filling as per varying depths/widths mentioned in project drawings. The CONTRACTOR shall indicate this scope on per cubic metre basis if asked for in BOQ

Cable Joints

Jointing of cables shall be made in accordance with relevant codes of practice and MANUFACTURER's special instructions. Cables shall be firmly clamped and supported within 300 mm from the joint to avoid mechanical stresses on the joint.

Joints shall not be permitted in control cables. However, in long runs of power cables, joints shall be permitted at an accessible location which shall be chosen in consultation with PURCHASER/ENGINEER before work is taken up. A record of all joints giving cable number, type of cable, type of joint, location and date of jointing shall be kept by the CONTRACTOR.

Jointing kits shall be suitable for the type of cable and for underground buried installation. The CONTRACTOR shall offer

Heat shrinkable jointing kits/cast resin type or tapex type jointing kits, complete with insulating materials, stress grading/relieving materials, plastic mould, resin, tinned copper lugs, plumbing materials and all other accessories to make the joint complete in all respects. Unit rates for supply and jointing shall be furnished for each type and size of cable if asked for in Section F. Unit rate quoted for outdoor straight through Joints/Jointing kits shall include erection of temporary shelter and safeguarding against ingress of moisture.

A 5M loop of cable shall be kept at each joint

Cable Trays and Markers

Each cable shall be tagged with numbers that appear in the cable schedule. The tag shall be of aluminium with the number punched on it and securely attached to the cable/conduit by not less than two turns of 20 SWG GI wire. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables. Cable tags shall be provided on all cables at each end, on both sides of wall/floor crossings, on each duct/conduit entry and at every 8 to 10 metres in cable trench/tray racks.

Location of cables laid directly underground shall be clearly indicated with cable marker made of galvanised iron plate. Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable joint". The marker shall project 150 mm above ground and shall be spaced at an interval of 20 meters, and at every change in direction. They shall be located on both sides of road and drain crossings.

The price of cable tags and markers shall be included in the installation rates for cables/conduits.

Sealing of Floor Openings

All floor openings for vertical cable trays/raceways shall be sealed by fire-proof compound. The scope of work shall include preparing and laying of the compound. The supply and installation rate for the compound shall be indicated separately by the CONTRACTOR if asked for in BOQ .

EARTHING AND LIGHTNING PROTECTION SYSTEM INSTALLATION

Scope of Supply

The earthing and lightning conductors, electrodes and accessories shall be supplied by the CONTRACTOR as mentioned in the relevant project layout drawings and schedule of prices BOQ .
The material, type and size shall be as indicated in the schedule of prices section-F.

When steel earthing conductors are specified, the same shall be hot dip galvanised when laid above ground unless otherwise stated to prevent atmospheric corrosion. Earthing conductor laid below ground shall be circular M.S conductor or as specified in section F.

When copper earthing conductors are specified, the same shall be stranded and annealed soft drawn type. Copper earthing rods and flats shall be hard drawn type. If specified in section-C, lead coating shall be provided on copper conductors to prevent its corrosion in aggressive environments.

Scope of Installation Work

The installation work shall include unloading, storing, laying, fixing, jointing/terminations, testing and commissioning of the safety earthing system of the plant and lightning protection system for buildings and allied structures. All welding/brazing equipment, necessary tools and testing equipment shall be furnished by the CONTRACTOR. Installation work shall also meet the requirements stipulated in Earthing and Lightning protection System Installation Notes:.

The CONTRACTOR shall carry out the lightning protection and earthing of all equipment/panels/structures as indicated in the PURCHASER's drawings. Whether specifically shown in drawings or not, building columns, hand rails, miscellaneous items such as junction/marshalling boxes, field switches, cable boxes etc., shall be earthed.

The CONTRACTOR shall install bare/insulated, copper/aluminium/steel conductors, braids, etc., required for system and individual equipment earthing. All work such as cutting, bending, supporting, painting/coating, drilling, brazing/soldering/welding, clamping, bolting and connection onto structures, equipment frames, terminals, rails or other devices shall be in the CONTRACTOR's scope of work. All incidental hardware and consumables such as fixing cleats/clamps, anchor fasteners, lugs, bolts, nuts, washers, bitumen compound, anti-corrosive paint as required for the complete work shall be deemed to be included by the CONTRACTOR as part of the installation work.

The approximate quantities, sizes and material of earthing conductors and electrodes to be installed shall be as indicated in schedule of prices BOQ and routes of the conductors and locations of electrodes shall be shown on the project drawings. The layout of conductors shown in the earthing drawings is approximate and these may be suitably shifted / finalised in consultation with the site

ENGINEER/OWNER to avoid any interference. If earth connection to any device is not shown specifically in the relevant earthing drawings, it shall be field routed.

The work of embedment of earthing conductor in RCC floors/walls along with provision of earth plate inserts/pads/earth risers shall normally be done by the civil contractor when the floors/walls are cast. However, when required to do so in these areas where flooring is to be done after the ELECTRICAL CONTRACTOR is at site, the ELECTRICAL CONTRACTOR shall co-ordinate with civil contractor and shall install the earthing conductors before the commencement of concrete work. In such cases, the CONTRACTOR's scope of installation shall include laying the conductors in position (before civil contractor makes 50 mm concrete finish flooring) making welded/brazed/cad weld joints as required including the requisite plate inserts/pads/risers above the floor near the equipment. The embedded conductors shall be connected to reinforcing rods wherever necessary.

The tap connections (earthing leads) from the floor embedded main earthing grid to the equipment of more than 500 mm long shall be embedded in floor by the CONTRACTOR where required, together with associated civil work such as excavation/chasing, concreting and surfacing, if not already done by the civil contractor. The concrete cover over the conductor shall not be less than 50 mm.

The installation of earth conductors in outdoor areas, buried in ground shall include excavation of trenches in earth (600 mm deep and 450 mm wide unless otherwise stated in project drawings), laying of conductor at 600 mm depth (unless stated otherwise), brazing/welding/cad welding as required, of main grid conductor joints as well as risers above ground at required locations and backfilling of trenches. Backfilling material to be placed over buried conductor shall be free from stones and other harmful mixtures. Backfill shall be placed in layers of 150 mm, uniformly spread along the ditch, and tampered utilising pneumatic tampers or other approved means. If the excavated soil is found unsuitable for backfilling, the CONTRACTOR shall arrange for suitable soil from outside.

The installation of earth connection leads to equipment and risers on steel structures/walls shall include laying the conductors, welding/cleating at specified intervals, welding/brazing to the main earth grid's risers, bolting at equipment terminals and coating welded/brazed joints by bitumastic paint. Galvanized conductors shall be touched up with zinc rich paint where holes are drilled at site for bolting to equipment/structure.

The scope of installation of electrodes shall include installation of electrodes (a) directly in earth, (b) in constructed earth pits and connecting to main buried earth grid, as per enclosed project drawings/relevant standards. The scope of work shall include excavation, construction of the earth pits including all materials required for construction of the earth pits, placing the rod, providing and fixing test links on those electrodes in test pits and connecting to main earth grid conductors.

The scope of installation of lightning conductors on the roofs of buildings shall include providing concrete upstands on roof, laying, fastening and cleating of horizontal conductors, grouting of vertical rods where necessary, laying fastening/cleating/welding of the down comers onto the walls/columns of the building and connection to the test links above ground level.

The installation of the test links shall include mounting of the same at specified height on wall/column by suitable brackets and connections of the test link to the earth electrode.

LIGHTING SYSTEM INSTALLATION WORK

The lighting system installation work shall cover the supply of lighting system equipment such as lighting distribution boards (LDBs), lighting panels (LPs), receptacles, light control switches, ceiling fans, lighting wires, conduits, junction boxes, lighting poles, towers, etc. if called for in scope and as described in enclosed standard and installation of these equipment along with lighting fixtures with lamps and accessories to be given by OWNER.

The CONTRACTOR shall carry out the installation of various lighting equipment as indicated in the PURCHASER's layout drawings. The work shall include unloading, storing, unpacking, fixing of all equipment, routing and laying of conduits/cables, wiring, termination, testing and commissioning of all the equipment of lighting system.

The supply of all mounting accessories, earthing wires and incidental hardware and consumable like fixing saddles, spacer plates, junction boxes and conduits required for the fitting fixing/suspension points, joint boxes and connectors, jointing, ferrules, all fixing brackets, screws and studs, shall be deemed to be included as part of installation work. Mounting accessories like saddles, spacer plates, joint boxes, junction boxes and fixing hardware shall be of galvanised mild steel/black enamelled steel.

The installation of lighting fixtures shall be based on the mounting arrangement shown in the drawings/BOQ. The unit rates quoted for installation of lighting fixtures shall include all materials required to mount the fixtures and control gear boxes wherever applicable.

Unit rates for installation of ceiling fans shall be based on mounting with standard suspension length of 300 mm unless noted elsewhere. Supply and installation of necessary hooks and regulator in switch box shall be included in the unit rate for installation of ceiling fans.

The CONTRACTOR shall work in coordination with the Civil and Air-conditioning Contractors and where holes or openings in walls and floors, cut-outs in false ceilings are required the CONTRACTOR shall inform the ENGINEER and other respective Contractors. Holes in wall made by the CONTRACTOR shall necessarily be patched-up by him in a good and approved manner, using the same kind of masonry as in the uncut surfaces.

The CONTRACTOR shall carry out touch-up painting on lighting panels/boards if the same is damaged during installation handling.

Point Wiring

Wiring of lighting fixtures/receptacle units/ceiling fans with regulators shall be on point wiring basis. Two types of point wiring have been envisaged viz. primary point wiring and secondary point wiring. CONTRACTOR shall quote primary point and secondary point wiring rates for each of building/area specified, on the basis of lighting layout drawings enclosed with the specification. Point wiring also covers the wiring of the associated control switches of lighting fixtures/control switches and regulators of ceiling fans/control switches of receptacle units.

Primary Point Wiring

Primary point wiring covers the wiring between a circuit of the lighting panel to the first lighting fixture/ceiling fan/receptacle unit, connected to that circuit of the lighting panel. In some cases where there are junction boxes, the primary point covers the wiring between junction box and the first lighting fixture/ceiling fan/receptacle unit in that circuit.

Secondary Point Wiring

Secondary point wiring covers the wiring of the remaining lighting fixtures/ceiling fans/receptacle units other than that covered under primary point of that circuit in the lighting panel.

Option of a combined point wiring item, including primary and secondary wiring can also be considered instead of separate rates

Cabling for Street and Boundary Lighting

The cabling for street and boundary lighting can be executed BOQ item based or point wiring based. In case of point wiring based the details shall be as below:

Primary Point Wiring

Primary point wiring covers the wiring between the lighting distribution board/lighting panel to the junction box of the first lighting pole or flood light tower and between the junction boxes of the subsequent lighting poles or flood light towers connected to a circuit in the lighting distribution board/lighting panel.

Secondary Point Wiring

Secondary point wiring covers the wiring between the junction box and the lighting fixture on the pole in case of street light and between junction box mounted near the base of the tower and all subsequent junction boxes mounted on that tower and also between junction box and the flood light fixture. The above refers to the remaining fixtures covered under the circuit referred under primary point wiring. Secondary point also covers the wiring of the associated control fuses, switches, looping of terminals, etc. as required.

In case it is BOQ based, all the applicable items with quantity from the description mentioned above shall be listed separately and executed accordingly

Supply and Installation of Conduit Point Wiring

The point wiring shall include supply of necessary materials for the conduit wiring such as coated/galvanised rigid steel conduit/black enamelled M.S. conduit, HR PVC heavy duty conduit (for residential building projects), galvanised M.S. fixing saddles with spacer plates, nylon/fibre fixing plugs, galvanised M.S. fixing screws, 14 SWG galvanised steel earthing wire, FR PVC insulated copper conductor wires, control switches and pulling, termination of the earthing/PVC insulated wire as required, installation of control switches, drilling holes in brick walls/RCC roof slabs for taking the wiring conduits and refinishing and any other works/material necessary for making point wiring complete in all respects.

Minimum size of conduit shall be 20 mm/25 mm for exposed/concealed conduits respectively.

Wires used for conduit point wiring of lighting fixtures/ceiling fans and receptacles shall be 1100V grade, FR PVC insulated, single core, multistranded copper conductor wires of sizes not less than 1.5 sq.mm and 2.5 sq.mm respectively for commercial and Residential or as specified in BOQ. Wires shall conform to IS standards and shall bear the ISI mark.

Wherever concealed conduit wiring is required the supply and installation of rigid conduits in ceiling/walls from lighting panels to lighting fixtures/receptacles, inspection/junction boxes etc. shall be in CONTRACTOR's scope. The CONTRACTOR shall closely coordinate his work with that of the civil contractor.

Supply and Installation of Cable Point Wiring

The cable point wiring shall include supply of necessary materials for the cable wiring such as 1100V grade, multicore, stranded aluminium/copper conductor, PVC insulated, armoured cables of sizes 2.5 sq.mm/4 sq.mm/6 sq.mm, for wiring of fixtures and receptacles in buildings where cable wiring is specified, MS fixing saddles with spacing plates, junction boxes, nylon/fibre fixing plugs, galvanised MS fixing screws, control switches and installation/termination of cables including supply of cable glands as required, installation of control switches, junction boxes, drilling holes in brick walls/RCC roof and grouting necessary conduit sleeves for taking the cables and any other work/materials necessary for making the point wiring complete in all respects.

Supply & Installation of Point Wiring for Street and Flood Lighting-

The cabling for street and flood lighting can be executed BOQ item based or point wiring based. In case of point wiring based the details shall be as below:

Supply and installation of cables required between LDB/LP and junction box mounted on street lighting pole/flood lighting tower and also between junction box to metal enclosed control gear box and fixtures, supply and installation of all the termination accessories such as crimping type cable lugs and cable glands at each junction box and fixture, termination, testing and commissioning of cables. CONTRACTOR's scope of work also includes excavation, preparation of riddled soil bedding, supply and installation of protective covers over the cable, backfilling, ramming, supply and installation of route markers, supply and installation of hume pipes for road crossing, supply and installation of necessary cleating arrangement for cables on flood light tower, etc.

Earthing of street light pole/flood light tower, lighting fixtures, control gear boxes, junction boxes, etc. are also included in the scope of point wiring. Earth strip of size as per project requirement shall be run along with the street lighting/flood lighting cable and looped from pole to pole. The earth strip from the end pole shall be connected to the nearby available grid. If nearby earth grid is not available, last lighting pole shall be earthed by providing local untreated earth pit with rod electrode near the lighting pole. The cost of supply and installation of earthing conductor/rod shall be included in the cost of point wiring for outdoor lighting. Alternatively, instead of running the earth strip along with the cable local untreated earth pit with rod electrode shall be provided for a group of @ 5 poles.

In case it is BOQ based, all the applicable items with quantity from the description mentioned above shall be listed separately and executed accordingly

CONTRACTOR shall provide necessary foundation for erecting street light pole/flood light tower/high mast and install the same. CONTRACTOR shall furnish foundation drawings with necessary details to PURCHASER/CONSULTANT for approval.

Fixture locations are liable to be shifted marginally at site within a radius of 3 to 4 meters from what is shown in the layout drawings. Point wiring rates quoted by the CONTRACTOR shall hold good and no extra prices shall be admissible.

Hazardous Area Wiring

The method of wiring used in hazardous area i.e. either in screwed rigid heavy gauge steel conduits or by armoured cable, shall be continued up to a distance as indicated below from the boundaries of the demarcated area considered as hazardous:

Where processes or operations necessitating the use of flameproof equipment and fittings are carried out in open: - 6m horizontally in any direction from the boundary line and 3m vertically above the highest source of hazard.

Where processes or operations necessitating use of flameproof equipment and fittings are carried out in enclosed equipment: - Up to 6m horizontally of open face or door opening of such equipment and 3m vertically above the roof of such equipment.

Circuits in hazardous area shall be controlled by switches outside the hazardous area in a convenient place and effectively protected from weather. The switches shall disconnect from all sources of supply all unearthed conductors terminating in any outlet in the room.

Joint/junction boxes shall be avoided in hazardous area. If necessary, boxes of approved flameproof design shall be used.

Bakelite ceiling roses and switches shall not be used in hazardous areas.

ESTING AND COMMISSIONING

Electrical Equipment

All checks and tests shall be conducted as per the MANUFACTURER's drawings/manuals, relevant codes of installation and enclosed commissioning check lists.

The CONTRACTOR shall also carry out additional tests if called for in section-C of the specification.

The CONTRACTOR shall carry out insulation resistance tests by megger of following rating.

(a) Control circuits up to 220 V - 500 V megger

b) Power circuits up to 433 V - 1000 V megger

(c) Power circuits above 433 V to 33 KV - 2500 V megger (motorised)

(d) Power circuits above 33 KV - 5000 V megger (motorised)

Earthing and Lightning Protection System

The CONTRACTOR shall ensure the continuity of all conductors and joints. Earth continuity and earth resistance measurement tests shall be performed by the CONTRACTOR at places indicated by the OWNER, at no additional cost.

Test Records

The OWNER's authorised representative shall be present during every test as called for by the OWNER. The CONTRACTOR shall record all test values and furnish the required copies of the test data to the OWNER. Electrical circuits and equipment shall be energised or used at nominal operating voltage after such reports are accepted as satisfactory by the OWNER

16. SOLAR SYSTEM WORKS

The scope of services covers the design, detailed engineering, preparation of construction drawing, manufacture, acceptance testing at manufacturer's works or at any accredited agency, supply, packing, forwarding and delivery from manufacturer's works/ place of storage to erection site including transit insurance, unloading, storage at site, moving from place of storage to place of installation, assembly, erection, testing, commissioning & performance demonstration and handing over along with all necessary spares of original ratings & specifications on Design & Build basis for roof top solar PV system. Inland and overseas transit insurance, transport, testing at site shall be Contractor scope. Tender Bill of Quantities (BOQ) and Drawings are for reference purpose only which is the minimum requirements. Contractor to ensure that design & equipment are as per specification requirements.

The Contractor shall prepare design calculations based on parameters/ design criteria indicated in the specifications. The Contractor shall prepare detailed engineering and construction purpose drawings to make his/ her own estimate of ratings & quantities (minimum requirements as per price schedule, technical data sheets, reference drawings & other relevant details) for entire electrical systems including all items, systems such as equipment, cables/ cabling system, , earthing, lightning protection, power distribution, instruments, civil works required for completion of Works.

Contractor shall take due care of the site Seismic conditions while design of all equipment/ components used in entire electrical systems covered in this specification. Contractor shall furnish list of additional design parameters considered in design to fulfill above requirement.

Design and detailed engineering of the materials procured by Contractor is included in scope. Contractor shall submit design drawings/ calculations of each system which is included in scope to Purchaser/ Purchaser's representative for final review/ approval. All design documents/ calculations prepared by Contractor shall be as per ISO documentation i.e., with duly singed by qualified authorities and stamped. Design documents/ calculations prepared by Sub-Contractors shall be approved by Contractor and stamped copy of approval along with no-deviation sheet from Sub-Contractor shall be submitted by the Contractor to Purchaser/ Purchaser's representative for final review/ approval.

Expert or manufacturer supervision for SUB-Contractor supplied material shall be provided by Contractor.

Nothing in this specification shall be constructed to relieve the Contractor of his/ her responsibilities towards following best engineering practices established in the country.

Even if all components of a system included in this specification are not explicitly identified and/ or listed herein, these shall be supplied under this contract to ensure completeness of the solat PV system and facilitate proper operation and easy maintenance. Any and all other works not indicated above but necessary/ required to complete the system in all aspects, are included in the Contractor's scope.

Contractor's scope shall include design, engineering, manufacture, supply, testing, commissioning and handover of following electrical equipment/ systems as per tender specifications, BOQ, reference drawings and other relevant details for the scope of work.

Solar PV Panels along with mounting accessories, module mounting structure, Inverters, surge protectors for AC & DC, DC cables, LT AC Cables, junction boxes, connectors/combiners, ladder & perforated cable trays, LT Panel complete with all required accessories.

Net metering, Data Logging & Monitoring System and Provision for continuous monitoring of electrical Power & Energy parameters like Voltage, Current, Power Factor, Frequency, Kilo Watts, Kilowatt-Hours as per MNRE requirement etc.

Earthing for equipment and lightning protection system for all solar installation in the plant premises. The general design shall be on the basis of following codes and standards (their latest amendments) in line with design criteria & specification requirements.

a)	IS 3043	:	Code of practice for Safety Earthing
b)	IS/ IEC 62305	:	Code of Practice for the protection of buildings and allied structures against lightning.
c)	CEA guidelines 2010	:	Measures related to safety & electric supply.

GENERAL TECHNICAL & PARTICULAR REQUIREMENTS FOR ELECTRICAL EQUIPMENT/ SYSTEMS:

DEFINITION

A Grid Tied Solar Rooftop Photo Voltaic (SRPV) power plant consists of SRPV array, Module Mounting Structure, Power Conditioning Unit (PCU) consisting of Maximum Power Point Tracker (MPPT), Inverter, and Controls & Protections, interconnect cables, Junction boxes, Distribution boxes and switches. PV Array is mounted on a suitable structure. Grid tied SRPV system is without battery and should be designed with necessary features to supplement the grid power during day time. Components and parts used in the SRPV power plants including the PV modules, metallic structures, cables, junction box, switches, PCUs etc., should conform to the BIS or IEC or international specifications, wherever such specifications are available and applicable. Solar PV system shall consist of following equipment/components.

- Solar PV modules consisting of required number of Mono Crystalline PV cells.
- Surge Protectors
- Cables DC & AC LT Cables.
- Cable Trays
- Grid interactive Power Conditioning Unit
- Mounting structures
- Junction Boxes.

- AC Distribution Panel Boards
- Earthing and lightening protections.
- IR/UV protected PVC Cables, Conduits and accessories

SOLAR PHOTOVOLTAIC MODULES:

The PV modules used should be made in India.

The PV modules used must qualify to the latest edition of IEC PV module qualification test or equivalent BIS standards Crystalline Silicon Solar Cell Modules IEC 61215/IS14286. In addition, the modules must conform to IEC 61730 Part-1 - requirements for construction & Part 2 – requirements for testing, for safety qualification or equivalent IS.

For the PV modules to be used in a highly corrosive atmosphere throughout their lifetime, they must qualify to IEC 61701.

The total solar PV array capacity should not be less than allocated capacity (kWp) and should comprise of solar crystalline modules of minimum 154 Wp and above wattage.

Protective devices against surges at the PV module shall be provided. Low voltage drop bypass diodes shall be provided.

PV modules must be tested and approved by one of IEC authorized test centers preferable NABL accredited.

The module frame shall be made of corrosion resistant materials, preferably/ shall be anodized aluminum.

Efficiency of PV modules at standard test conditions (STC) shall not be less than 15.5% and fill factor of the module shall not be less than 0.80.

Modules shall be made of light weight cells, resistant to abrasion, hail impact, rain, water and environmental pollution. The PV modules shall be provided with anti-reflection coating

Other general requirement for the PV modules and subsystems shall be as follows:

- The rated output power of any supplied module shall have tolerance within +/- 3%.
- The peak-power point voltage and the peak-power point current of any supplied module and/or any module string (series connected modules) shall not vary by more than 2 (two) per cent from the respective arithmetic means for all modules and/or for all module strings, as the case may be.
- The module shall be provided with a junction box with either provision of external screw terminal connection or sealed type and with arrangement for provision of by-pass diode. The box shall have hinged, weather proof lid with captive screws and cable gland entry points or may be of sealed type and IP-65 rated.

I-V curves at STC should be provided by bidder.

Modules deployed must use a RF identification tag. The following information must be mentioned in the RFID used on each module. This should be inside the laminate only.

- Name of the manufacturer of the PV module
- Name of the manufacturer of Solar Cells.
- Month & year of the manufacture (separate for solar cells and modules)
- Country of origin (separately for solar cells and module)
- I-V curve for the module Wattage, I'm, Vm and FF for the module
- Unique Serial No and Model No of the module
- Date and year of obtaining IEC PV module qualification certificate.
- Name of the test lab issuing IEC certificate.
- Other relevant information on traceability of solar cells and module as per ISO 9001 and ISO 14001

Power Conditioners/ Inverters including MPPT and Protections: Efficiency Measurements as per IEC 61683 / IS 61683(10%, 25%, 50%, 75% & 90-100% Loading Conditions) and Environmental Testing as per IEC 60068-2 (1, 2,14, 30) / Equivalent BIS Std. Safety of power converters for use in photovoltaic power systems shall be as per IEC 62109-1, IEC 62109-2. Overall efficiency of grid-connected photovoltaic inverters shall be as per BS EN 50530/IEC 62891. Utility-interconnected Photovoltaic Inverters - Test Procedure of Islanding Prevention Measuresas per IEC 62116 or, IEEE 1547.

Switches/Circuit Breakers /Connectors: General Requirements Connectors – safety A.C./D.C. as per IEC 60947 part I,II, III / IS 60947 Part I,II,III EN 50521.

Junction Boxes /Enclosures for Inverters/Charge Controllers: General Requirements Junction boxes and solar panel terminal boxes shall be of the thermo plastic type with IP 65 protection for outdoor use, and IP 54 protection for indoor use as per IEC 60529.

Meters: a.c. Static direct connected watt-hour Smart Meter Class 1 and 2 — Specification (with Import & Export/Net energy measurements) As per IS 16444/ latest CEA Guidelines/ DISCOM guidelines.

Solar PV Roof Mounting Structures: Material for the structure mounting as per IS 2062/IS 4759. In-addition, "IS 800: Code of practice for general construction in steel" shall be followed, along-with the 'National Building Code' (latest edition)

Surge Arrestors: Low-voltage surge protective devices - Part 11: Surge protective devices connected to low voltage power systems - Requirements and test method as per IEC 61643-11:2011 / IS 15086-5 (SPD).

Lightning Protection System Components: Lightning protection system components (LPSC) - Part 1: Requirements for connection components shall be as per IEC 62561 Series (Chemical earthing) or, equivalent Indian Standards

Earthing: S.I.T.C. of earth pit of minimum bore dia 150 mm size aproved make Safe Earthing Electrode consisting pipe-in pipe Technology made of corrosion free GI Pipe having outer pipe dia of 50 mm having 80-200 Micron galvanising, Inner pipe dia of 25 mm having 200-250 Micron galvanising connection terminal dia. of 12 mm with constant ohmic value surrounded by highly conductive

compound with high charge dissipation suitable for following type of applications. independent earthing in normal soil with Length of Pipe 3.00 mtr. & Back filling compound - 2 No. Bag of 25Kg each.Separate double earthing for solar mounting structure, inverters and lighting arrester.

In each location where solar trees are provided, net metering with a separate LT panel with adequate nos. of incoming from Solar trees and an outgoing for the existing supply. The existing meter shall be replaced by net meter and the supply to existing Panel shall be taken from the newly installed LT panel, so that there will not be any requirement of augmentation in the existing power system.

The structure/ pylon/trunk shall be not less than 4m high from the ground level.

The Design Wind-load bearing capacity shall be as per IS 875 Part 3.

Single axis Tracking system with controller with Fully Automated East to West Tracking

Inbuilt panel washing system.

Warranties:

Material Warranty:

- Material Warranty is defined as: The manufacturer should warrant the Solar Module(s) to be free from the defects and/or failures specified below for a period not less than five (05) years from the date of sale to the original customer ("Customer")
- Defects and/or failures due to manufacturing
- Defects and/or failures due to quality of materials
- Non conformity to specifications due to faulty manufacturing and/or inspection processes. If the solar Module(s) fails to conform to this warranty, the manufacturer will repair or replace the solar module(s), at the Owners sole option

Performance Warranty:

The predicted electrical degradation of power generated not exceeding 20% of the minimum rated power over the 25 year period and not more than 10% after ten years period of the full rated original output.

CIVIL FOUNDATIONS AND ARRAY STRUCTURE

The structures shall resist the worst combination of the required/ specified loads / stresses under test and working conditions; these include dead load, live load, equipment load, water pressure, soil pressure, wind load, seismic load, stresses due to temperature changes, shrinkage and creep in materials, dynamic loads.

Hot dip galvanized MS mounting structures shall be used for mounting the modules/ panels/arrays. Each structure should have angle of inclination as per the site conditions to take maximum insulation. However to accommodate more capacity the angle inclination may be reduced until the plant meets the specified performance ratio requirements.

The Mounting structure shall be so designed to withstand the speed for the wind zone of the location where a PV system is proposed to be installed (Banglore-

wind speed of 33m/s as per IS 875 Part 3). Bidder may design the structures to sustain wind speed as specified in the indicated IS code. It may be ensured that the design has been certified by a recognized Lab/ Institution in this regard and submit wind loading calculation sheet to Consultant for approval. Suitable fastening arrangement should be provided to secure the installation against the specific wind speed.

The structures shall be designed taking into considerations the Seismic zone (earthquake loading) for the region. This shall be computed as per I.S. 1893. The site falls in Zone II as per IS: 1893 (2002). An importance factor appropriate to the type of structure shall be considered for design of all the structures. Environmental condition shall be considered appropriate as per IS 456, IS 800.

The individual members of the frame shall be designed for worst combination of forces such as bending moment, axial force, shear force and torsion as applicable. Permissible stresses for different load combinations shall be taken as per latest IS456.

The mounting structure steel shall be as per latest IS 2062: 2011 and galvanization of the mounting structure shall be in compliance of latest IS 4759.

As far as possible non penetrative methods shall be preferred for mounting the structures over conventional penetrative method for the foundations for all kinds of roofs – GI sheet as well as RCC roofs tops.

Structural material shall be corrosion resistant and electrolytic ally compatible with the materials used in the module frame, its fasteners, and nuts and bolts. Aluminum structures also can be used which can withstand the wind speed of respective wind zone. Necessary protection towards rusting need to be provided either by coating or anodization.

The fasteners used should be made up of stainless steel. The structures shall be designed to allow easy replacement of any module. The array structure shall be so designed that it will occupy minimum space without sacrificing the output from the SRPV panels

Regarding civil structures the bidder need to take care of the load bearing capacity of the roof and need arrange suitable structures based on the quality of roof.

The total load of the structure (when installed with PV modules) on the terrace should be less than 75 kg/m2.

The minimum clearance of the structure from the roof level should be 300 mm.

JUNCTION BOXES (JBs)

The junction boxes are to be provided in the PV array for termination of connecting cables. The JBs shall be made of Polycarbonate/GRP/FRP/Powder Coated Aluminum /cast aluminum alloy with full dust, water & vermin proof arrangement.

It should be UV resistant in accordance with suitable for outdoor application at an ambient of 50°C.

The junction boxes shall have IP protection of IP 65 for outdoor and IP21 for Indoor as per IEC 529.

All wires/cables must be terminated through cable lugs. The JBs shall be such that input & output termination can be made through suitable cable glands.

Copper bus bars/terminal blocks housed in the junction box with suitable termination threads Conforming to IEC 62208 Hinged door with EPDM rubber gasket to prevent water entry. Double compression cable glands. Provision of earthlings. It should be placed at 5 feet height or above for ease of accessibility.

All the component including the Hardware that are required for mounting shall be include in the scope of work.

Each Junction Box shall have High quality Suitable capacity Metal Oxide Varistors (MOVs) / SPDs, suitable Reverse Blocking Diodes. The Junction Boxes shall have suitable arrangement for disconnection of each of the groups.

Suitable markings shall be provided on the bus bar for easy identification and the cable ferrules must be fitted at the cable termination points for identification.

The fuses shall be provided on both positive and negative terminal of the incoming string.

All fuses (Input Side) shall have DIN rail mountable fuse holders and shall be housed in thermoplastic IP 65 enclosures with transparent covers.

Array Junction Box shall have isolator that will be used to disconnect both positive and negative sides simultaneously on output side.

Array Junction Box shall have the sensors to monitor below parameters

- Analog signals: 1. String currents 2. String Voltage
- Digital signals: 1. Isolator ON/OFF status

  There shall be provision for mounting RTD element on String Monitoring device

  Either shunt-based (or) CT/hall-effect sensor (LEM)-based Mechanism shall be employed for sensing string currents together with Analog to digital converters for converting above current, voltage and temperature signals.

  Monitoring of the following parameter shall be possible using SCADA
- DC Switch ON/OFF Status
- SPD operated
- Ambient and Junction box Temperature
- Bus Voltage
- Current through individual string
- Overall Output Current

  Insulated pin type and ring type lugs, ferrules, cable ties etc. required for connecting the communication cables to the combiner boxes shall be in the bidder scope.

  Routine tests shall be conducted, as per relevant standards (IS, IEC etc), shall be carried out on the string combiner box and all the tests may be witnessed by Client/ Client representatives. Vendor shall submit manufacturing quality plan, indicating relevant IS/IEC standards for Client's approval. Following shall be the minimum checks
- Visual inspection check
- Bill of materials check

- Electrical continuity check
- HV insulation tests
- Functional checks

Test reports shall be submitted prior to dispatch of the system to the site.

Type test report for Temperature rise test performed at NABL accredited Lab shall be submitted for approval for Client/ Client's representative.

PCU/ARRAY SIZE RATIO:

The combined wattage of all inverters should not be less than rated capacity of power plant under STC.

Maximum power point tracker shall be integrated in the PCU/inverter to maximize energy drawn from the array.

PCU / Inverter:

As SPV array produce direct current electricity, it is necessary to convert this direct current into alternating current and adjust the voltage levels to match the grid voltage. Conversion shall be achieved using an electronic Inverter and the associated control and protection devices. All these components of the system are termed the "Power Conditioning Unit (PCU)". In addition,

PCU shall also house MPPT (Maximum Power Point Tracker), an interface between Solar PV array & the Inverter, to the power conditioning unit/inverter should also be DG set interactive, if necessary. Inverter output should be compatible with the grid frequency. Typical technical features of the inverter shall be as follows:

Switching devices	IGBT/MOSFET
Control	Microprocessor /DSP
Nominal AC output voltage and Frequency	415V, 3 Phase, 50Hz (In case single phase inverters are offered, suitable arrangement fo balancing the phases must be made.)
Output frequency	50 Hz
Grid Frequency Synchronization range	+ 3 Hz or more
Ambient temperature considered	-20o C to 50o C
Humidity	95 % Non-condensing
Protection of Enclosure	IP-20(Minimum) for indoor. IP-65(Minimum) for outdoor.
Grid Frequency Tolerance range	+ 3 or more
Grid Voltage tolerance	-0.20.15
No-load losses	Less than 1% of rated power

Inverter efficiency(minimum)	>93% (In case of 10 kW or above with in-buil galvanic isolation) >97% (In case of 10 KW or above withou in-built galvanic isolation)
THD	< 3%
PF	> 0.9
Surge Protection	Required on both AC as well as DC side
Enclosure	Shall be made of non corrosive material

PCU/inverter shall be capable of complete automatic operation including wake-up, synchronization & shutdown.

The output power factor of PCU inverter is suitable for all voltage ranges or sink of reactive power; inverter should have internal protection arrangement against any sustainable fault in feeder line and against the lightning on feeder.

Built-in meter and data logger to monitor plant performance through external computer shall be provided. It shall have multi-line display to indicate following parameters

- Output Voltage
- Output Current
- Output frequency
- Harmonics
- Power Factor
- KW (Output)
- kWH (Output)
- DC Input Voltage
- DC Input Current
- KW (input)
- kWH (input)

The inverter control system shall be fully compatible for remote operation via communication link.

Bidder to indicate the type of communication protocol supported by the system along with the details of links provided in the system. The control system shall operate on windows or equivalent platform.

Alarm shall be produce for the following operating conditions

- Inverter failure
- IGBT/MOSFET over temperature
- Breaker / Dis-connecter failure
- Over load
- Over load shutdown

- Emergency shutdown
- DC circuit breaker/switch open
- AC Main failure
- Fan failure
- Asynchronous condition and Synchronous condition
- Control power failure
- DC ground fault

The communication protocol in inverter shall be compatible with the Data acquisition system implemented for the entire solar plant.

Anti-islanding (Protection against Islanding of grid): The PCU shall have anti-islanding protection in conformity to IEEE 1547/UL 1741/ IEC 62116 or equivalent BIS standard.

Successful Bidders shall be responsible for galvanic isolation of solar roof top power plant with electrical grid or LT panel.

In PCU/Inverter, there shall be a direct current isolation provided at the output by means of a suitable isolating transformer. If Isolation Transformer is not incorporated with PCU/Inverter, there shall be a separate Isolation Transformer of suitable rating provided at the output side of PCU/PCU units for capacity.

The PCU/ inverter generated harmonics, flicker, DC injection limits, Voltage Range, Frequency Range and Anti-Islanding measures at the point of connection to the utility services should follow the latest CEA (Technical Standards for Connectivity Distribution Generation Resources) Guidelines and shall also be within the specified limits in IEEE 519.

Power conditioning units / inverters should comply with applicable IEC / equivalent BIS standard for efficiency measurements and environmental tests as per standard codes IEC 61683/IS 61683 and IEC 60068-2 (1,2,14,30)/ Equivalent BIS Std.

The MPPT units environmental testing should qualify IEC 60068-2 (1, 2, 14, 30)/ Equivalent BIS std. The junction boxes/ enclosures should be IP 65 (for outdoor) / IP 54 (indoor) and as per IEC 529 specifications.

The PCU/ inverters should be tested from the MNRE approved test centers/ NABL/ BIS/ IEC accredited testing- calibration laboratories. In case of imported power conditioning units, these should be approved by accredited international test houses. Bidder shall furnish copies of all type test reports required.

The Inverter shall have the option of Positive or Negative grounding. The inverter shall have less power consumption when in service and shall have minimum power consumption on standby mode. Inverter DC input side shall be provided with DC Circuit breaker and output side provided with AC circuit breaker

The minimum following devices shall be provided to protect the inverter:

- Reverse polarity
- Reverse power
- Short Circuit
- Over-current

- Earth fault protection
- Islanding
- Under / Overvoltage
- Over / Under frequency
- Surge Protection on both AC and DC side.

The BIDDER shall clearly bring out the earthing philosophy to be adopted for the Inverter electronics, protective earthing (PE) and neutral earthing. The requirement of separate earth pit independent of the plant electrical system earth pits shall be clearly brought out.

Types including Heat run test and routine tests certificates for all components used in the inverter system shall be furnished. Testing of components shall be as per relevant standards.

Bidder shall furnish copies of all type test reports required as per the relevant standards. The type test should have been carried out in last five years on equipment of similar rating. Without the type test reports,the Contract shall be considered incomplete.

Bidder shall furnish his quality assurance plan for the equipment offered. The quality assurance plan shall include bought out component and assemblies used in the Inverter system.

System tests shall be performed on the completely assembled inverter system. System tests shall include frequency regulations. Voltage regulation, current limiting feature and harmonic content tests in addition to the tests to prove the functional requirements such synchronization with range of adjustments, overload and under voltage conditions.

Heat run test shall be carried out on inverter system at rated load under relevant ambient conditions for a period of 8 hours. This test shall be conducted as a routine test on all inverters being supplied.

INTEGRATION OF PV POWER WITH GRID:

The output produced from the SRPV System shall be supplied to the grid through inverter and proper switching arrangement. In case of power failure, or low or high voltage, solar PV system shall be out of synchronization and shall be isolated from the network.

The bidirectional electronic energy meter (0.5 S classes) shall be installed for the measurement of import/Export of energy. The Meter shall be as per DISCOM norms.

The bidder must intimate to the Concerned DISCOM for the connectivity, technical feasibility, and synchronization of SRPV plant with distribution network and submit the same to GANDHINAGAR SMART CITY DEVELOPMENT LIMITED before commissioning of SRPV plant.

The Reverse power relay shall be provided by bidder (if necessary), as per the local DISCOM requirement.

DATA ACQUISITION SYSTEM / PLANT MONITORING

Data Acquisition System shall be provided for each of the solar PV plant. The details shall be integrated with building BMS system.

Data Logging Provision for plant control and monitoring, time and date stamped system data logs for analysis with the high quality, suitable PC. Metering and Instrumentation for display of systems parameters and status indication to be provided.

Solar Irradiance: An integrating Pyranometer / Solar cell based irradiation sensor (along with calibration certificate) provided, with the sensor mounted in the plane of the array. Readout integrated with data logging system.

Temperature: Temperature probes for recording the Solar panel temperature and/or ambient temperature to be provided complete with readouts integrated with the data logging system

The following parameters are accessible via the operating interface display in real time separately for solar power plant:

- AC Voltage.
- AC Output current.
- Output Power
- Power factor.
- DC Input Voltage.
- DC Input Current.
- Time Active.
- Time disabled.
- Time Idle.
- Power produced
- Protective function limits (Viz-AC Over voltage, AC Under voltage, Over frequency, Under frequency ground fault, PV starting voltage, PV stopping voltage.
- Parameters mentioned in above Clause.

All major parameters available on the digital bus and logging facility for energy auditing through the internal microprocessor and read on the digital front panel at any time) and logging facility (the current values, previous values for up to a month and the average values) should be made available for energy auditing through the internal microprocessor and should be read on the digital front panel.

PV array energy production: Digital Energy Meters to log the actual value of AC/ DC voltage, Current & Energy generated by the PV system provided. Energy meter along with CT/PT should be of 0.5 accuracy class.

Computerized DC String/Array monitoring and AC output monitoring shall be provided as part of the inverter and/or string/array combiner box or separately.

String and array DC Voltage, Current and Power, Inverter AC output voltage and current (All 3 phases and lines), AC power (Active, Reactive and Apparent), Power Factor and AC energy (All 3 phases and cumulative) and frequency shall be monitored.

Computerized AC energy monitoring shall be in addition to the digital AC energy meter.

The data shall be recorded in a common work sheet chronologically date wise. The data file shall be MS Excel compatible. The data shall be represented in both tabular and graphical form.

All instantaneous data shall be shown on the computer screen. It shall show the mimic diagram indicating status of each system component and value of each system parameters

Software shall be provided for USB download and analysis of DC and AC parametric data for individual plant.

Provision for instantaneous Internet monitoring and download of historical data shall be also incorporated.

Remote Server and Software for centralized Internet monitoring system shall be also provided for download and analysis of cumulative data of all the plants and the data of the solar radiation and temperature monitoring system.

Ambient / Solar PV module back surface temperature shall be also monitored on continuous basis.

Simultaneous monitoring of DC and AC electrical voltage, current, power, energy and other data of the plant for correlation with solar and environment data shall be provided.

Remote Monitoring and data acquisition through Remote Monitoring System software at the owner location with latest software/hardware configuration and service connectivity for online / real time data monitoring / control complete to be supplied and operation and maintenance / control to be ensured by the bidder.

The bidders shall be obligated to push real-time plant monitoring data on a specified intervals (say 15 minute) through open protocol at receiver location (cloud server) in XML/JSON format, preferably. Suitable provision in this regard will be intimated to the successful bidder.

All the Alarm as indicated in the Clause 21.9 shall be displayed on the computer screen.

PROTECTIONS

The system should be provided with all necessary protections like earthing, Lightning, and grid islanding as follows:

LIGHTNING PROTECTION

The SRPV power plants shall be provided with lightning & overvoltage protection. The main aim in this protection shall be to reduce the over voltage to a tolerable value before it reaches the PV or other sub system components. The source of over voltage can be lightning, atmosphere disturbances etc.The entire space occupying the SRPV array shall be suitably protected against Lightning by deploying required number of Lightning Arrestors. Lightning protection should be provided as per IEC 62305 standards. The protection against induced high-voltages shall be provided by the use of metal oxide varistors (MOVs) and suitable earthing such that induced transients find an alternate route to earth. Radio-active air-terminals shall not be allowed. Any other kind of air- terminal like dissipation system shall not be acceptable.

SURGE PROTECTION

Internal surge protection shall consist of three MOV type surge-arrestors connected from +ve and –ve terminals to earth (via Y arrangement).

EARTHING PROTECTION

Each array structure of the PV yard should be grounded/ earthed properly as per IS: 3043-1987. In addition the lighting arrester/masts should also be earthed inside the array field. PCU, ACDB and DCDB should also be earthed properly.

Earth resistance shall not be more than 5 ohms. It shall be ensured that all the earthing points are bonded together to make them at the same potential.

Earthing of data logging & monitoring system shall be as per the supplier.

All other earth pits Earth electrodes shall be of heavy duty galvanized mild steel of not less than 40 mm NB and minimum 3000 mm long. Where multiple rods are used they shall be separated by a distance of not less than 2000mm.

The earth pits may require boring & drilling in the soil & the same shall be considered in Contractor's scope.

Lightning protection down comers shall not be used as earthing conductors above ground.

Earth resistance shall not be more than 5 ohms. It shall be ensured that all the earthing points are bonded together to make them at the same potential.

GRID ISLANDING:

In the event of a power failure on the electric grid, it is required that any independent power-producing inverters attached to the grid turn off in a short period of time. This prevents the DC-to-AC inverters from continuing to feed power into small sections of the grid, known as "Islands." Powered Islands present a risk to workers who may expect the area to be unpowered, and they may also damage grid-tied equipment. The Rooftop PV system shall be equipped with islanding protection. In addition to disconnection from the grid (due to islanding protection) disconnection due to under and over voltage conditions shall also be provided.

A manual disconnect 4-pole isolation switch beside automatic disconnection to grid would have to be provided at utility end to isolate the grid connection by the utility personnel to carry out any maintenance. This switch shall be provided with locking facility to be locked by the utility personnel for taking outage clearances.

CABLES

Cables of appropriate size to be used in the system shall have the following characteristics:

- Shall meet IEC 60227/IS 694, IEC 60502/IS1554 standards
- Temp. Range: –10 deg C to +80 deg C.
- Voltage rating 660/1000V
- Excellent resistance to heat, cold, water, oil, abrasion, UV radiation
- Flexible

Sizes of cables between array interconnections, array to junction boxes, junction boxes to Inverter etc. shall be so selected to keep the voltage drop (power loss) of the entire solar system shall not exceed 2%.

For the DC cabling, XLPE or, XLPO insulated and sheathed, UV-stabilized single core multi-stranded flexible copper cables shall be used; Multi-core cables shall not be used.

For the AC cabling, PVC or, XLPE insulated and PVC sheathed single or, multi-core multi-stranded flexible copper cables shall be used; Outdoor AC cables shall have a UV-stabilized outer sheath.

The cables (as per IS) should be insulated with a special grade PVC compound formulated for outdoor use. Outer sheath of cables shall be electron beam cross-linked XLPO type and black in color.

The DC cables module array shall run through a UV-stabilized PVC conduit pipe of adequate diameter with a minimum wall thickness of 1.5mm.

Cables and wires used for the interconnection of solar PV modules shall be provided with solar PV connectors (MC4) and couplers

All cables and conduit pipes shall be clamped to the rooftop, walls and ceilings with thermo-plastic clamps at intervals not exceeding 50 cm; the minimum DC cable size shall be 4.0 mm2 copper; the minimum AC cable Size shall be 4.0 mm2 copper.

In three phase systems, the size of the neutral wire size shall be equal to the size of the phase wires.

Cable Routing/ Marking: All cable/wires are to be routed in a GI cable tray and suitably tagged and marked with proper manner by good quality ferule or by other means so that the cable easily identified. In addition, cable drum no. / Batch no. to be embossed/ printed at every one meter.

Cable Jacket should also be electron beam cross-linked XLPO, flame retardant, UV resistant and black in color.

All cables and connectors for use for installation of solar field must be of solar grade which can withstand harsh environment conditions including High temperatures, UV radiation, rain, humidity, dirt, salt, burial and attack by moss and microbes for 25 years and voltages as per latest IEC standards. DC cables used from solar modules to array junction box shall be solar grade copper (Cu) with XLPO insulation and rated for 1.1kV as per relevant standards only.

Bidder shall indicate size and length as per system design requirement. All the cables required for the plant shall be provided by the bidder. All cable schedules/ layout drawings shall be approved prior to installation.

Multi Strand, Annealed high conductivity copper conductor PVC type ‘A’ pressure extruded insulation or XLPE insulation. Overall PVC/XLPE insulation for UV protection Armored cable for underground laying. All cable trays including covers to be provided. All cables conform to latest edition of IEC/ equivalent BIS Standards as specified below: BoS item / component Standard Description Standard Number Cables General Test and Measuring Methods, PVC/XLPE insulated cables for working Voltage up to and including 1100 V, UV resistant for outdoor installation IS /IEC 69947.

The total voltage drop on the cable segments from the solar PV modules to the solar grid inverter shall not exceed 2.0%.

The total voltage drop on the cable segments from the solar grid inverter to the building distribution board shall not exceed 2.0%.

CONNECTIVITY

The PV system of each Building shall be connected to the Grid at 415V at the OWNER's LT system at Main Distribution Board/ Power Control Centre (PCC) of the respective building with incoming switchgear.

DANGER BOARDS AND SIGNAGES:

Danger boards of appropriate voltage level shall be provided as and where necessary as per CEA guidelines 2010 as amended up to date. Appropriate Signage shall be provided at appropriate locations to identify the equipment, indicate the purpose etc.

FIRE EXTINGUISHERS:

The firefighting system for proposed power plant for fire protection shall be consisting of:

Portable fire extinguishers (CO_2) in the control room for fire caused by electrical short circuits

Sand buckets in the control room – One stand with 4 Buckets

The installation of Fire Extinguishers should confirm to TAC regulations and BIS standards. The fire extinguishers shall be provided in the control room housing PCUs as well as on the Roof where the PV arrays have been installed.

DRAWINGS & MANUALS:

Two sets of Engineering, electrical drawings and Installation and O&M manuals are to be supplied. Bidders shall provide complete technical data sheets for each equipment giving details of the specifications along with make/makes in their bid along with basic design of the power plant and power evacuation, synchronization along with protection equipment.

Approved ISI and reputed makes for equipment offered/ to be used.

PLANNING AND DESIGNING:

The bidder should carry out Shadow Analysis at the site and accordingly design strings & arrays layout considering optimal usage of space, material and labour. The bidder should submit the array layout drawings along with Shadow Analysis Report to consultant for approval.

DRAWINGS TO BE FURNISHED BY BIDDER AFTER AWARD OF CONTRACT

The Bidder shall furnish the following drawings and obtain approval

- General arrangement of PV Panels and other equipment with dimensions and section layouts indicating all views for each location wherever Bidder's equipment shall be installed.
- Schematic drawing showing the requirement of SV panel, Power conditioning Unit(s)/ inverter, Junction Boxes, AC and DC Distribution Boards, meters etc.
- Detailed Single line Diagram (SLD) indicating the Rating of components including switchgear, bus-bar, CT, PT, cables etc.; Configuration of components; Protection details; interlocks; indications & annunciations provided; etc. for each system.
- Supporting calculations with formulae, reference to standards and assumptions shall be submitted for each system.
- Structural drawing along with foundation details for the structure.

- Itemized bill of material for complete SV plant covering all the components and associated accessories.
- Layouts of solar Power Array, cable tray routing, earthing including downcomers, lightning arrestors and earth pits with building dimensions, inverters, lighting, metering etc.
- Shadow analysis of the roof
- Type Test certificates of the components from Accredited Laboratories.

SOLAR PV SYSTEM ON THE ROOFTOP FOR MEETING THE ANNUAL ENERGY REQUIREMENT

The Solar PV system on the rooftop of the selected buildings will be installed for meeting up to 40% or as specified by the state Electricity Regulatory Commission (AERC), of the annual energy requirements depending upon the area of rooftop available and the remaining energy requirement of the office buildings will be met by drawing power from grid at commercial tariff of DISCOMs

SAFETY MEASURES:

The bidder shall take entire responsibility for electrical safety of the installation(s) including connectivity with the grid and follow all the safety rules and regulations applicable as per Electricity Act, 2003 and CEA guidelines etc.

Since the Job involves Working at Height more than 3 m, all safety measures related to Working at height shall be followed as per standard engineering practice including mounting of Pipe Scaffolding, Safety Net, Personal protective equipment, Safety Belt, Special vehicle mounted elevator etc.

Also for Maintenance purpose on regular basis working of Gujarat type Roofs, adequate foolproof safe arrangements shall be provided for the operator and workmen to carry out their routine work without and risk of accident.

Refer Safety Guidelines enclosed with this document for further requirements.

A write up of the steps to be followed and equipment to be used for installation, testing, operation and maintenance shall be provided as a part of evaluation document.

DISPLAY BOARD

The bidder has to display a board at the project site mentioning the following:

Plant Name, Capacity, Location, Type of Renewable Energy plant (Like solar, wind etc.), and Date of commissioning, details of tie-up with transmission and distribution companies, Power generation and Export FY wise.

Quality Certification, Standards and Testing for Grid-connected Rooftop Solar PV Systems/Power Plants

Quality certification and standards for grid-connected rooftop solar PV systems are essential for the successful mass-scale implementation of this technology. It is also imperative to put in place an efficient and rigorous monitoring mechanism, adherence to these standards. Hence, all components of grid-connected rooftop solar PV system/ plant must conform to the relevant standards and certifications given below:

IEC 61215/ IS	Design Qualification and Type Approval for Crystalline Silicon

14286/IEC61646	Terrestrial Photovoltaic (PV) Modules
IEC 61701/IS 61701	Salt Mist Corrosion Testing of Photovoltaic (PV) Modules
IEC 61853-Part 1/ IS 16170: Part 1	Photovoltaic (PV) module performance testing and energy rating –: Irradiance and temperature performance measurements, and power rating
IEC 62716	Photovoltaic (PV) Modules – Ammonia (NH3) Corrosion Testing (As per the site condition like dairies, toilets)
IEC 61730-1,2	Photovoltaic (PV) Module Safety Qualification – Part 1: Requirements for Construction, Part 2: Requirements for Testing
IEC 62804	Photovoltaic (PV) modules - Test methods for the detection of potential-induced degradation. IEC TS 62804-1: Part 1: Crystalline silicon (mandatory for applications where the system voltage is >600 VDC and advisory for installations where the system voltage is < 600 VDC)
IEC 62759-1	Photovoltaic (PV) modules – Transportation testing, Part 1: Transportation and shipping of module package units
Solar PV Inverters	
IEC 62109-1, IEC 62109-2	Safety of power converters for use in photovoltaic power systems – Part 1: General requirements, and Safety of power converters for use in photovoltaic power systems Part 2: Particular requirements for inverters. Safety compliance (Protection degree IP 65 for outdoor mounting, IP 54 for indoor mounting)
IEC/IS 61683 (as applicable)	Photovoltaic Systems – Power conditioners: Procedure for Measuring Efficiency (10%, 25%, 50%, 75% & 90-100% Loading Conditions)
BS EN 50530 (as applicable)	Overall efficiency of grid-connected photovoltaic inverters: This European Standard provides a procedure for the measurement of the accuracy of the maximum power point tracking (MPPT) of inverters, which are used in grid- connected photovoltaic systems. In that case the inverter energizes a low voltage grid of stable AC voltage and constant frequency. Both the static and dynamic MPPT efficiency is considered.
IEC 62116/ UL 1741/ IEEE 1547(as applicable)	Utility-interconnected Photovoltaic Inverters - Test Procedure of Islanding Prevention Measures
IEC 60255-27	Measuring relays and protection equipment – Part 27: Product safety requirements
IEC 60068-2 (1,	a) IEC 60068-2-1: Environmental testing - Part 2-1: Tests -

2, 14, 27, 30 & 64)	Test A: Cold b) IEC 60068-2-2: Environmental testing - Part 2-2: Tests - Test B: Dry heat c) IEC 60068-2-14: Environmental testing - Part 2-14: Tests - Test N: Change of temperature d) IEC 60068-2-27: Environmental testing - Part 2-27: Tests - Test Ea and guidance: Shock e) IEC 60068-2-30: Environmental testing - Part 2-30: Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle) f) IEC 60068-2-64: Environmental testing - Part 2-64: Tests - Test Fh: Vibration, broadband random and guidance
IEC 61000- 6–1/3; IEC 61000-3– 2/3 (as applicable)	Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC) testing of PV Inverters
Surge Arrestors	
IEC 62305-4	Lightening Protection Standard
IEC 60364-5-53/	Electrical installations of buildings - Part 5-53: Selection and
IS 15086-5 (SPD)	erection of electrical equipment - Isolation, switching and Control
IEC 61643-11:2011	Low-voltage surge protective devices - Part 11: Surge protective devices connected to low-voltage power systems- Requirements and test methods
Cables	
IEC 60227/IS 694, IEC 60502/IS 1554 (Part 1 & 2)/ IEC69947	General test and measuring method for PVC (Polyvinyl chloride) insulated cables (for working voltages up to and including 1100 V, and UV resistant for outdoor installation)
BS EN 50618	Electric cables for photovoltaic systems (BT(DE/NOT)258), mainly for DC Cables
Earthing /Lightning	: IEC 62305& IS3043
IEC 62561 Series (Chemical earthing)	IEC 62561-1 Lightning protection system components (LPSC) - Part 1: Requirements for connection components IEC 62561-2 Lightning protection system components (LPSC) - Part 2: Requirements for conductors and earth electrodes IEC 62561-7 Lightning protection system components (LPSC) - Part 7: Requirements for earthing enhancing compounds

Junction Boxes	
IEC 60529	Junction boxes and solar panel terminal boxes shall be of the thermo-plastic type with IP 65 protection for outdoor use, and IP 54 protection for indoor use
Energy Meter	
IS 16444 or as specified by the BISCOMs	A.C. Static direct connected watt-hour Smart Meter Class 1 and 2 — Specification (with Import & Export/Net energy measurements)
Solar PV Roof Mounting Structure	
IS 2062/IS 4759	Material for the structure mounting

Note- Equivalent standards may be used for different system components of the plants. In case of clarification following person/agencies may be contacted.

- Ministry of New and Renewable Energy (Govt. of India)
- National Institute of Solar Energy
- The Energy & Resources Institute
- UV Rheinland and UL

SAFETY GUIDELINES

General Safety:

Contractor shall take all necessary precautions not only for safe working of his own workmen but also deploy all precautions to ensure safety of structures, equipment and workmen of other agencies in and around his work site.

Contractor shall assign an experienced and trained safety In-charge who is aware of all the risks involved in the works related to Installation, testing Commissioning of such Rooftop Solar jobs.

Contractor should conduct daily safety briefing with the team and ensure strict compliance of safety procedures.

Contractor will follow all National and internationally applicable electrical safety norms in installation of solar plant and during operation and maintenance of the plant.

GSCDL/GMC will not be responsible for any clearances and permits.

Contractor shall take permission from Chief Electricity Inspector for setting up the plant, if necessary.

Contractor shall take permission from concerned authorities (Local/state/central) if required under any Laws, rules and regulations.

Any damage caused to existing structure due to construction activities or the operation of the plant thereof will be the responsibility of the Contractor and it will be required to fix the damage as per the specification of GSCDL/GMC or compensate an equivalent amount.

It is responsibility of the Contractor to acquaint himself with the existing policies.

Contractor has to comply with the Environmental, Occupational Health & Safety and Security requirements of GSCDL/GMC and has to ensure that adequate measures have been taken from their end for the safe working of their men and machines.

Contractor shall ensure that his workmen do not trespass into prohibited/restricted work areas.

Contractor shall execute the work in a manner causing the least possible interference with the business of the EMPLOYER/CONSULTANT, or with the work of any other CONTRACTOR who may be engaged on the premises and shall at all times co-operate with the other CONTRACTORS working at site.

Contractor shall obtain daily work permit from the EMPLOYER/CONSULTANT before start of any work at site. The work permits are issued to prevent the CONTRACTOR from working in unauthorised areas and shall be valid for specific area for a stipulated period.

Contractor shall ensure at all times that his workers do not lie down or sleep under or around any machine, equipment, vessel or vehicle in his work area at any time.

Contractor must follow Entry to the project premises with valid Photo ID and mandatory PPE's (safety helmet, shoe & reflective jackets).

The record of Entry / Exit of the personnel will be maintained

Working at Heights

Contractor workmen engaged must undergo medical fitness examination before deploying them for work at heights.

Contractor workers should wear safety full body harness with double lanyard with hook properly fastened.

Contractor workmen engaged on work at heights should be experienced in such work.

Steel scaffold staging should be erected as per IS code. Design for Scaffold staging must be approved by Chartered Engineer.

Wherever multiple work activities Contractor must use safety nets beneath the place of work for safety.

Contractor when working over equipment or tanks, Full body safety harness with double lanyard, safety lifeline and safety nets should always be used whether or not staging and scaffolding is provided.

Safe access to all points of works should be provided in the form of Suitable Ladders /stairways/ boom lifts by Contractor.

Area around the work place should be barricaded suitably or fenced off to avoid Injuries to personnel passing by. Suitable warning boards and sign should be put up by Contractor.

Life line and fall protection arrangements should be provided for working at heights by Contractor

Contractor must ensure loose materials should be cleared on daily basis from scaffolds.

Man-basket not permitted for height works.

Hot Work (Welding / Gas cutting work)

Only qualified welders should be employed at the work site.

Contractor must organise for all welding work at site, Rectifier / Thyristor sets instead of AC transformer sets. AC transformer sets are banned for welding jobs (both open and closed top type).

Contractor should get his welding sets certified by concerned engineer of the GSCDL/GMC before start of the work. These certificates should have to be renewed every month. A copy of the certificates should be displayed on respective welding sets.

Contractor welder should not use the structure etc. as a return path of the current. Adequately rated circuit breaker should be provided in the power circuit for human protection on all power supply points.

Before starting any hot work like Gas cutting, welding and grinding etc., the Contractor should obtain hot work permit from the concerned engineer of the GSCDL/GMC. The permit should be renewed on day-to-day basis.

No combustible material should be stored on or near any source of heat like hot pipes, welding or gas. Before leaving the place of work or the Contractor's sheds, the Contractor's workmen should ensure that no material or item that could start a fire is left at site. Special attention should be paid to collection and disposal of oil soaked cotton waste or rags. On no account are these to be dropped into corners, pushed below equipment or left hanging on pipes.

Contractor must use gas cylinders in a safe manner. These should not be dropped from heights or dragged on the floor. Trolley with rubber rimmed wheels should be used for transporting gas cylinders within the site. All cylinders should be kept in upright position. Oxygen cylinders should not be kept near inflammable materials like oil etc.

Standard colour codes for the cylinder must be followed (Oxygen-Black, Acetylene-Maroon) by Contractor.

Contractor must provide the gas cutting sets with flash back arrestor at both ends (Cylinder and Torch) and gas cutting rubber tube ends fixed with the clamps.

Contractor must provide the fire blankets for fire protection in the vicinity of welding and gas cutting jobs.

Contractor must provide charged fire extinguisher of DCP / CO2 type with each welding/gas cutting set.

LPG shall not be used for cutting / heat treatment purpose (strictly prohibited).

MECHANICAL SAFETY:

Contractor shall ensure that all his equipment and machinery are safe to use while in motion or working. Operators shall have received training or instruction on operation of the machinery and the regulatory requirements.

Contractor shall have adequate procedure to ensure the stability and securing of his working machinery during operation. He shall restrict repair and maintenance of the machinery to trained personnel and maintain records of repairs and maintenance. The equipment shall have appropriately designed means of isolating from sources of energy and shall have emergency stop control, which is easily accessible. All controls shall be clearly and uniformly marked. All operation controls, interlocks, sensing devices and guards on tools and equipment shall be

functional and their status shall be regularly checked and recorded. Contractor shall provide evidence of compliance to these requirements in any contractual write-ups submitted to owner /Engineer for approval in respect of critical construction/ contract works.

Contractor shall provide only good quality hand-tools and ensure control of condition, storage, routine inspection and use of such hand-tools. Unsafe tools such as with cracked or broken handles, mushroomed chisels and punches, worn screwdrivers, hardened hammerheads; power tools with unsafe resistance to earth or without safety guards shall be prohibited.

All safety ladders and scaffolding and such access equipment shall meet requirements of IS 3696: and IS 4014:1967 and such standards Engineer/ Owner may stipulate. The safety work permits shall be issued only after ensuring that all safety requirements of access equipment are complied with. Access equipment shall be inspected on a routine basis to prevent injuries caused by falls.

A checklist shall be used for inspection and certification of hand tools, safety ladders, scaffolding and other equipment.

Scaffolds:

- Only MS tubes shall be used for scaffolding.
- Scaffolding shall be erected, altered and dismantled under supervision of authorized person and by person with adequate experience.
- No scaffold shall be left partly erected or dismantled unless adequate notices are displayed and access blocked.
- Scaffoldings shall be mounted only on hard foundations. Bricks, concrete blocks and odd, uneven timber scraps shall not be used for sole plates. Adjustable base plates shall be used in uneven surface.
- Bracing and Ties shall be done to ensure the stability of the scaffold. Bracing shall be done in both directions. Bracing shall be done on the outer face of the scaffold from base to the full height in diagonal manner or along each bay in Zigzag manner. Braces shall be connected to standards using swivel coupler or to the ends of transoms with right angle coupler.
- Scaffold shall be securely tied to the structure throughout their length and height to prevent movement of the scaffold either towards or away from the structure.
- A scaffold should be strong enough to bear the load of the worker and the material. Normally, scaffolds are erected in such a way that they can withstand at least four times the anticipated working load.
- Width of the working platform shall be of minimum width of 600 mm. Boards free from damages/ paint /oil shall be used. Thickness of the planks used shall be from 32-38 mm and width shall be 225-300 mm. Width of the platform shall be decided to suit type of work from 600 mm to 1.5 M Planks shall be decked closely as close as practicable, locked or secured on both ends to prevent tipping and displacement during normal use. Overhang at least 50 mm but not more than 4 times thickness of the board, unless secured from tipping.
- Provide a safe and convenient means to gain access to the working platform. Keep the platform free from any unnecessary obstruction, rubbish and projected nails.

- Guardrails must be provided on the exposed sides and ends of all working platforms more than 3 m in height. The guardrail may be fixed to the outside of the standard.
- A toe board or equivalent protection must be fitted on the outside edge of every working platform more than 3 m in height, if materials and tools are placed on the platform and are likely to be dislodged. Scaffold plank of 225 mm minimum width may be used as a toe board.
- To facilitate the movement of materials, guardrails and toe boards may be temporarily removed, but they must be replaced as soon as practicable. Scaffolds more than 2 m in height shall be provided with secured ladder fixed at top or bottom for access and it shall extend at least 1 meter above platform.
- Inspect the scaffolding thoroughly before allowing the worker on it. A separate log shall be maintained by the Safety Engineer regarding inspection details and date of next inspection. Proper colour tagging shall be provided for the incomplete and complete with inspection scaffoldings.
- No scaffold shall be kept in partly dismantled condition. If for any reason, the scaffolding is left in partly dismantled condition, a suitable warning sign shall be displayed on or near the scaffold.
- Scaffold location must not foul access ways, roads and doors. If fouling is unavoidable, warning boards shall be installed and the area cordoned off for traffic.

  Contractor shall ensure safety of all those concerned with lifting and those who may be affected by material hoisting, lifting and handling using various mechanical aids.

  All lifting equipment such as cranes, hoists, lifting shackles, hooks chains and links shall be designed as per appropriate International codes of construction and shall have valid test certificate from competent person. Operators shall have been trained in operation and maintenance of such equipment besides training on standard hand signals to be employed during the hoisting and lifting operations.

  - The lifting machines, chain pulley blocks etc. must be tested and valid test certificates should be submitted to the Project in charge.
  - Ensure that the chain pulley blocks with locking lever (safety catch) are used.
  - Check the wire rope for distortion, kinking, unevenness and general corrosion. Never use ropes, which are having these defects.
  - Proper crimping should be done for wire rope joints and ends. Use standard ‘U’ clamp for tying up the rope and object.
  - The safe working loads should be clearly marked on each of the above items. In no case, this rated capacity should be exceeded.
  - Never work or move below the suspended loads.

  Riding on construction equipment, forklifts and cranes shall be prohibited unless such vehicles are provided with passenger seats.

  Pressurised gas and air systems shall be maintained safe in good working order and shall meet the requirements of the Factories Act 1948, The Static and Mobile Pressure Vessels Rules 1984 and the Gas Cylinder Rules 1934 as applicable. The safety relief valves, safety appurtenances and isolation systems shall be

compliant with safety code of practices. Any statutory register of pressure vessel records and the code of practices shall be subject to periodic auditing by Owner and Engineer.

The areas of highly dangerous activities like hoisting & lifting, shall be appropriately barricaded to protect personnel and machinery and guided by work permit discipline. Emergency plans shall cater to emergencies arising out of such activities.

Signs, barricades, barrier tapes and warning or entry restriction devices or accessories shall be provided to minimise work related risks of accidents and injuries. Signage shall meet all regulatory requirements such as under The ` and other Construction Workers Act 1996, Factory Act 1948, Manufacture, Storage, Import of Hazardous Chemicals Rules under Environmental Protection Act 1986,Indian Explosives Act 1984 and Gas Cylinder Rules1981 and Indian Electricity Act 1910 and Rules thereof and any other safety requirements of Owner and Engineer.

Electrical equipment-Safety

Contractor shall provide only such equipment for work that is electrically safe to work. Contractor shall have a procedure to identify and record all his electrical equipment in a register, with provisions to record his periodic inspections of such equipment. Inspection shall cover cables, extension leads, all electrical equipment drawing power from socket outlet. He shall identify and maintain in good working order all electrical installations such as distribution panels and major switchgear ensuring safe accessibility. A clear area shall be maintained around Panels and switchgears. The installed equipment shall be periodically inspected by qualified personnel to ensure their continued safe operating condition. Inspection shall include earth polarity checks, continuity checks and earth resistance checks. Contractor shall ensure use of flameproof and explosion proof switchgears and lighting fittings where required as per governing codes.

Approved earth leakage relays or alternative safety devices conforming to relevant ARE /International codes shall be used on all portable electrical hand tools. Where possible low-voltage electric power supply shall be used for hand-tools. Earth leakage units shall protect electrical installations. Record of regular checks shall be maintained. Contractor shall comply with "Code of practice for earthing" as per IS 3043:1987

Safety rubber matting of appropriate voltage rating conforming to IS 15652:2006 shall be provided in front of all switchgears and power distribution panels for the safety of personnel operating such equipment.

Contractor shall arrange displaying signage under Indian Electricity Act 1910, such as:

- Danger notices as per IS 2551 in conspicuous places on all low, medium and High voltages as per Rule 35,
- Instruction of restoration of persons suffering from electric shock in English and local languages as per Rule 44 in switch gear rooms, substations and places where electricity is used and
- Notice prohibiting unauthorised entry in areas where electrical apparatus are used.

All power cables providing construction power to various construction machinery and the connectors shall be in safe and sound condition. Cables shall be routed through cable trays/ UPVC or DWC pipes supported on appropriately designed structures, duly clamped, secured and identified. Road crossing cables shall be laid in conduits buried atleast 750 mm below the surface to prevent damage due to vehicular traffic. All cables shall be off the floor to avoid damage or tripping hazard. Cables shall be terminated at the switchgears and sockets in a workman like manner to prevent loose contacts and flashover. Only safety receptacles shall be used for providing power connection to hand-tools. All switches and distribution boards shall be clearly marked. All electrical distribution and panel wiring diagrams shall be available with the electrical maintenance personnel. Contractor shall maintain a safe electrical isolation/lockout procedure.

Contractor shall ensure lighting circuits are not used for hand-tools. No electrical equipment shall be overloaded. Tools and test equipment used on electrical systems shall be insulated.

ELCB provided should be rated 30mA

All the electrical work should be carried out by persons holding valid electrical license / certificate.

No vehicle or construction equipment shall be parked and operated below / near HT and LT electrical lines.

Use portable grinders, drilling machines, etc. confirming to IS standards. All these tools should be properly insulated.

Never overload cables beyond the rated capacity. This is one of the common causes of fire.

Provide the rubber gloves to electricians who work in HT zone. Ensure that the gloves are tested as per IS 4770 :1968 and the same are approved.

Before commencing repair or maintenance work on any machine, switch off the main supply / remove fuse, display caution tags on machines and switchboards. Follow the standard lock out, tag out procedure.

All equipment should have earthing arrangements.

Do not insert bare wires in sockets for energizing any equipment. Use only plug tops for all electrical equipment.

While laying cables, ensure that cables are so laid that they do not obstruct the smooth movement of men and machinery.

Make sure that all cables are protected against abuses and possible damage.

Use junction / extension boxes for long distances. Open connections are not permitted.

Approved flameproof fittings shall be used in flameproof areas.

Arrange for sufficient lighting, incase work extension is required beyond normal working hours. Obtain necessary approvals for the same.

Check for any underground cables before starting excavation jobs.

No loose cable allowed to cross the Road. If cable is required to cross the road it should hang at certain elevation. No joints allowed without proper connections.

SAFETY IN HANDLING SOLAR PANELS

Read the installation guidelines completely before installing, operating and maintaining the Solar PV Panels.

Contact with any solar panel connected or disconnected to the system is dangerous as the solar cells shall start generating power when they are exposed to light, hence it is imperative that proper care should be taken while storing and handling such panels. Installation of such panels shall be carried out by only trained personnel. Access to unauthorised persons to these areas should be strictly restricted.

Adequate signage in this regards should be installed at the storage and installation site to make people aware of the hazards related to Solar Panels.

All exposed conducting parts shall be well insulated while storing and installing.

Housekeeping in the storage and installation areas should be strictly maintained to avoid accumulation of any combustible material in the surrounding which may lead to fire.

These areas shall be maintained dry. Care should be taken not to damage the panels by keeping/ dropping material on top of it.

Avoid artificially concentrated sunlight beam from falling on the stored panels.

Use proper care while lifting these panels to avoid damage.

HAZARDOUS SUBSTANCES CONTROL

Contractor shall prevent all injuries, illnesses and damage to property or the environment caused by any article or substance, which proves to be hazardous. The code of practices of construction and operation and maintenance and control procedures shall meet required statutory and regulatory requirements. Personnel shall be trained on use, handling, storage and disposal of and emergency spillage procedures.

Contractor shall detail and deploy Operational controls to reduce hazardous wastes and their disposal as required by the statute “Hazardous Waste (Management and handling) Rules 2008”. Oil wastes, used oils, soil and cotton soaked in oil consequent to handling operations, grease and many class of paints and asbestos sheets and gaskets are typical hazardous wastes.

Contractor shall identify, contain and control all sources of radiation. Appropriate regulatory approvals shall be obtained before commencement of work involving radiation sources. Radiation protection advisors suitably qualified and experienced shall be appointed whose names shall be submitted to owner/ engineer. Dosimetry and surveillance of personnel engaged in such work shall be maintained in accordance with regulatory requirements.

PERSONAL SAFEGUARDING

Personal protection equipment (ppe): General

Contractor shall provide his employees required PPE meeting the requirements of the stated IS Specifications and Guidelines or equivalent International Standards as may be prescribed by the Engineer from time to time. Contractor shall have instituted good working procedures and practices in providing PPE, maintenance, issue and training on their use. All PPE shall be periodically checked to ensure worn, damaged equipment are replaced expeditiously.

- Control of use of issue, use and maintenance of PPE - Employees shall be responsible for PPE issued to them. Contractor shall meet requirements of IS 8519: 1977 titled “Guide for selection of Industrial safety equipment for body protection” or any equivalent international Specification that the Engineer/Owner may prescribe.
- Head Protection - Contractor shall comply with requirements as per IS 2925. Hardhats shall be used and worn where a hazard of falling or flying objects exist. Hard hats intended for use by visitors shall have replaceable paper lining. Wearing of helmets inside the project site is compulsory. Colour coding of helmets may be followed for different category of personnel working at the site / visitors.
- Eye and face protection - Eye protection shall be worn during all operations by operators and people in the vicinity, where there is a danger of flying particles of metal such as generated during use of hand tools such as chisels, grinding, welding and cutting lathe work on brass and cast iron, acid and alkali splash, and high pressure jet cleaning or insulation removal from heights using high pressure jets. Contractor shall meet the requirements of IS 8520 titled “Guide for selection of Industrial safety equipment for eye, face and ear protection”.
- footwear - Safety shoes, boots and gumboots fitted with steel toe-caps of approved quality conforming to prescribed Indian or international standards. Wearing of unsafe safety shoes such as jogging shoes, tennis shoes, slippers and sandal etc. are prohibited. Contractor shall meet the requirements of IS 10667:1983 titled “Guide for selection of Industrial safety equipment for protection of foot and leg”.
- Protective clothing - Contractor shall prevent hazards of loose clothes worn by workmen getting caught in moving machine parts. Loose and thin garments such as Dhoti and pyjamas shall be prohibited. While Contractors shall ensure that all workmen wear long sleeved shirts, jackets or the like with the sleeves rolled down and secured at the cuff, long pants/ trousers extending upto the top of the safety shoes so as to prevent injuries caused by contact with heat, cold abrasive and sharp surfaces shall be strictly enforced. Contractor shall meet the requirements of IS 8990:1978 titled “Maintenance and care of industrial safety clothing.” Women wearing saree and other loose dress should wear outer jacket / shirt. It is suggested to wear reflective jackets for better visibility.
- Hand Protection - Contractor shall provide appropriate hand gloves as per IS 8807:1978 titled: “Safety equipment for protection of arms and hands” to prevent injuries to hands during work. Contactor shall maintain appropriate inventory of gloves for different applications like Acid/ alkali handling, general-purpose work gloves and asbestos or heat resistant Hand gloves etc.
- Safety harness/ fall arrest - Contractor shall provide safety harness or means of restraint such as safety Belts, harness and lifelines etc to workmen engaged to work in heights such as Open –sided Floors, Open-sided scaffoldings, floor and roof openings, overhead construction works of various nature etc where there is a falling hazard of six feet or above. To prevent any fall from a height of 2 Metres or above. Storage, issue wearing and maintenance of safety harness shall be under strict supervision and records shall be maintained. Safety belts should be tested and certified by competent person. All fall arrests shall consist of full-body harnesses, lanyards with shock absorbers, lifelines, rope grabs and associated hardware. Two alternate

lanyards shall be used to facilitate tying off at a new location before disconnecting from the previous location's of practices for safety harnesses and fall arrests shall conform to IS 4912:1978, IS 11972:1987, IS 8519:1977 or equivalent international codes.

- Falling object protection - Where work is in progress in elevated areas, barricades, barrier tapes signs and such entry restriction devices shall be used to keep area below clear of personnel to prevent injury due to falling objects. If work is required in the area below elevated work area, it shall be scheduled at a time different from elevated works. The workmen below shall be protected from falling objects by the debris net or a catch platform with an adequate toe board to prevent material from falling off. Use of safety net for elevated works shall be considered in the work-permits where appropriate. Where a lift is made above a working area, the area below the path of the lift shall be cleared of personnel during the lift and barricaded and guarded to prevent entry o persons generally in conformity with IS 4912, IS 11972 and IS 13416 "for protective barriers in and around structure and preventive measures against safety hazards in work places and safety requirements for floor and, wall opening, railings and toe-boards." Hard barricading shall be provided for excavation more than 2 meter deep.
- Hearing conservation - Contractor shall ensure reasonable precautions are taken to avoid injury to the hearing of the employee. All noise levels shall be controlled within 90 dBA. Contractor shall identify noise areas where noise levels exceed prescribed safe level for arranging for appropriate Engineering revision. Where this is not feasible, appropriate Earmuffs or protectors shall be provided to workmen ensuring they are worn by those exposed to noise levels beyond safe levels. Periodic hearing acuity tests shall be conducted on such persons exposed to high noise levels to ensure that they do not suffer any hearing impairment` as per requirements of IS 8520: 1977

Manual handling: & ergonomics

Contractor shall have procedures to identify risks involved in manual handling operation and tasks. He shall ensure appropriate training to prevent any possible injury. Full use of mechanical aids shall be made to avoid risks arising out of such manual handling. Employees shall be adequately trained on such manual tasks and related safety precautions to reduce the risk of injury to personnel engaged in such work.

Contractor shall undertake ergonomic study of manual operations to prevent musculoskeletal injury during manual handling, besides visual fatigue and mental stress giving considerations to matters such as seating. Lighting and ventilation etc. Person should not lift / carry more than 50 Kg load.

PREMISES AND HOUSE –KEEPING

Contractor shall maintain a well-managed safe working place in sound clean condition. Contractor shall ensure that there is a place for everything and everything in its place so that optimum use is made of valuable floor space with commensurate cleanliness and reduced handling time. He shall ensure that his entire infrastructure is kept clean and good repair.

All temporary constructions like rest sheds, storage sheds etc shall be constructed using MS pipes and GI sheets only. The temporary sheds shall have substantial strength to withstand local site weather conditions.

Contractor shall provide lighting, natural or artificial, to enable carry out work processes safely. Artificial lighting shall be adequate especially in the nights and emergencies. The lumen levels shall meet the statutory requirements.

Movement of Equipment and machinery

Before starting the activity, plan properly by examining the route, taking measurements, if needed, to ensure that sufficient clearances are available.

While planning the route, look for overhead cables, pipelines, guide ropes and other protruding objects.

Use properly rated trolley to move the equipment / machinery.

Ensure no damage to the walls, or other surrounding machinery during movement. Make clear to all the fellow contract men about communication system, to avoid misunderstanding.

If you are moving smaller items like pipelines etc. ensure that these items are properly secured and tied.

Proper sling arrangement to provided for crane in case of lifting equipment to a elevated height. No person is allowed to lift with equipment.

Stacking and storage practice

Contractor shall ensure stacked material is bonded on a stable and level footing capable of carrying the mass of the stack. Adequate clearances shall be provided between the sides of the stack and top to facilitate unimpeded access to service equipment like overhead wiring, cranes, forklifts and firefighting equipment, and hoses. Circular items shall be sufficiently choked with wedges not with odd bits of materials. Free-standing stacks of gunny bags and sacks such as Cement bags shall be stacked to prescribed safe-stack heights with layers formed for stable bonding, preventing slippage causing accidents. Stacking against walls shall not be permissible.

Contractor shall maintain the premises and surrounding areas in clean and clear manner with safe access and egress. There shall be sufficient and adequate storage racks, shelving, bins and pallets and material handling equipment to stack his construction materials such as Pipes, structural and his construction enabling materials. Unwanted materials shall be promptly moved away for efficient material movement.

Scrap and Refuse Bins-Removal System

Contractor shall ensure that he has sufficient waste bins that are identified for different wastes and maintained in clearly demarcated areas. Wastes with oily or other ignitable materials such as Oily cotton wastes and Hand gloves shall be stored separately with covers to prevent fires and shall be made of metal. Different Wastes shall be segregated and stored separately and disposed off. They shall be emptied at routine intervals to prevent that they do not overflow with wastes.

Emergency Planning / Emergency Response

Contractor shall plan to deal with on site emergencies. An emergency planning/emergency response specific to the job site shall be written and communicated to all employees. The emergency planning/emergency response shall identify for the potential for and responses to incidents and emergency

situations and for preventing and mitigating the likely illness and injury that may be associated with them.

17. DIESEL GENERATOR SETS

SCOPE

The scope of this section consists of but not necessarily limited to the following in accordance to Technical specification prescribed in tender. The contractor shall supply, deliver to site, hoisting into position, install, test and commission the Prime rated power generating set together with the necessary controls and switchboards as specified and indicated in the Drawings.

Protection circuits, control wiring and interlock circuits not specified or indicated in the Drawings, but deemed necessary for the safe operation of the generating system shall be provided without any additional cost to complete the system. Provide manufacturer's factory representative's services, including coordination, and start-up and testing supervision.

Testing (factory and field), start-up supervision, training and providing necessary documentation and tools for operation. Carry out performance test run at site with Load bank & Lube oil etc. arranged by contractor.

CODES AND STANDARDS

The design, material, construction, manufacture, inspection, testing and performance of equipment shall comply with all currently applicable standards, codes of practice, regulations, and safety codes in the locality where the equipment will be supplied & installed. Nothing in this specification shall be construed to relieve the CONTRACTOR of this responsibility.

The codes and standards mentioned in the various specifications and requirements specified in the enquiry document shall be latest as on the day of award of contract of the works unless otherwise specified. Contractor shall be responsible to inform to the Consultant/ Owner in case of any revisions/re-affirm/amendment in the relevant codes and standards after the date of award of contract within 30 days of the issue of such revision/re-affirm/amendment of the code/ standard. Consultant/ Owner may approve use of the earlier code/ standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed.
The VENDOR shall ensure that instruments and gauges to be used for testing and inspection shall have valid calibration and the accuracy can be traced to National and International Standards as applicable.

DIESEL ENGINE

Diesel Engine shall be of proven design, multi-cylinder direct injection; turbo charged compression ignition type, operating at a speed of 1500 rpm and shall be silent, vibration free while in operation and comply to latest Centre/State Pollution Control Board & local authority norms and shall conform to ISO 3046,8528-1 / BS 649,5514. The fuel grade shall be high speed diesel.

The engine shall be complete with radiator cooled (coolant) type engine, fan, lubricating oil pump, lubrication oil pressure gauge (microprocessor built-in display), tachometer, digital or electronic type governor, integrated hours-run recorder, over-speed trip and all other necessary auxiliaries.

The engine speed shall be regulated through an electronic governing system

which shall also provide the over speed protection. The governor shall ensure that the speed of the set is regulated within 1% of the nominal speed under normal operating conditions.

The brake horsepower of the engine with all attached accessories as specified shall not be less than that which is required by the full load rating of the alternator at site operating conditions taking into consideration losses, plus a reserve factor of at least 10%.

The engine shall be suitable for Prime power application and should be capable to run on 10% overload for 1 hour duration in every 12 hours of operation as per ISO regulations.

Lube Oil System

Lube oil system shall be complete in all respects but not limited to the following:

Engine Mounted Lube Oil Sump.

Engine operated lube oil pump.

Plate/ Shell and tube type water cooled lube oil cooler.

Full flow paper cartridge type oil filters.

All necessary piping, valves, specialities, instrumentation and supports

First fill of lube oil and all other lubricants, greases and consumables.

Unless otherwise specified in Data sheet- A, thermostatically controlled electric heaters for lube oil shall be provided, if ambient conditions warrant the same.

Engine Cooling System

The Engine shall be provided with Radiator for cooling the engine as well as the body and the cooling system shall be complete, but not limited to the following:

Radiator with engine driven fan

Engine driven circulating pump

Expansion tank

Anti corrosion cartridge

All necessary piping, valves, specialities, instrumentation and supports.

Thermostatically controlled jacket water pre-heater, if required.

DG Starting System

Starting of the DG shall be automatic and manual.

Electric starting system, the same shall be complete, but not limited to the following:

- Starter motor
- Maintenance free batteries, with capacity suitable for minimum three (3)

continuous Cold starts

- Engine driven Battery charger

Air Intake System

The Air Intake System shall be complete, but not limited to the following:

Engine mounted Air intake filter and silencer.

All necessary piping including, specialities like bends, flanges, expansion joints, etc.; and supports.

Air Exhaust System

The Air Exhaust System shall be complete, but not limited to the following:

Residential type Exhaust gas Silencer.

All necessary piping from Diesel Engine up to Exhaust gas silencer including, specialities like bends, flanges, expansion joints and insulation.

Exhaust Stack and Exhaust Piping

Exhaust stack, if specified in data sheet A, shall be self-supported and designed as per IS 6533. The stack shall be complete with all accessories and insulated up to a height of two (2) meters from ground level.

The exhaust piping shall be fabricated from 6mm thick MS pipes.

Stack height shall be maximum of the following, in meter:

1. $14\ Q^{0.3}$, Q= Total SO_2 emission from the plant in kg/hr.
2. Minimum 6 m. above the building where generator set is installed.
3. 30 m.

Fuel Oil System

Fuel oil system external to engine shall be complete in all respects but not limited to the following:

Day tank with secondary containment trays and structural supports

One number of SS wire braided Flexible Hose.

All piping, valves, specialities, instrumentation and supports between day tank and engine.

Day oil storage tank shall be fabricated from 4 mm thick MS plates.

The day tank, as minimum, shall have following accessories:

Inlet connection with filter and flange

Inlet connection for return from fuel pump

Outlet connection with valve

Drain connection with valve

Overflow connection with flange

Vent connection with flame arrestor.

Manhole for cleaning

Level gauge with isolation valves

Two (2) numbers of level switches with two independent switch contacts each, for 'High' and 'Low' oil Level.

All pipes shall be of carbon steel pipes: ASTM A 106 Gr. B as per ASME B 36.10.

All valves shall be of ASTM A 216 Gr. WCB, 150 CL., RF and fire safe AF 51/52.

The piping shall be painted with one coat of primer and two coats of finishing paint of approved colour.

GENERATOR

GENERAL

The line and neutral ends of each phase winding of the generator shall be brought out on six (6) suitably located terminals.

If the termination will be through cables, the size of the conductor cables, to be provided by the PURCHASER, will be furnished during detailed engineering. Suitable clamping arrangement shall be provided for connecting the cables to the machine terminals. The terminals shall be suitably enclosed to prevent short circuits by rodents etc. Suitable cable glands shall be provided on the enclosure to facilitate entry of the cables.

If the termination will be through Busduct, the terminal arrangement shall be provided suitable for busduct and the necessary details shall be furnished during detailed engineering.

The connection between the generator phase side terminal box and the breaker isolation panel to be provided by the Bidder shall be through Non segregated phase bus duct which also will be in Bidders scope.

240 V single phase space anti-condensation heaters of adequate ratings shall be provided in the lower part of the stator frame.

The generator shall be provided with two (2) grounding terminals with clamps suitable for connection to the PURCHASER'S grounding grid.

The generator shall be provided with winding and bearing RTDs, if specified in data sheet A.

EXCITATION SYSTEM

The excitation system shall be as specified in data sheet A.

The response ratio of the excitation system shall not be less than 0.50.

The excitation system shall be so designed and/or protected, that harmful over-voltage cannot occur at the main exciter commutator due to combined effect of maximum exciter field current and machine over-speed.

VOLTAGE REGULATOR

The generator shall be capable for operating over a range of ± 5% of the rated voltage, unless specified otherwise in data sheet A.

The voltage regulator shall be supplied complete with cross-current compensation preferably of the static type. The regulator shall be supplied complete with voltage setting device, all accessories and alarm contacts.

CONTROL SYSTEM

Auto mains Failure (AMF) feature shall be provided by the vendor.

The DG shall be normally at rest when the AC supply is available from normal power source. In case of normal AC supply failure, the DG shall be started as follows:

For Automatic Main Failure (AMF), an impulse from under voltage relay shall automatically initiate the DG starting sequence. After attaining the rated speed and voltage the isolation breaker shall be closed automatically through AMF. Also necessary potential free contacts (4 NO+ 4 NC) shall be provided by Vendor in AMF panel for Purchasers use to close the incoming breaker at receiving end Panel. Provision for starting the DG through remote push button through auto/manual, local/remote selector switches initiating the same starting sequence shall also be made.

For AMF start, minimum three (3) attempt starting facility shall be provided and in case the DG fails to start and reach rated speed within 30 seconds, it shall be disconnected and locked out automatically. For battery started sets this aspect shall govern the battery Ampere Hour rating.

Unless specified otherwise in data sheet A, stopping of the DG for a normal shut-down shall be done manually by means of push button either locally or remote.

Engine and alternator control panel with protective, monitoring and control devices, annunciation, interlocks, indicating lamps etc. shall be provided.

GOVERNING SYSTEM

The governor characteristics shall comply with the requirements of class of ISO 3046, unless specified otherwise in data sheet A.

The governor shall be provided with an electrically operated speeder gear for remote adjustment of generator frequency, suitable for operation on DC voltage, if indicated in data sheet A.

The governor shall be capable of responding to a step change of load either switch-in and/or throw-off as specified in data sheet A such that all operating parameters are within limits.

CONTROL, PROTECTION AND METERING

Microprocessor based control panel for DG set shall have protection, meters and alarm annunciation windows. DG control panel shall have minimum following control facility :

Local/Remote : Auto/ manual / test/off

Speed : raise/ lower

Voltage : raise/ lower

AVR reference voltage setting

Trip/ close

Emergency STOP

The DG set shall have manual control on following operations and facilities when the Auto/ Manual switch on the DG Panel is in Manual mode :

DG Start/stop

Speed raise / lower

Voltage raise / lower

Close the DG Isolation breaker

When the Auto/ Manual switch on the DG Panel is in Auto mode, following operations shall be done automatically without any operator intervention:

DG Start/Stop

Speed raise / lower

Voltage raise / lower

Close the DG breaker

Load DG set

Interlocking Arrangement

Necessary interlocking arrangement shall be made with Purchaser's breaker; however, the same shall be subject to the purchaser's approval.

Annunciators

Window type annunciators shall be supplied and mounted on each DG control panel to give visual and audible indication for the following conditions. The annunciation list shall be subject to approval of the PURCHASER.

Isolation Circuit Breakers

Type:

Circuit Breakers shall be of the air break, fully draw out type. Circuit breakers shall comprise three separate identical single pole units operated through a common insulated shaft by the operating mechanism.

Circuit breaker along with its operating mechanism shall be mounted on a wheeled carriage moving on guides, designed to align correctly and allow easy movement. Plugs and sockets for power circuits shall be silver faced and shall be insulated with suitable insulating material shrouds.

Each breaker shall be provided with auxiliary contacts of 4NO + 4NC directly

operated from breaker operating mechanism. These contacts shall be in addition to those used in circuit breaker internal wiring. These contacts shall be rated for 10A at 240V AC and 5A (inductive breaking) at 110V DC. If more breaker auxiliary contacts are required, latched type relays shall be used to multiply the contacts. All these contacts shall be wired to terminal box for Purchaser's use.

There shall be 'Service', 'Test' 'Fully withdrawn' positions for the breakers. In the 'Test' position the circuit breaker shall be capable of being tested for operation without energising the power circuits, i.e. the control circuits shall remain undisturbed while the power contacts shall remain disconnected. Separate limit switches, each having a minimum of 2 'NO' + 2 'NC' contacts shall be provided for both 'Service' and 'Test' positions of the circuit breakers for Purchaser's use. These contacts shall be rated for 10 amps, 240 V AC and 5 amps (inductive breaking) at 110V DC.

The circuit breakers shall be provided with the following:

Mechanically operated targets to show 'Open', 'Closed', 'Service' and 'Test' positions of the circuit breakers.

Mechanically operated, red 'trip' push button, shrouded to prevent accidental operation.

'Red', 'green' and 'amber' indicating lamps to show 'Closed' 'Open', and 'Auto-trip' conditions of the circuit breaker.

Closing and trip coil shall operate satisfactorily under the following conditions of supply voltage variation :

Closing coils - 85% to 110% of rated voltage, 110V DC

Trip coils - 70% to 110% of rated voltage, 110V DC

Circuit breakers shall be provided with facilities for remote closing and opening operations.

Power operating mechanism shall be provided with following additional features :

Closing of the circuit breaker shall automatically initiate recharging of the spring ready for the next closing stroke.

The motor shall be mechanically decoupled as soon as the emergency manual charging handle is inserted.

Mechanism shall be such that failure of any auxiliary spring shall not prevent tripping and will not cause tripping or closing operation of the power operated closing devices. When the circuit breaker is already closed, failure of any auxiliary spring shall not cause damage to the circuit breaker or endanger the operator.

Breaker operation shall be independent of the motor, which shall be used solely for charging the closing spring.

Motors shall be rated for 240 V AC tapped from input side of DG breaker and shall operate satisfactorily at all values of voltage between 85% to 110% of rated

voltage. Motor shall be protected against overloads and stalling.

MCCB

For all MCCBs, Ics shall be selected as 100% of Icu.

All protective components especially MCCBs shall be with Utilisation Category "B" (i.e. offering time discrimination with downstream devices).

MCCBs shall be of current limiting type. Operating mechanism shall be quick-make, quick-break and trip-free type.

The instantaneous short circuit release of MCCB shall be so chosen by the VENDOR as to operate at a current in excess of the peak motor inrush current and a range of settings shall be provided for the PURCHASER'S selection.

MCCB terminals shall be shrouded and designed to receive cable lugs for cable sizes relevant to circuit ratings.

Protection tripping of MCCB shall be identified with Trip/Alarm contact.

The ON, OFF and TRIP positions of the MCCB shall be clearly indicated and visible to the operator and one contact of each shall be brought out for PURCHASER’s use.

LOCAL PUSH BUTTON STATION

The Local Push Button Station shall be furnished in sheet steel or cast Aluminium enclosure (minimum 2.0 mm thick) of weatherproof gasketed construction with dust and vermin proof suitable for outdoor use without canopy conforming to IPW-55 or better.

The enclosures shall be suitable for mounting on column/wall and complete with push button, anodized aluminium inspection plate, earthing terminal and knockout for cable/conduit entry from top and bottom. The thickness of enclosure sheet shall be 14 SWG.

The push button station shall be provided with separate terminal blocks so that outgoing cabling shall be terminated in these terminals and not directly to the push button terminals. Push button station shall be provided with removable gland plate along with double compression type glands.

The open/close/start push buttons shall be of momentary contact push to actuate type and stop push buttons shall be stay put type with mushroom knob. The stop push button shall be of lockable type in 'OFF' position.

All push buttons shall be fitted with two (2) normally open and two (2) normally closed contacts rated for 415V, 10A.

PERFORMANCE GUARANTEES

The DG and accessories shall be so designed as to meet the following performance requirements:

The DG shall be capable of starting from cold condition, reaching synchronous speed and taking up load within the period specified from the ‘start’ impulse and

shall be capable of delivering continuously at the generator terminals a net output specified, with invisible exhaust.

With the DG running at no-load, rated voltage and speed, the transient voltage drop at its terminals shall not exceed specified percentage of rated voltage, on starting a specified capacity induction motor direct-on-line or star-delta as specified in data sheet A. Governor response, over-speed trip and speeder gear capability, voltage regulator response, excitation at full load and under specified variation of voltage and speed shall be guaranteed.

Performance parameters to be guaranteed by the CONTRACTOR and tolerances permitted shall be as indicated in Data sheet A. The BIDDER shall confirm acceptance of these by indicating values in Data sheet A. DG set or any portion thereof is liable for rejection, if it fails to give any of the guaranteed performance parameters.

DATA TO BE FURNISHED BY THE CONTRACTOR AFTER THE AWARD OF CONTRACT

List of drawings and documents to be submitted for review, approval and information with scheduled submission dates.

Quality Assurance Plan (QAP)

Detailed P&I diagram clearly showing the scope of supply of equipment, piping with line sizes and material specifications, valves, specialities, instrumentation, and control and all the accessories. All equipment, lines, valves, specialities, and instruments shall be tagged as per the PURCHASER's procedure to be given to the successful BIDDER. All terminal points shall be clearly identified. All design data and other information furnished in data sheets A shall be covered either in this drawing or other relevant drawings or documents mentioned below.

Detailed equipment list and bill of materials of all items in the CONTRACTOR's scope

Sub-vendor list for all bought-out items

Dimensioned to-scale equipment layout drawing showing all equipment, accessories, relevant external dimensions, location and elevation of terminal points, details of piping, ducting and electrical connections to be made by the PURCHASER, clearances required for erection, dismantling, operation and maintenance

Dimensioned cross-section drawings of proprietary equipment like pumps,etc. with part list and materials of construction

Manufacturer's outline drawings, data sheets and performance curves for pumps and compressors etc.

DG, fuel oil system, lube oil system, engine cooling system, air intake and exhaust system, governing system and instrumentation and control system write-up

Detailed fabrication drawings for all fabricated equipment like tanks along with complete mechanical design calculations

Line designation schedule for all lines in the CONTRACTOR's scope

List of valves, specialities and instruments in the CONTRACTOR's scope with tag numbers, type, makes, pressure ratings, materials of construction and ranges for instruments etc.

Manufacturer's drawings, data sheets and catalogues for valves, specialities and instruments etc.

Dimensioned to-scale piping layout drawing for piping in the CONTRACTOR's scope with allowable forces and moments on the piping nozzles and displacement of the nozzles

Overall foundation plan, base frame drawing for each equipment, static and dynamic loads on each of the anchor bolts and dimensional details of pockets and anchor bolts

Electrical control wiring diagrams with all interlocks

Control philosophy, interlock description and logic diagrams

Dimensional to-scale general arrangement and section drawings of DG control panel & Protection with complete bill of materials

List of alarms and trip settings

Wiring diagram of various sensing devices mounted on engine, air receiver etc., generator control panel, switch-gear panel, automatic voltage regulator, governor and excitation system

Control schematic for synchronising scheme for generators in parallel with themselves as well as with grid, whenever applicable

Cable schedule for interconnecting cabling between DG set and control panel

Generator parameters

Erection, start-up, operation, and maintenance manual complete with lubrication schedule etc.

TESTING:

Inspection and testing shall be carried out based on latest revision of this specification and approved vendor drawing certified for construction. Purchaser shall have right to carry out stage inspection and shop visit to review the manufacturing progress.

However, manufacturer need not hold any manufacturing activity for witness of purchaser/consultant's stage inspection. All routine and type tests shall be carried out during final inspection.

A. Factory Tests: The Factory tests shall incorporate the following: ¬

Routine Tests of alternator and Engine at respective manufacturer's works. ¬

Load Test of the complete DG set with control panel at UPF at 100% load about 4Hrs. (FAT) and 1 Hrs. (FAT) on 110% load. Total 2 Hrs. FAT.

Fuel consumption tests by using flow meters. (Fuel costs shall be included)

These tests shall be conducted, and the original test certificates shall be furnished.

Copies of type test certificates conducted on similar type of D.G. set shall also be submitted.

1. DG set starting time

2. Fuel consumption test

SITE Tests: After the erection and wiring and earthing of D.G. Set the tests as stipulated by the manufacturers shall be conducted.

a) Insulation resistance of the generator.

b) Speed, no-load voltage and full load voltage regulation.

c) Load Test of the complete DG set with control panel at 100% load 8 Hrs. (SAT) and 1 Hrs. (SAT) on 110% load. Total 9Hrs. SAT.

d) Fuel consumption tests by using flow meters.

e) Sequence checking, interlocks checking, measurement of starting time, loading of generator etc. shall be carried out by the vendor.

f) Vendor shall supply first fill of lubrication oil & fuel oil.

g) Statutory clearance: VENDOR shall be responsible to obtain following clearances:-

- Electrical Inspector (CEA) clearance
- Supply authorities (State Electricity Board) clearance
- State Pollution Control Board clearance.

h) Testing of Controls: All the safety controls and protective device of the D.G. set shall be tested for correct calibration and operation. The results of the tests shall be tabulated and submitted in triplicate.

The reading shall be observed with calibrated meters. Only one meter shall be used for the test. The readings shall be properly tabulated and submitted in triplicate.

The BIDDER, at no extra cost, shall provide all instruments, load banks, consumables (likeÐube oil, HSD, Filters etc) and accessories required for testing and commissioning of the items specified for the required duration of test.

ACOUSTIC TREATMENT FOR DIESEL GENERATING SETS/ ROOMS

SCOPE

The scope of work covers providing Acoustic Enclosure to reduce the noise from Diesel Generating Sets as required in the schedule of work.

DESIGN CRITERIA

The design criteria shall be that the insertion loss across the enclosure/ room acoustic lining shall not be less than 25dB as per CPCB while the Average sound pressure level at 1m from any part of the enclosure shall be not more than 75dB as per CPCB. The enclosure shall provide for an air intake, engine exhaust outlet, cable, and fuel pipe entries. A control & monitoring panel shall be accessible from outside with toughened glass cover. An emergency trip device shall be provided in the control panel.

The enclosure should also accommodate a breaker panel appropriate for the set capacity. Access door shall be suitably gasketed so that the opening does not degrade the integrity of the acoustic enclosure.In the case of sets larger than 1000 KVA, the DG room should be acoustically insulated meeting the above noise criteria.

ACOUSTIC INSULATION

Wall & Ceiling Acoustic

Walls and ceilings shall be acoustically insulated wherever shown on drawings or as required by the Engineer-in-charge. The wall/ceiling surface shall be cleaned and a grid work of 600 x 600 to max 1000 x 1000 shall be made using 50 x 50 x 0.8 G.I pressed steel forms. 50mm rock wool covered with tissue cloth shall be cut to size and positioned within the grid work and held with 1.0 mm galvanised steel wire at 300 mm intervals. Entire insulation shall be covered with 0.8 mm thick aluminium sheets having 3 mm perforations at 5 mm staggered centres.

The sheet shall be neatly cut and the edges reinforced with a 20 mm sheet fold and made into neat looking panels. The panels shall be fixed on the frame work using cheese headed No. 8-20 mm sheet metal CP brass screws at 300 Mm centres. Where the insulation thickness is 100 mm the channels shall be 50 x 100 and th remaining work shall be as specified above.

The materials for acoustic insulation shall be as follows:

Application	Material	Sound Absorption Coefficient at Octave Mid band frequency HZ				
		250	500	1000	2000	4000
Walls & Ceiling 64 Kg/Cum 50 mm thick	Rock Wool	0.76	1.04	0.75	1.15	0.83

Ambient Air is drawn through louvers and drawn over alternator and engine(to pick up radiant heat) by means of Radiator Fan mounted on the DG Engine and exhausted outside through louvers. Also, the radiator fan shall be selected considering the air flow rate required to maintain the temperature and also the static pressure drop across louvers, sound attenuators, exhaust duct etc.

The sound attenuators to be provided on the fresh air intake and exhaust louver openings of the DG Room. DG room ventilation shall be provided by the vendor. These fans shall be selected to maintain minimum room ventilation of 2 air changes/hour or to take care of the heat radiated to the heat radiated to the room. This fan shall continue for certain period of time even after the DG set is switched off. Necessary interlocks for the same to be built in the panel. Multiple fans to be selected to meet the cumulative capacity. Fan selection calculation shall be furnished by the vendor along with equipment datasheets. The system shall be designed such that the room temperature inside DG room shall not exceed 5 Deg C above ambient dry bulb temperature. The feeder for this shall be provided from the proposed DG distribution board.

The fans are provided with attenuators. It is required that the pipe, duct opening has to be thoroughly sealed. The double doors of the DG room are also to be acoustically treated and fire rated for one hour. The fresh air opening/exhaust fan attenuator shall be provided with aluminium, powder coated louvers to prevent water entry into the same.Vendor shall furnish all information required for the DG room civil construction. These details shall include foundation details, necessary opening required for louvers and fans, supporting details of chimney, pipes etc.

RECD'S (RETROFIT EMISSION CONTROL DEVICE)

Manufacturer shall provide appropriate Retrofit Emission Control Device (RECD) to meet latest emission norms stipulated in Central / State / Local pollution control boards. In case of multiple emission norms are available from boards, stringent among the latest to be followed. The Retrofit Device shall be designed based on the filter-less technology by utilizing Electrostatic Precipitation principle.

RECD shall be capable of removal of suspended particles such as dust and acid mists etc. from flue gas by charging the particles and precipitating them by applying a strong electric field. RECD working shall be generally in accordance with following working principle: The device will be installed in the line of DG

exhaust pipe. While flue gas pass through the electrostatic field created within RECD.
Surface of particulate matter acquires electrical charge and it get attracted to electrodes of opposite charge.
The PM gets agglomerated and the size of the PM increases beyond PM10 (10 microns).
The agglomerated PM is collected in powder form and is available for environmentally safe disposal/reuse.

Vendor shall furnish Performance Test Certificate from an authorized test lab approved by CPCB.RECD shall be designed, constructed and capable of being mounted on open terrace so as to enable the application to comply with the rules set out by CPCB/NGT throughout the normal life of the RECD under normal conditions of use. A RECD shall be durable and shall be designed, constructed and capable of being mounted on open terrace so that reasonable resistance is obtained to phenomena such as the corrosion, oxidation, vibration and mechanical stress to which it will be exposed under normal conditions of use.

Devices that by-pass or reduce the efficiency of the RECD are not permitted and shall be considered defeat device or strategy. RECD shall be fitted with an on-board diagnostics and operator warning system that signals to the operator/control room the presence of a failure affecting the efficiency of the RECD. A particulate reduction RECD shall be equipped with a monitoring device that detects incorrect operation or removal of the RECD and that triggers an audible and/or visual alarm to the operator. The warning system can be based for example, on the continuous measurement of the engine exhaust backpressure.

The RECD shall be fitted with particulate control diagnostics with ability to diagnose and trigger operator warning system when confirmed fault/s is detected as per stated requirements below.

- complete loss of particulate capture function.
- Removal of the RECD system
- Failure of the RECD system.
- detection of exhaust bypass, temporary or permanently as part of a field/operator tampering or as a design architectural requirement.

The RECD shall be demonstrate all the above particulate diagnostics conditions during commissioning process. Particulate diagnostics system shall register self-healing and non-erasable fault codes in its on-board memory or any capable alternative such as but not limited to connected cloud-based storage along with a time counter to track fault code active period. Such fault code active period shall be utilized for operator inducement.

Operator warning system through audible shall activate once confirmed fault code is registered. intensity of the audible warning system shall be at 100 dB sound pressure measured at 1 meter level at least at the location external to RECD where audible alarm device is mounted. It is also recommended to have visual warning in the form of ‘flashing RED light’ on the RECD control panel if such control panel provision is made.

RECDs installed with provision of audible and visual operator warning system both, can provide audible warning temporary ‘snooze’ function with snooze timer

not more than 12 hrs. duration. The RECD shall be fitted with operator inducement system that will disable genset operation.The RECD manufacturer shall furnish written instructions about the RECD system and its correct operation to be provided to all operators /control room of DG sets. These instructions shall state that if the RECD system is not functioning correctly, the operators /control room will be informed of a problem by the operator warning system and that activation of the operator inducement system as a consequence of ignoring this warning will result in DG set being unable to re-start.

The instructions shall indicate requirements for the proper use and maintenance of the RECD in order to maintain its emissions performance. RECD shall meet the particulate matter emission reduction limit values 70% as specified in latest order of CPCB/NGT/PCB. The reduction means before and after of RECD which needs to be proved with approved lab test report.

The reduction level of a RECD system is characterised by means of its reduction efficiency as specified. The reduction efficiency shall be determined by comparison of the emissions measured over the weighted specified test cycle for RECDs to be applied to DG set engines. The reduction efficiency shall be calculated from the measured emissions of the relevant pollutant downstream of the RECD (EREC) and the engine system emissions measured before fitment of the RECD (EBase) for that pollutant, both measured in accordance with the procedures defined in this CPCB/NGT Regulation. If two particle measurement systems are used in parallel for measurement of the particle reduction efficiency, they shall give measurements within 5 per cent of each other when measuring simultaneously from the same sample point.

Reduction efficiency (percent) = (1 - (EREC ÷ EBase)) × 100. NO2 emissions requirements
There shall be no increase in NO2 emissions above the NO2 baseline emissions.
Secondary emissions requirements

The RECD system shall provide documentary evidence to show that materials and processes used in the RECD do not present any additional hazard to health and the environment. The RECD shall not increase secondary emissions to concentrations known to be hazardous to health.

The RECD shall be so designed that it can be used in its intended applications, when fitted in accordance with the supplied instructions, without exposing operators or bystanders to any safety hazard either directly or as result of modifications to the DG set or its operating characteristics.

The RECD shall be so designed that it can be used in its intended applications, when fitted in accordance with the supplied instructions, without impairment of the operating behaviour of the DG set unless,

- The impairment does not cause a safety hazard.
- The impairment does not increase the fuel consumption.
- The RECD shall not lead to an increase of the DG set’s noise emissions.

The RECD shall demonstrate to the Approval Authority. Any change instructed by approval authority shall be carryout by DG vendor without any additional cost

RECD shall have good provision for a porthole/suitable arrangement just after tail pipe for emission monitoring at a later stage.

Method for measuring Smoke.

Method of smoke measurement shall be as per the guideline given in the applicable ISO- 8178-3: Reciprocating internal combustion engines — Exhaust emission measurement — Part 3: Test procedure for measurement of exhaust gas smoke emissions from compression ignition engines using a filter type smoke meter.
Method of smoke measurement shall be the guideline given in the ISO 8178-9:2019 Reciprocating internal combustion engines — Exhaust emission measurement — Part 9: Test cycles and test procedures for measurement of exhaust gas smoke emissions from compression ignition engines using an opacimeter.

TECHNICAL SPECIFICATIONS FOR ELECTRICAL WORKS DATA SHEET

DATASHEET – ELECTRICAL WORKS
CONTENTS

A. DATA SHEET FOR LT POWER CABLES

SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
1.0	**SYSTEM DATA**		
1.1	System Voltage with voltage variation	V	415V
1.2	Short circuit for 1 Sec.	KA (rms)	50kA
1.3	Design ambient temperature of cable	deg. C	45
1.4	Laying (underground/air/duct/trench)		air/duct/trench
2.0	**CABLE DATA**		
2.1	Type of Cable(HV Power/LV Power/Control/Instrumentation/Tele communication)		LV POWER
2.2	Rated voltage of cable (U_0/U)	kV	1.1
2.3	Core (Multi/single)		REFER BOQ
2.4	Conductor (Aluminium/Copper)		REFER BOQ
2.4.1	Conductor (stranded/solid)		REFER BOQ
2.4.2	Conductor Screen required	Yes/No	NO
2.4.3	Effective cross sectional area of conductor	sq.mm.	REFER BOQ
2.5	Insulation material (XLPE/PVC/PTFE/etc.)		XLPE
2.5.1	If PVC, type of insulation (Type A or C)		
2.5.2	Insulation screen required	Yes/No	NO
2.6	Inner Sheath required	Yes/No	NO
2.6.1	Inner sheath material and type (A or C)		ST2

SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
2.7	Armour Required	Yes/No	YES
2.7.1	Armour Type and material		GI STRIP & ROUND FOR SMALLER CABLES
2.7	Outer sheath Required	Yes/No	YES
2.7.1	Outer Sheath material and type (ST 1 or ST 2)		ST2
2.8	Cable Drum Type (Wooden/Steel)		WOODEN
2.8.1	Drum length required	m	AS PER SITE REQUIREMENT . NO JOINTING KIT IS ALLOWED
2.8.2	Cable quantity tolerance		+5%
3.0	SPECIFIC REQUIREMENT		
3.1	Outer Sheath type (Fire Survival (FS) /Flame Retardant Low Smoke (FRLS)/ FRLSZH		FRLS
3.2	Fire Protective paint required	Yes/No	NO
3.3	Instrumentation Cable type(Pair/Triad/Quad/ Quintuple)		

B. DATA SHEET FOR LT FIRE SURVIVAL (FS) CABLES

SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
1.0	SYSTEM DATA		
1.1	System Voltage with voltage variation	V	415V
1.2	Short circuit for 1 Sec.	KA (rms)	50kA
1.3	Design ambient temperature of cable	deg. C	45
1.4	Laying (underground/air/duct/trench)		air/duct/trench
2.0	**CABLE DATA**		
2.1	Type of Cable(HV Power/LV Power/Control/Instrumentation/Telecommunication)		LV POWER
2.2	Rated voltage of cable (U_0/U)	kV	1.1
2.3	Core (Multi/single)		REFER BOQ
2.4	Conductor (Aluminium/Copper)		REFER BOQ
2.4.1	Conductor (stranded/solid)		REFER BOQ
2.4.2	Conductor Screen required	Yes/No	NO
2.4.3	Effective cross-sectional area of conductor	sq.mm.	REFER BOQ
2.5	Insulation material (XLPE/PVC/PTFE/etc.)		XLPE
2.5.1	If PVC, type of insulation (Type A or C)		
2.5.2	Insulation screen required	Yes/No	NO
2.6	Inner Sheath required	Yes/No	NO
2.6.1	Inner sheath material and type (A or C)		ST2
2.7	Armour Required	Yes/No	YES
2.7.1	Armour Type and material		GI STRIP & ROUND

SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
			FOR SMALLER CABLES
2.7	Outer sheath Required	Yes/No	YES
2.7.1	Outer Sheath material and type (ST 1 or ST 2)		ST2
2.8	Cable Drum Type (Wooden/Steel)		WOODEN
2.8.1	Drum length required	m	AS PER SITE REQUIREMENT. NO JOINTING KIT IS ALLOWED
2.8.2	Cable quantity tolerance		+5%
3.0 3.1	**SPECIFIC REQUIREMENT** Outer Sheath type (Fire Survival (FS) /Flame Retardant Low Smoke (FRLS)/ FRLSZH		FS
3.2	Fire Protective paint required	Yes/No	NO
3.3	Instrumentation Cable type(Pair/Triad/Quad/ Quintuple)		

C. DATA SHEET FOR LT CONTROL CABLES

SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
1.0	SYSTEM DATA		
1.1	System Voltage with voltage variation	V	415V
1.2	Short circuit for 1 Sec.	KA (rms)	50kA
1.3	Design ambient temperature of cable	deg. C	45
1.4	Laying (underground/air/duct/trench)		air/duct/trench
2.0	**CABLE DATA**		
2.1	Type of Cable(HV Power/LV Power/Control/Instrumentation/Telecommunication)		LV POWER
2.2	Rated voltage of cable (U_0/U)	kV	1.1
2.3	Core (Multi/single)		REFER BOQ
2.4	Conductor (Aluminium/Copper)		Copper
2.4.1	Conductor (stranded/solid)		stranded
2.4.2	Conductor Screen required	Yes/No	No
2.4.3	Effective cross sectional area of conductor	sq.mm.	REFER BOQ
2.5	Insulation material (XLPE/PVC/PTFE/etc.)		PVC
2.5.1	If PVC, type of insulation (Type A or C)		
2.5.2	Insulation screen required	Yes/No	NO
2.6	Inner Sheath required	Yes/No	NO
2.6.1	Inner sheath material and type (A or C)		ST2
2.7	Armour Required	Yes/No	YES
2.7.1	Armour Type and material		GI ROUND
2.7	Outer sheath Required	Yes/No	YES
2.7.1	Outer Sheath material and type (ST 1 or ST 2)		ST2

SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
2.8	Cable Drum Type (Wooden/Steel)		Wooden
2.8.1	Drum length required	m	As per site requirement. No jointing kit is allowed.
2.8.2	Cable quantity tolerance		+5%
3.0	**SPECIFIC REQUIREMENT**		
3.1	Outer Sheath type (Fire Survival (FS) /Flame Retardant Low Smoke (FRLS)/ FRLSZH		FRLS
3.2	Fire Protective paint required	Yes/No	No
3.3	Instrumentation Cable type(Pair/Triad/Quad/ Quintuple)		

D. DATA SHEET FOR DISTRIBUTION TRANSFORMER

SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
1)	No. of transformers	Nos	As per BOQ
2)	Service		Indoor Installation.
3)	Type		Core type
4)	Overall dimensions of transformer		To be indicated by the Manufacturer. But confirm accommodation in the space shown in drawing with clearance of 1000mm (Minimum) on all sides
5)	Weight		To be indicated by the Manufacturer.
6)	Rating		
	a. Rated capacity	KVA	2500
	b. Rating enhancement with forced air fans		Not Applicable
	c. Rated primary voltage	Volts	11000 V
	d. Rated secondary voltage		433 V
	e. Rated frequency	Hz	50
	f. No. Of Phases		3
	g. Cooling		Cast resin Dry type, Air Natural (AN) + 2 Fans
	h. Temperature rise by		
	resistance of winding	Deg C	90 Deg C - As per IS 11171
	i. Ambient temperature	Deg C	50°C Peak
			45° C Daily average
			18° C Minimum
	j. Overload capacity		As Per IEC 60076-12
	k. Class of Insulation		CLASS - F
7)	Enclosure (OEM Approved)		"Enclosed Dry-Type" as per IS:2026-11
			IP - 23 (Louvers with perforated sheet)
8)	Winding and Vector Group		Copper winding
			Dyn11 connection,
9)	Tap changer		a) Onload tap changer with RTCC
	High Voltage		- 5% to + 5.0% at steps of 2.5%
10)	Impedance at rated current	%	6.25 % (approx.)
	frequency and at 75°C		Inline to Tolerances in IS
11)	Transformer losses		Low losses as per ECBC-2017
11.1)	Load Losses at 50 % of Load	KW	To be indicated by the Bidder
11.2)	Load Losses at 100 % of Load	KW	To be indicated by the Bidder
13)	Efficiency at 0.8 Pf		
	a. at 50% load		To be indicated by the Bidder
	b. at 75% load		
	c. at full load		
14)	Efficiency at Unity Pf		

	a. at 50% load		To be indicated by the Bidder
	b. at 75% load		
	c. at full load		
14)	Neutral		Effectively Earthed - Neutral to be separately brought out
15)	Terminals		
	a) Primary side		HV Cable Box - 26.3 kA
			Suitable for termination of
			1 R # 3C 300sqmm XLPE ALUMINIUM ARMOURED
	b) Secondary side		LV Cable Box - 50kA
			Flange Suitable for termination of
			3PH 4W 4000 A CU SANDWICH BUS DUCT
16)	Insulation level		
	BIL - HV		75 Kvp / 28 kV rms
	BIL - LV		3 kV rms
17)	Fittings & Accessories		Following fittings and accessories shall be
			provided.
			IEC 60076-11 & 60076-12
			Lifting eyes or lifting lugs.
			Bi – directional wheels
			HV and LV terminals
			Earthing terminals
			Pulling holes on the under base
			Winding temperature control system:
			Fan Control Circuit
			Neutral CT: As per SLD/BOQ (specification to be matched with LT Panel Side CT ratings)
18)	Transformer shall have a rating plate of weatherproof stainless-steel material placed in a clear position. Nameplate information as called for by standards shall be provided. This includes:		
			- Type of transformer
			- Manufacturer’s name
			- Serial number
			- Year of Manufacture
			- Insulation Level
			- Number of phases
			- Rated power
			- Rated frequency
			- Rated voltage
			- Rated currents
			- Vector Group
			- Impedance voltage at rated current

			- Type of Cooling
			- Total Mass
			- Temperature rise of windings
19)	Noise Level		60 Db Average As Per NEMA TR-1
20)	Paint Shade		Epoxy Shade - RAL 7032
	Note:		
	Information by supplier as indicated above shall be furnished by the tenderer along with the tender, otherwise the tender is not liable to be considered.		

E. DATA SHEET FOR HT CABLES

SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
1.0	SYSTEM DATA		
1.1	System Voltage with voltage variation	V	11KV
1.2	Short circuit for 1 Sec.	KA (rms)	26.2
1.3	Design ambient temperature of cable	deg. C	45
1.4	Laying (underground/air/duct/trench)		Duct/ Trench
2.0	**CABLE DATA**		
2.1	Type of Cable(HV Power/LV Power/Control/Instrumentation/Telecommunication)		HV Power
2.2	Rated voltage of cable (U_0/U)	kV	12kV
2.3	Core (Multi/single)		Multi core
2.4	Conductor (Aluminium/Copper)		Aluminum
2.4.1	Conductor (stranded/solid)		Refer BOQ
2.4.2	Conductor Screen required	Yes/No	Yes

SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
2.4.3	Effective cross sectional area of conductor	sq.mm.	Refer BOQ
2.5	Insulation material (XLPE/PVC/PTFE/etc.)		XLPE
2.5.1	If PVC, type of insulation (Type A or C)		
2.5.2	Insulation screen required	Yes/No	
2.6	Inner Sheath required	Yes/No	YES
2.6.1	Inner sheath material and type (A or C)		ST2
2.7	Armour Required	Yes/No	YES
2.7.1	Armour Type and material		STRIP
2.7	Outer sheath Required	Yes/No	YES
2.7.1	Outer Sheath material and type (ST 1 or ST 2)		ST2
2.8	Cable Drum Type (Wooden/Steel)		WOODEN
2.8.1	Drum length required	m	AS PER REQUIREMENT. NO JOINTING KIT IS ALLOWED
2.8.2	Cable quantity tolerance		+5%
3.0	**SPECIFIC REQUIREMENT**		
3.1	Outer Sheath type (Fire Survival (FS) /Flame Retardant Low Smoke (FRLS)/ FRLSZH		FRLS
3.2	Fire Protective paint required	Yes/No	NO

F. DATA SHEET FOR BUSBAR TRUNKING/BUSDUCTS

SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
1.0	**General**		
1.1	Bus Bar arrangement		Refer BOQ
1.2	Bus Bar configuration		Refer BOQ
1.3	Phase, Wire (3W/4W)		Refer BOQ
1.4	Rated operational voltage	V	415
1.5	Rated insulation voltage	V	1100
1.6	Rated Dielectric voltage	kV in r.m.s	75
1.7	Rated impulse withstand voltage	kV	28
1.8	Rated frequency	Hz	50
1.9	Degree of protection		IP 42 for indoor IP 66 for outdoor
2.0	**Bus Bar**		
2.1	Bus Bar Ratings	A	Refer BOQ
2.2	Short circuit rating	kA	Refer BOQ
2.3	Bus Bar material (Phase / Neutral)		Refer BOQ
2.4	Bus Bar material (earth bus bar)		Refer BOQ
2.5	Bus Bar insulation		CLASS F
2.6	Fire rating		Refer BOQ
2.7	Joint type		Refer BOQ
3.0	**Bus enclosure**		
3.1	Enclosure material		As per OEM standard
3.2	Paint		RAL 7035
4.0	**End Feed unit/Centre feed Unit**		
4.1	End Feed unit Required	Yes/No	Yes
4.2	End Feed unit rating	A	Refer BOQ
4.3	Centre feed Unit Required	Yes/No	NO
4.4	Centre feed Unit rating	A	
5.0	**Tap off Units**		
5.1	Tap off unit Required	Yes/No	Yes
5.2	Tap off unit Qty. and rating	A	Refer SLD
5.3	Tap off unit type		Refer BOQ

SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
6.0	**Terminations**		
6.1	Flanged End Terminations required	Yes/No	Yes
6.2	Cu Flexible Connections required	Yes/No	Yes

BUSDUCTS			
SL. NO.	**ITEM**	**UNIT**	**TECHNICAL PARTICULARS**
1.0	**DESIGN PARTICULARS**		
1.1	Type of Bus Duct		SANDWICH TYPE
	Applicable standard		Latest IS/IEC standards
	System		3 phase 4 wire
	Class of Insulation		Class F
1.2	Type of Cooling		Self cooled
1.3	Installation Indoor/Outdoor		Indoor
1.4	Nominal Service Voltage	kV	0.415
1.5	Frequency	Hz	50
1.6	Continuous Current Rating of Bus Ducts under Site Conditions	A	Refer SLD
1.7	Basic Impulse Insulation Level (1.2 x 50 micro second wave)	kV (Peak)	75
1.8	One minute Power Frequency Withstand Voltage	kV (Peak)	28
1.9	Momentary Current Rating	kA (Peak)	105
1.10	Short Time Current Rating for one second	kA (RMS)	50kA
1.11	Design maximum Temperature (Hot Spot) of Busbars at Rated Current (a) Plain joint (b) Silver plated joints	°C	 45 ^{0} C 60 ^{0} C

BUSDUCTS			
SL. NO.	**ITEM**	**UNIT**	**TECHNICAL PARTICULARS**
1.12	Design maximum Temperature (Hot Spot) of Enclosure at Rated Current	°C	Not to exceed 70 ^{0} C
1.13	Busbar Material		As per SLD
1.14	Busbar Section	sq.mm.	Rectangular section
1.15	Bus Enclosure Material & thickness	mm	COPPER & as per SLD
1.16	Shape of Enclosure		Bidder to decide
1.17	Material of Phase Barriers & thickness		
1.18	Phase Clearance (Minimum) - Phase to Phase - Phase to Earth	mm	25 19.4
1.19	Type of Joints between Adjacent Sections of Bus Conductor Welded/Bolted		Bolted
2.0	**INSULATORS AND SEAL OFF BUSHING**		
2.1	Rated Voltage	kV	0.433
2.2	ONE MINUTE POWER FREQUENCY WITHSTAND VOLTAGE		
2.2.1	Dry	kV (rms)	2.5kV rms
2.2.2	Wet	kV (rms)	
2.3	Impulse Withstand Voltage (1.2 x 50 micro-second Wave)	kV	75
2.4	Minimum Creepage Distance	mm	25 mm/kV
2.5	Material of Insulators		

BUSDUCTS			
SL. NO.	**ITEM**	**UNIT**	**TECHNICAL PARTICULARS**
2.6	Current rating of Seal of Bushings	A	Refer SLD
2.7	Material of Seal Off Bushings		Porcelain
3.0	**LINKS**		
3.1	DISCONNECTING LINKS		
3.1.1	Quantity		
3.1.2	Rated Current	A	Refer SLD
3.2	SHORTING LINKS		
3.2.1	Location		Bidder to indicate
4.0	**BUS DUCTS TENTATIVE LENGTH**		
4.1	Bus Duct length.	M	Refer BOQ/Drawings
4.2	90° Bend		Refer BOQ/Drawings
4.3	Tees		Refer BOQ/Drawings
4.4	No. of Terminations		Refer BOQ/Drawings
5.0	**GENERAL**		
5.1	EARTHING CONDUCTOR		
5.1.1	Material Size		2Runs of 50 x 10 sq.mm GI Earth flat conductor
5.2	FINISH OF BUS ENCLOSURE		

BUSDUCTS			
SL. NO.	**ITEM**	**UNIT**	**TECHNICAL PARTICULARS**
5.2.1	Exterior		RAL 7032
5.2.2	Interior		Glossy white
5.3	Layout Drawing Reference No.		
5.4	Rain hood required	Yes/No	Yes for outdoor
6.0	**TESTS**		
6.1	Routine test		As per QAP
6.2	Acceptance tests		Bidder to Produce the test reports
6.3	Type tests		Bidder to Produce the test reports
6.4	Tests on components such as insulators, seal-off bushings, bolted and flexible joints, busbars, enclosure material, galvanizing of supporting structures, CTs, VTs and fuses		Bidder to Produce the test reports
7.0	**START-UP AND ESSENTIAL SPARES**		Bidder to recommend

G. DATA SHEET FOR HT PANELS

SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
1.0	**SWITCHGEAR & BUSBAR RATING**		11kV SWITCHGEAR
1.1	RATED VOLTAGE, FREQUENCY WITH VARIATION		11kV ,3 PH & 50 Hz
1.2	SYSTEM NEUTRAL EARTHING		EFFECTIVELY
1.3	MAXIMUM SYSTEM VOLTAGE		12kV
1.4	ONE MINUTE POWER FREQUENCY VOLTAGE	kV (RMS)	28 kV (rms), 1min
1.5	1.2/50 SEC IMPULSE WITHSTAND VOLTAGE	kV (peak)	75 kV (peak)
1.6	CONTINUOUS CURRENT RATING OF BUSBARS UNDER SITE REFERENCE AMBIENT TEMPERATURE		Refer SLD
1.7	DESIGN AMBIENT TEMPERATURE	°C	45
1.8	MAXIMUM TEMPERATURE OF BUSBARS, DROPPERS AND CONTACTS AT CONTINUOUS CURRENT RATING UNDER SITE REFERENCE AMBIENT TEMPERATURE	°C	90°C FOR NON-SILVER PLATING JOINTS 105°C FOR SILVER PLATING JOINTS
1.9	SHORT CIRCUIT WITHSTAND FOR BUSBARS AND DROPPERS A) SHORT TIME AT RATED VOLTAGE B) DYNAMIC RATING	kA (RMS)/ SEC kA (PEAK)	26.2 kA 2.5 TIMES OF STC
1.10	INTERNAL ARC WITHSTAND CAPACITY (A FLR) AT RATED SWITCHGEAR	kA / sec	26.2 kA/1 Sec

SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
	FAULT CURRENT		
1.11	BUSBAR INSULATING MATERIAL		HEAT SHRINKABLE PVC SLEEVES
1.12	STANDARD APPLICABLE		AS PER DATA SHEET-A2
2.0	**SWITCHGEAR PARTICULARS**		As per SLD
NOTE: FEEDER DESIGNATION, RATING & MODULE TYPES: SEE SLD ENCLOSED DWGS.			
3.0	**SWITCHGEAR CONSTRUCTIONAL REQUIREMENTS**		BIDDER TO INDICATE as per OEM standards
3.1	THICKNESS OF SHEET STEEL ENCLOSER, DOORS & COVERS A) COLD ROLLED B) HOT ROLLED	 mm mm	 2 mm 2.5 mm
3.4	THICKNESS OF BOTTOM GLAND PLATE	mm	3 mm (NON MAGNETIC FOR 1 CORE CABLES) & 2 mm MS FOR 3 CORE CABLES
3.3	DEGREE OF PROTECTION (IP CLASS)		BUSBARS IP-4X
3.4	COLOUR FINISH SHADE A) INTERIOR B) EXTERIOR		 RAL 7035 RAL 7035
3.4 3.5	EARTHING BUS A) MATERIAL B) SIZE PURCHASER'S EARTHING CONDUCTOR A) MATERIAL B) SIZE	 mm mm	 CU 50x6 GI
3.6	CLEARANCES IN AIR OF LIVE PARTS		As per OEM design for required BIL level.
3.7	METAL ENCLOSED BUSDUCT/BUS TRUNKING ENTRY TO CUBICLES IF REQUIRED		NA

SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
3.9	REQUIREMENT OF ARC RESISTANCE FEATURE	YES/NO	YES
4.0	CIRCUIT BREAKER		
4.1	CIRCUIT BREAKER TYPE		VACUUM CIRCUIT BREAKER (VCB)
4.2	VOLTAGE, FREQUENCY & NO. OF POLES		11kV ,3 PH & 50 Hz
4.3	RATED OPERATING DUTY		O - 3 MIN – CO-3 MIN - CO
4.4	RATED BREAKING CAPACITY	MVA kA (RMS)	
4.5	SHORT CIRCUIT WITHSTAND CURRENT FOR 1 SEC. DURATION	kA (RMS)	26.2/1sec
4.6	RATED MAKING CURRENT	kA(PEAK)	2.5 TIMES OF STC
4.7	RATED CURRENT AT SITE REFERENCE AMBIENT TEMPERATURE	A	BIDDER TO INDICATE
4.8	ASYMMETRICAL BREAKING CURRENT A) A.C COMPONENT B) % D.C COMPONENT AT TIME IN m SEC	kA (RMS)	AS PER IEC
4.9	TOTAL BREAKING TIME	CYCLE	< 3 cycles
4.10	TOTAL MAKING TIME	CYCLE	< 5 cycles
4.11	OPERATING MECHANISM	TYPE	MOTOR WOUND SPRING CHARGED. MANUAL TRIP & CLOSE FACILITY TO BE PROVIDED.
4.12	TRIP FREE MECHANISM	YES/NO	YES
4.13	ANTI PUMPING FEATURES		ELECTRICAL & MECHANICAL

SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
4.14	MINIMUM NO OF AUXILIARY CONTACTS		6 NO + 6 NC
4.15	WITHSTAND TEST VOLTAGE A) ONE MINUTE POWER FREQUENCY B) 1.2/50 MICRO SEC. IMPULSE	kV (RMS) kV (PEAK)	28 kV (rms) 75 kV (peak)
4.16	CONTROL VOLTAGE A) FOR SPRING CHARGING MOTOR B) FOR CLOSING/TRIPPING COIL C) FOR SPACE HAETERS & ILLUMINATION D) FOR AUXILIARY CIRCUIT	V AC/DC	240 VOLT 240VAC/110 VOLT 240 VOLT
4.17	STANDARDS APPLICABLE		AS PER DATA SHEET-A2
6.0	**CURRENT TRANSFORMERS**		
6.1	TYPE		CAST RESIN
6.2	SYSTEM VOLTAGE& FREQUENCY		11kV, 3 PH & 50 Hz
6.3	INSULATION CLASS		CLASS F OR BETTER
6.5	RATED PRIMARY CURRENT, RATIO, BURDEN AND ACCURACY CLASS		REFER SLD
6.6	SHORT TIME 1 SEC. / 3 SEC. CURRENT RATING & DYNAMIC RATING	kA (RMS) kA(peak)	26.2 kA (rms) for 1 sec 2.5 TIMES OF STC (peak)
6.7	STANDARDS APPLICABLE		AS PER DATA SHEET-A2

SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
7.0	**VOLTAGE TRANSFORMERS**		
7.1	TYPE		CAST RESIN
7.2	INSULATION CLASS		CLASS F OR BETTER
7.3	RATED PRIMARY VOLTAGE, RATIO, BURDEN, TOTAL NO OF WINDINGS, METHOD OF CONNECTION AND ACCURACY CLASS		AS PER DATA SHEET-A3 OR ENCLOSED SLD
7.4	RATED VOLTAGE FACTOR A) CONTINUOUS B) SHORT TIME		1.2 (Continuous) 1.9 FOR 8 HOURS
7.5	WITHSTAND TEST VOLTAGE A) ONE MINUTE POWER FREQUENCY B) 1.2/50 MICRO SEC. IMPULSE	kV (RMS) kV (PEAK)	28 kV (rms) 75 kV (peak)
7.6	STANDARDS APPLICABLE		AS PER DATA SHEET-A2
8.0	**HRC FUSES**		
8.1	RATED CURRENT	A	As per requirement
8.2	VOLTAGE CLASS	kV	BIDDER TO INDICATE
8.3	SYMMETRICAL INTERRUPTING RATING	kA (RMS)	BIDDER TO INDICATE
8.4	STANDARDS APPLICABLE		AS PER DATA SHEET-A2
9.0	**METERS**		
9.1	TYPE		Refer SLD

SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
9.2	ACCURACY CLASS A) INDICATING METERS B) ENERGY METERS C) MULTIFUNCTION METER		Refer SLD
9.3	MULTIFUNCTION METER REQUIRED	YES / NO	YES (Refer SLD)
11.0	**INDICATION LAMPS**		
11.1	TYPE		CLUSTER LED OR 7 SEGMENT LED
11.2	RATED VOLTAGE	V	
11.3	COLOUR OF LAMPS A) ON B) OFF C) AUTO TRIP D) SERVICE POSITION E) TEST POSITION F) SPRING CHARGED G) TRIP CIRCUIT HEALTHY H) CONTROL SUPPLY HEALTHY I) READY TO CLOSE		RED GREEN AMBER BLUE WHITE BLUE WHITE WHITE YELLOW
12.0	**CONTROL SWITCHES**		
12.1	TYPE		STAY PUT / SPRING RETURN
12.2	BREAKER CONTROL SWITCH		SPRING RETURN
12.3	CONTROL SELECTOR SWITCH		STAYPUT
12.4	LOCKABLE TYPE	YES / NO	YES

SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
12.5	STANDARDS APPLICABLE		AS PER DATA SHEET-A2
13.0	**AUXILIARY RELAYS**		
13.1	TYPE		NON DRAWOUT
13.2	APPLICATION		AS PER REQUIREMENT
13.3	RESET TYPE		HAND RESET
13.4	FLAG INDICATOR	YES / NO	YES
13.5	COIL VOLTAGE	V D.C	AS PER REQUIREMENT
13.6	MONITORING FACILITY	YES / NO	YES
13.7	STANDARDS APPLICABLE		AS PER DATA SHEET-A2
14.0	REQUIREMENT OF INERT GAS SUPPRESSION SYSTEM	YES/NO	NO
SL. NO.	**ITEM**	**UNIT**	**TECHNICAL PARTICULARS OF NUMERICAL RELAY**
15.0	**TRANSFORMER FEEDER RELAY (HV SIDE)**		
5.1	APPLICATION		Transformer Protection
5.2	RELAY MAKE & MODEL NO		
5.3	MINIMUM PROTECTION / CONTROL FUNCTION		AS PER ENCLOSED SLD
5.4	MINIMUM DI+DO		
5.5	AUXILIARY POWER SUPPLY	V D.C	

SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
5.6	NOMINAL CURRENT RATING	A	1A
5.7	COMMUNICATION PROTOCOL		IEC 61850
5.8	COMMUNICATIONWITH SAS / SCADA		SCADA
5.9	COMMUNICATION METHOD WITH OTHER IED WITHIN THE SWITCHGEAR		IEC 61850
5.10	TYPE & NO OF COMMUNICATION PORT		IEC 61850
5.11	UPLOADING / DOWNLOADING SOFTWARE REQUIREMENT	YES / NO	YES
6.0	**TRANSFORMER FEEDER RELAY (LV SIDE)**		
6.1	APPLICATION		
6.2	RELAY MAKE & MODEL NO		
6.3	MINIMUM PROTECTION / CONTROL FUNCTION		51, 51N, 50, 50N, 67, 67N, 51NS, 64R, 25, 27+2, 74TC (BREAKER TRIP COIL & 86 RELAY SUPERVISION), 95,50LBB (OR) AS PER SLD
6.4	MINIMUM DI+DO		
6.5	AUXILIARY POWER SUPPLY	V D.C	
6.6	NOMINAL CURRENT RATING	A	1A OR 5A
6.7	COMMUNICATION PROTOCOL		
6.8	COMMUNICATIONWITH SAS / SCADA		
6.9	COMMUNICATION METHOD WITH OTHER IED WITHIN		RING TOPOLOGY OR STAR TOPOLOGY

SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
	THE SWITCHGEAR		
6.10	TYPE & NO OF COMMUNICATION PORT		
6.11	UPLOADING / DOWNLOADING SOFTWARE REQUIREMENT	YES / NO	
10.0	**BUS PT FEEDER RELAY**		
10.1	APPLICATION		UV PROTECTION
10.2	RELAY MAKE & MODEL NO		
10.3	MINIMUM PROTECTION / CONTROL FUNCTION		AS PER ENCLOSED SLD
10.4	MINIMUM DI+DO		
10.5	AUXILIARY POWER SUPPLY	V D.C	
10.6	NOMINAL CURRENT RATING	A	1A
10.7	COMMUNICATION PROTOCOL		IEC 61850
10.8	COMMUNICATIONWITH SAS / SCADA		SCADA
10.9	COMMUNICATION METHOD WITH OTHER IED WITHIN THE SWITCHGEAR		RING TOPOLOGY OR STAR TOPOLOGY

H. DATA SHEET FOR LT PANELS

SL. NO.	ITEM	UNIT	
1.0	**SWITCHGEAR & BUSBAR RATING**		
1.1	RATED VOLTAGE, PHASES & FREQUENCY		415V & 3 PH & 50 Hz
1.2	SYSTEM NEUTRAL EARTHING: EFFECTIVELY/NON-EFFECTIVELY		EFFECTIVELY Earthed
1.3	MAXIMUM SYSTEM VOLTAGE		457V
1.4	ONE MINUTE POWER FREQUENCY VOLTAGE		
	A) POWER CIRCUITS B) CONTROL CIRCUITS C) AUX. CIRCUITS CONNECTED TO SEC. OF CTS	VOLTS VOLTS VOLTS	2500 1500 2000
1.5	CONTINUOUS CURRENT RATING OF BUSBARS UNDER SITE REFERENCE AMBIENT TEMPERATURE		REFER SLD
1.6	REFERENCE AMBIENT TEMPERATURE	°C	45
1.7	MAXIMUM TEMPERATURE OF BUSBARS, DROPPERS AND CONTACTS AT CONTINUOUS CURRENT RATING UNDER SITE REFERENCE AMBIENT TEMPERATURE	°C	85°C FOR NON-SILVER-PLATING JOINTS 105°C FOR SILVER PLATING JOINTS
1.8	SHORT CIRCUIT WITHSTAND FOR BUSBARS AND DROPPERS A) SHORT TIME (1 SEC.) AT 415V B) DYNAMIC RATING	kA (RMS) kA (PEAK)	As per SLD kA (rms) 105kA (peak)
1.9	PHASE CROSSOVER ARRANGEMENT REQUIRED		YES/NO
2.0	**SWITCHGEAR PARTICULARS**		REFER SLD
3.0	**SWITCHGEAR CONSTRUCTIONAL REQUIREMENTS**		

SL. NO.	ITEM	UNIT	
3.1	THICKNESS OF SHEET STEEL COLD ROLLED	mm	Frame Doors/ Covers Partitions 2.5 2 1.6
3.2	DEGREE OF ENCLOSURE PROTECTION - IP52/IP42/IP54/IP55		AS PER IS:13947 For Indoor Panels IP 4X For indoor panels IP 55
3.3	DEGREE OF ENCLOSURE PROTECTION AGAINST EXTERNAL MECHANICAL IMPACTS		AS PER IEC – 62262 IK08
3.4	PANEL TYPE- FRONT OPERATED FRONT MAINTAINED/FRONT OPERATED BACK MAINTAINED		RAL 7035
3.5	EARTHING BUS MATERIAL SIZE	mm	Cu 50 x 10 Sq.mm
3.6	PURCHASER'S EARTHING CONDUCTOR MATERIAL SIZE	mm	GI 75 x 10
3.7	CLEARANCES IN AIR OF LIVE PARTS		As pet type tested design complying to required BIL level
3.8	METAL ENCLOSED BUSDUCT/BUS TRUNKING ENTRY TO CUBICLES IF REQUIRED		As per layout
3.9	FORM OF SEPARATION AS PER IEC 61439-1		Form 4b
3.10	REQUIREMENT OF ARC RESISTANCE FEATURE		YES
3.11	SALT SPRAY TESTING FOR 500 HRS		YES/NO
3.12	TYPE OF PAINTING/COATING		EPOXY/ POLYURETHANE/SYNTHETIC ENAMEL/POLYESTER/RU

SL. NO.	ITEM	UNIT	
			BBER
3.13	COLOUR FINISH SHADE INTERIOR EXTERIOR		RAL 7035
4.0	**STARTERS**		
4.1	TYPE		(a) Refer SLD
4.2	CONTACTOR RATED DUTY		AS PER IS:60947
4.3	UTILISATION CATEGORY		(a) DOL - (b) REV - (c) Y-Δ - (d) ANY OTHER
4.4	FOR Y-Δ STARTER OPEN/CLOSED TRANSITION		
4.5	CONTROL TRANSFORMER:		Not required
4.5.1	SEPARATE FOR EACH MODULE		YES/NO
4.5.2	COMMON FOR EACH SWITCHGEAR SECTION WITH 100% STANDBY		YES/NO
4.6	SINGLE PHASING PREVENTOR REQUIRED		YES
4.7 4.8	RELAY (i)THERMAL OVER LOAD RELAY RESET (ii) ELECTRONIC OVERLOAD RELAY MOTOR PROTECTION CIRCUIT BREAKER TO BE CONSIDERED		HAND HAND YES
4.9	LOW BURDEN TYPE CONTACTORS (SUITABLE FOR DIRECT OPERATION FROM DCS/PLC)		YES

SL. NO.	ITEM	UNIT	
5.0	CIRCUIT BREAKER		
5.1	CIRCUIT BREAKER TYPE		REFER SLD
5.2	VOLTAGE, FREQUENCY & NO. OF PHASES		415V,50Hz & 3Ph
5.3	RATED BREAKING DUTY		B-0.3 SEC-MB-3 SEC-MB
5.4	ARRANGEMENT IN PANEL		WILL BE DECIDED DURING DETAILED ENGINEERING STAGE
5.5	SHORT CIRCUIT WITHSTAND CURRENT FOR 1 SEC. DURATION	kA	REFER SLD
5.6	RATED MAKING CURRENT	kA(PEAK)	105 kA (peak)
5.7	RATED CURRENT AT SITE REFERENCE AMBIENT TEMPERATURE	A	AS PER REQUIREMENT
5.8	TYPE OF OPERATING MECHANISM		MOTOR WOUND SPRING CHARGED
5.9	KEY INTERLOCKING REQUIRED		AS PER SLD
5.10	SHUNT TRIP REQUIRED		YES
5.11	PROTECTION REQUIRED (A) RELAYS/ RELEASES MICROPROCESSOR BASED (B) RELAY/RELEASE TYPE & SETTINGS (C) UNDER VOLTAGE RELEASE REQUIRED SETTING (D)SHUNT TRIP REQUIRED		AS PER SLD YES
5.12	BREAKER SCADA COMPATIBILITY REQUIRED		NO
5.13	CONTROL VOLTAGE (a) FOR SPRING CHARGING MOTOR (b) FOR CLOSING/TRIPPING	V AC/DC	240V AC

SL. NO.	ITEM	UNIT	
5.14	EMERGENCY MANUAL OPERATION REQUIRED IN ADDITION TO ELECTRICAL OPERATING DEVICES (a) FOR SPRING CHARGING & CLOSING (b) FOR TRIPPING		YES YES
5.15	ANNUNCIATOR REQUIRED		YES
5.16	BREAKER CONTROL SWITCH-PISTOL GRIP TYPE/ POLE DISCREPANCY TYPE		
6.0	MCCB's		
6.1	MOULDED CASE CIRCUIT BREAKERS TO BE PROVIDED. (a) FOR MOTOR CONTROL CIRCUITS (b) FOR OTHER CIRCUITS		YES YES
6.2	VOLTAGE, FREQUENCY & NO OF PHASES		
6.3	TYPE OF RELEASE		REFER SLD
6.4	RATED OPERATING DUTY		
6.5	RATED BREAKING CAPACITY (AT 415V 0.25 P.F.)	kA(RMS)	REFER SLD
6.6	RATED MAKING CURRENT	kA (Peak)	105 (Peak)
6.7	RATED CURRENT AT SITE REFERENCE AMBIENT TEMPERATURE		AS PER REQUIREMENT
6.8	ON/OFF OPERATION MANUAL REMOTE POWER OPERATED		YES NO
6.9	RELEASES REQUIRED OVER LOAD SHORT CIRCUIT EARTH FAULT UNDER VOLTAGE		REFER SLD

SL. NO.	ITEM	UNIT	
6.10	NUMBER OF AUXILIARY CONTACTS EXCLUSIVELY FOR PURCHASERS USE		AS PER REQUIREMENT
6.11	EARTH FAULT PROTECTION FOR TPN MCCB- THROUGH IN BUILT RELEASE WITH A SEPARATE NEUTRAL CT INPUT OR THROUGH CBCT, ELR AND SHUNT TRIP COIL		REFER SLD
7.0	**CURRENT TRANSFORMERS**		
7.1	TYPE		CAST RESIN
8.0	**POTENTIAL TRANSFORMERS**		
8.1	TYPE		CAST RESIN
8.2	FUSES OR MPCB/MCB PROVIDED ON PRIMARY AND SECONDARY SIDE		PRIMARY - MPCB SECONDARY - MCB
9.0	**INDICATION METERS**		
	ANALOGUE/DIGITAL		REFER SLD
	ACCURACY CLASS		REFER SLD
	IF ANALOGUE SIZE 144MM X 144 MM OR 96MM X 96MM		REFER SLD
	TAUT BAND		YES
	COMMUNICATION PROTOCOLS		MODBUS/ETHERNET TCP IP/ 61850/PROFIBUS
10.0	**RELAYS**		NUMERICAL
	COMMUNICATION PROTOCOLS FOR RELAYS		IEC 61850/IEC 101/IEC 103/DNP 3
	CONTROL SUPPLY FOR SPACE HEATER, SPRING CHARGING MOTOR, SOCKET, PANEL ILLUMINATION LAMP PROTECTED BY		MCB

SL. NO.	ITEM	UNIT	
11.0	CABLE GLANDS IN VENDORS SCOPE		YES

I. DATA SHEET FOR APFCR PANELS

SL. NO.	ITEM	UNIT	
1.0	Application		Capacitor Controller for Power factor correction
2.0	Quantity		Refer SLD
3.0	Rated Voltage	V	480/525
4.0	Frequency	Hz	50
5.0	Ambient temperature	^{0}C	45
6.0	Target P.F setting		0.98
7.0	No. of relay output terminals	Nos.	Refer SLD
8.0	Rated Capacity at UPF		Refer SLD
9.0	Auto / Manual operation		Auto/Manual
10.0	Display Parameters		Voltage, Current, P.F
11.0	Safety lock out time	Sec	
12.0	Switching Principle		
13.0	Switching delay		
	(a) On delay	Sec	
	(b) OFF delay	Sec	
14.0	Communication port		

AHF DATA SHEET		
Sl.no	**Description**	**Technical Particulars**
1	AHF RATING	As Per SLD
2	System Voltage (RMS)	350 - 525 V
3	Fundemental Frequency (Hz)	50 ± 5%
4	System configuration	3P4W
5	Power Semiconductor Devices	IGBTs
6	Peak Compensating Current	2.2 Times RMS value
7	Harmonic Compensation Range	Odd harmonics up to 51st order
8	Selective Harmonic Compensation	From 0% to 100% for all 51 Harmonics
9	Reactive Power Compensation	Any power factor (inductive to capacitive). Full dynamic control.
10	Harmonic Attenuation Factor	More than 97% at rated load

11	Load Current Balancing	Yes
12	Cooling	Forced air cooling
13	Cable entry	TOP/ Bottom
14	Mounting	Floor Mounting
15	Ingress Protection Level	IP20
16	Controller Type	Digital Controller
17	Control Method	OEM standards
18	Dynamic Response Time	100 Micro-seconds
19	HMI Display Type	7-inch Capacitive Touchscreen Display
20	Remote Monitoring	MODBUS / software on USB Port
21	Operating Temperature Range	0°C to 50°C
22	Active Power Loss	Less than 3%
23	Parallel Operation	Yes
24	Short - Circuit protection	Yes
25	Color	OEM standards
26	Noise Level	<65 db

J. DATA SHEET FOR VFD

SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
1.0	Application		Pumps/compressors/fans/blowers/ AHU/
2.0	Quantity		As per BOQ
3.0	(a) Starting/rated torque		As per HVAC requirement
	(b) Type of converters		Voltage source IGBT based Inverter with PWM technology
	(c) Inverter capacity at specified pf		As per HVAC requirement
	(d) Rated Current		As per HVAC requirement
	(e) Load power factor		As per HVAC requirement
	(f) Max. continuous current		As per HVAC requirement
	(g) Rated voltage with number of phases		As per HVAC requirement
	(h) Rated frequency		50Hz
	(i) Converter Bridge		6/12/18/24 pulse
	(j) Quadrant operation		1
	(k) Duty class (cl.no.3.4)		II
4.0	Power supply voltage		415 V, 3ph, 50 Hz
5.0	Voltage variation		±10%
6.0	Frequency variation		±5%
7.0	Combined voltage and frequency variation		±10%
8.0	Power system fault current/ time	kA/sec	Refer SLD
9.0	Location		Indoor
10.0	Whether in air conditioned room	Yes/no	No
11.0	Average ambient temperature	^{0}C	Refer Project data
12.0	Design ambient temperature	^{0}C	45
13.0	Relative humidity	%	Refer Project data
14.0	Motor rated kW/ RPM/ voltage		Refer SLD
15.0	Motor data sheet		Refer motor data sheet

SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
	(driven equipment data)		no……
16.0	Drive efficiency		98% or more
17.0	Drive power factor		>96%
18.0	Speed control range	RPM/ %	As per HVAC requirement
19.0	Type of braking		Dynamic/ regenerative braking
20.0	Speed accuracy		
21.0	Closed loop/ open loop		
22.0	Type of tacho-generator		Digital (pulse type)
23.0	Remote operation		DCS/ PLC
24.0	Miscellaneous		
24.1	Soft-start	Yes/no	
24.2	Flying restart	Yes/no	
24.3	Auto restart	Yes/no	
25.0	**Cable details**		
25.1	Incoming cable size and type		Refer Cable schedule
25.2	Outgoing cable size and type		Refer Cable schedule
26.0	Cable entry	Top/bottom	Refer drawings

K. DATA SHEET FOR UPS

SL. NO	DESCRIPTION	TECHNICAL PARTICULARS
1.1	Application	UPS supply will be provided to all critical loads such as computer loads, servers,IBMS emergency lighting
1.2	Power rating at load PF 0.8 lagging	Refer BOQ
1.3	Quantity (nos.)	Refer BOQ
1.4	Method of energy storage	Battery back -up
1.5	Type	Refer BOQ
1.6	Parallel Redundant configuration	As per SLD
1.7	Installation	Indoor, Normal Ventilation
1.8	Ambient Temperature (^{0}C)	45
1.9	Relative Humidity	Up to 95% Non-Condensing
2.0	ENCLOSURE	
2.1	Sheet steel thickness	2mm, CRCA for doors and 1.6mm CRCA for side covers
2.2	Degree of protection as per IS-13947	IP42 if located in non-air conditioned area /IP20 if located in air-conditioned area.
2.3	Painting	
	Exterior	RAL 7032
	- Interior	Glossy White
2.4	Cable Entry	Bottom / Top
2.5	Acoustic Noise level Measured at a distance of 1m	60 – 65 dBA up to 120KVA 65 – 75dBA above 120KVA
2.6	Space heater, 240V, 1 Ph	Required
3.0	UPS SYSTEM	
3.1	Input	
3.1.1	Supply voltage	415 V, 3 PH, 4W, 50 Hz AC, effectively earthed.
3.1.2	Allowable Variation	
	(a) Voltage	± 10%
	(b) Frequency (c) Combined voltage + frequency	± 5% 10%
3.1.3	Harmonic content (Input)	<5%
3.2	Output	
3.2.1	Output voltage	415 V, 3 PH, 3 W
3.2.2	AC voltage accuracy (steady state) over entire load, load PF & DC voltage range.	± 2% for balanced load
3.2.3	Transient voltage regulation	8% at 100% load step
3.2.4	Transient recovery	Return to steady state condition within 50

SL. NO	DESCRIPTION	TECHNICAL PARTICULARS
		ms after disturbance.
3.2.5	Voltage wave from	Sinusoidal
3.2.6	Range of adjustment of AC output voltage	$\pm$ 5% at rated load
3.2.7	AC Harmonic content (THD-Voltage)	As per IEEE 519
3.2.8	Phase displacement for three phase outputs	$120^0 \pm 1^0$ for balance load $120^0 \pm 3^0$ for 20% unbalanced load.
3.2.9	Nominal frequency	50 Hz
3.2.10	Frequency regulation (Without static by-pass source)	$\pm$ 0.1 %
3.2.11	Frequency regulation (With static by-pass source)	$\pm$ 2 Hz
3.3	AC standby supply	
3.3.1	Servo controlled voltage stabilizer (SCVS)	Not Required
3.3.2	Isolation transformer (K13 rated)	NA
	(a) Rating	
	(b) Input voltage phase & frequency	
3.4	Maintenance bypass switch	Required
4.0	BATTERY	
4.1	No. of 100% capacity batteries	1
4.2 4.3	Type of battery cell Battery backup time	SMF VRLA 30 min/90 min
4.4	DC link voltage	To be chosen by Bidder
4.5	Mounting Arrangement	Open Type Rack: Multi-Tier
5.0	RECTIFIER	
5.1	Type	IGBT
5.2	Parallel Operation	Required
5.3 6.0	Recharge time on battery boost charge INVERTER	As per Battery manufacturers recommendation
6.1	Overload Capacity	125% for 10 Min.
		150% for 1min
		300% for 4 milli seconds
6.2	Synchronizing	
	- Between inverters	Bidder to Specify
	- Between inverters and standby supply	
6.3 6.4	Parallel Operation Synchronizing Range	Required/Not Required (Bidder to Specify) 50 $\pm$ 3 Hz(adjustable)
7.0	STATIC SWITCH	
7.1	Maximum transfer time	<5ms
7.2	Short time current rating	1000% for 10 milli seconds
8.0	CIRCUIT BREAKER & LOAD	

SL. NO	DESCRIPTION	TECHNICAL PARTICULARS
	BREAK SWITCHES	
8.1	Type	MCCB
9.0	ACDISTRIBUTION BOARD	If required, provide as per below spec. (to be Decided by Bidder)
9.1	Type	Integral or separate
9.2	Construction	Modular, single front
9.3	Busbars	Aluminum/Copper
9.4	Incoming	MCCB
9.5	Outgoing	MCB/MCCB
9.6	Cable entry facility	Top / Bottom
10	STANDARDS	
a	UPS	IEC - 62040 (Part-III)
b	Basic climatic & mechanical durability tests for components for electronic and electrical equipment	IS 9000
c	Environmental tests for electronic & electrical equipment	IS 9000
d	Transformer and inductors (Power, Audio, Pulse & switching) for electronic equipment	IS 6297
e	Printed wiring boards	IS 7405
f	Environmental requirements for semiconductor devices and integrated circuits	IS 6553
g	Terminals for electronic equipment	IS 4007
h	HRC Cartridge fuses	IS 9224/IEC 60269.1
i	Indicating Instruments	IS 1248/IEC 60051
j	Degree of protection	IS 13947/IEC60 947-1
k	Semiconductor converters	IEC 60146
l	Semiconductor rectifier equipment code	IS 6619
m	Thyristor converters	IS 5082
n	Emergency std by power systems	IEEE 446
o	Sealed lead acid cells	IEC 60896-2
p	Vented type Ni-Cd batteries	IEC 60623
q	Stationary cells of batteries lead acid type	
r	(a) Tabular plate	IEC 60896-1
s	(b) Plante plate	IEC 60896-1
t	IEEE recommended practice for sizing Ni-Cd batteries for stationary application.	IEEE 1115
u	1100V cables	IS 1554
v	Surges withstand capability test in accordance with	IEC 60255-5
w	Harmonic levels	IEEE-519

L. DATA SHEET FOR DG SETS

Sr. No	ITEM	UNIT	
1.0	**GENERAL**		
1.1	Designation		Emergency DG System
1.2	Applicable Standard		Center/State Pollution Control Board norms, ISO 3046,8528-1 / BS 649,5514., IS
2.0	**SCOPE**		
2.1	DG Foundations		By Others
2.2	DG Set as per BOQ		By DG System Vendor
2.2	Room Acoustic		By DG System Vendor
2.3	Insulated Engine exhaust Piping with fittings, specials, valves and supports etc complete		By DG System Vendor
2.4	Chimney as per CPCB with supports		By DG System Vendor
2.5	Diesel day Tanks with tank mounted instruments for DG at inside acoustic canopy		By DG System Vendor
2.6	Fuel piping from HSD to Main tank and Day tank to DG		By DG System Vendor
2.7	415 V DG switchgear isolation Panel ad DG sync panel		By DG System Vendor
2.8	Suitable Bus duct (NSPBD)connection between Isolation panel to DG terminal		By DG System Vendor
2.9	Busduct / Cable connection between Isolation panel to PCC		By DG System Vendor
2.10	AMF starting		By DG System Vendor
2.11	Control and Instrument cabling between DG set, DG control, DG switchgear and instruments and between any to equipment supplied by this Vendor		By DG System Vendor
2.12	DG set Foundation drawings		By DG System Vendor
2.13	Services		
	a) General design, materials, construction features, manufacture, shop inspection and testing at the manufacturer's		By DG System Vendor

Sr. No	ITEM	UNIT	
	works, delivery at site, handling at site, erection, testing, commissioning, performance testing and handing over of Diesel Generator set with Acoustic Enclosures, inbuilt isolation module with necessary items.		
	b) DG control Panel		By DG System Vendor
	c) Obtaining Statutory Approvals		
	i. Central Pollution Control Board		By DG System Vendor
	ii. Electrical Inspector		By DG System Vendor
	iii. Local Electrical Utility		By DG System Vendor
	iv. Chief Controller of Explosives if any		By DG System Vendor
	v. Any other deemed necessary to install and commission & operation of DG		By DG System Vendor
3.0	**DIESEL GENERATING SET**		
3.1	GENERAL		
3.1.1	Designation		Emergency DG Set
3.1.2	Numbers Required	Sets	As per BOQ
3.1.3	Rated kVA	kVA	2000(prime rated)
3.1.4	Location		Inside DG room (With room Acoustic)
3.1.6	Fuel		HSD as per IS: 1460
3.2	DESIGN DATA		
3.2.1	Continuous output at site conditions		Min 80% of Rated kVA
3.2.2	Overload capability for one (1) hour in twelve (12) consecutive hours of operation		10%
3.2.3	Output		
	a) Output Voltage		415 V, 3 phase, 50 Hz AC
	b) Power Factor		0.8 pf
3.2.4	Permissible Variation		

Sr. No	ITEM	UNIT	
	a) Voltage		± 10 %
	b) Frequency		± 5 %
3.2.5	Noise Level		75 dbA at 1 M from room acoustic in all directions
3.2.6	Largest Motor to be started with Voltage dip limited to 15%		
	a) Motor Rating	kW	308 kW (tentative) and will be confirmed during design stage
	b) Method of starting		Star Delta
3.2.7	Harmonic Loading		As per the IEEE limitation.
3.3	OPERATION REQUIREMENTS		
3.3.1	Black Start Capability		Required
3.3.2	Starting		Electrical start from Remote/ Local & Manual with AMF starting
3.3.3	Stopping		Electrical stop from Remote/ Local & Manual
3.3.4	Parallel Operation		
	a) If more than one dg is in operation, whether in isolation / in parallel		Suitable for parallel operation whenever required
	b) DG Sets in parallel with Grid		No
	c) Momentary parallel operation with Grid		No
	d) Under frequency Load shedding scheme		No
3.3.5	Period for taking Load from 'Start' impulse	sec	<15 sec
3.4	DIESEL ENGINE		
3.4.1	General		
	a) Numbers Required	Sets	As Per BOQ
	b) Applicable Standard		ISO 3046,8528-1 / BS 649,5514.
	c) Rating		To suit DG Design Data
3.4.2	Engine Cooling System		Radiator Cooled
3.4.3	Cooling Tower		
	a) Type		Not Applicable
	b) Capacity	TR	Not Applicable
3.4.4	Cooling Water Pumps		
	a) Type		Not Applicable
	b) Capacity (Flow)/ Head	m3/hr	Not Applicable
3.4.3	Engine Starting System		Electric Starting
	a) Battery		
	Battery Type		Maintenance free
	Capacity	AH	minimum three (3) continuous Cold starts
	b) Battery Charger		From AC Mains & Engine driven

Sr. No	ITEM	UNIT	
			Battery charger
3.4.4	Fuel Oil Day Tank		
	a) Type		Rectangular MS Fabricated
	b) Applicable Standard		Generally as per IS 10987
	c) Capacity		990 Ltrs day tank
	d) Location		AS per DG room layout
3.4.5	Instruments on each day tank		
	Level Indicator & level switches		Yes
	Type		Bidder to specify
	Range		To suit day tank
3.4.6	Air Intake and Exhaust system		
	Intake Air Filters		Required
	Exhaust Silencer		Heavy duty Residential Type
	Height of stack		As per CPCB/KPCB requirements
	EXHAUST PIPE/ STACK		Exhaust pipe shall be considered with necessary MS supports arrangements
3.5	ALTERNATOR		
3.5.1	General		
	a) Numbers Required	Sets	As per BOQ
	b) Applicable Standard		IS 4722/ BS 5000 Part 99
	c) Rating		Suitable for 2000kVA Prime rated
3.5.2	Construction Features		
	a) Enclosure		IP 23
	b) Insulation Class		Class H
	c) Terminal Box		Suitable for termination of Non-Segregated Phase Bus Duct (NSPBD).
3.5.3	Temperature Rise		Limited to Class F
3.5.4	Method of Neutral Grounding		415V SYSTEM - SOLIDLY EARTHED
3.5.5	Governing		Class A1
3.5.6	Excitation		BRUSHLESS
3.5.7	Winding and Bearing RTDs for generator		Yes
3.5.8	Battery Voltmeter		Yes
3.5.7	DG set Termination from Purchaser end		Sandwich Busduct
3.6	INSPECTION & TESTING		
3.6.1	At FACTORY Complete DG set		
	At 100 % Load		4.0 Hour
	At 110 % Load		1 Hour
3.6.2	At Site Complete DG set		
	At 100 % Load		8 Hours
	At 110 % Load		1 Hour
3.6.3	Diesel Engine		Type and Routine tests as per ISO 3036
3.6.4	Generator		Type & Routine tests as per IS4722/ BS5000

Sr. No	ITEM	UNIT	
3.6.5	Exciter		Type & Routine tests as per IS4722/ BS5000
3.7	PERFORMANCE GURANTEES		
3.7.1	Continuous Output (at site conditions)		Guaranteed capacity (kVA) provided by the Vendor during Bid, which shall be greater than 80% of the rated KVA.
3.7.2	10% Overload capacity		For One (1) hour out of Twelve (12) hours operation without overheating.
3.7.3	Fuel oil consumption at 50%, 75% and 100% Load		+ 3.0 % of data furnished by Bidder
3.7.4	Lube oil consumption		+ 5.0 % of data furnished by Bidder
3.7.5	Noise Level		75 dba at 1 m from surface of room Acoustic in all directions
4	ROOM ACCOUSTIC		
4.1	Type of Room Accoustic Enclosure		Factory Fabricated Tile Panel Type.
4.2	Dimensions of the Tile (L x H x D)		Bidder to Specify
4.3	Material of the Panel		22 SWG Aluminium Sheet Panel (Prefabricated)
4.4	Material of the Frame		22 SWG G I frame for holding panels
4.5	Level Of Perforations on Panel		Min 15 % Perforated.
4.6	Accoustic Material Used		RockWool covered with tissue cloth (64 KG / M3 DENSITY)
4.7	No. of tiles / Panels required.		As per the room dimensions.
4.8	Finishing Colour of Panel		RAL 7032 , Powder Coated.
5	ACCOUSTIC DOOR		
5.1	Type of Door		Fire Rated, Accoustics Door
5.2	Width of the Door		As per BOQ.
5.3	Door Frame -		3mm Thick LCMS
5.4	Door Inner Sheet -		1mm Thick GI perforated
5.5	Level Of Perforations on Panel -		Min 15 % Perforated.
5.6	6Accoustic Material Used -		Rock Wool covered with tissue cloth
			(64 KG / M3 DENSITY)
5.7	Door Outer Sheet		2mm LCMS / CRCA Sheet
5.8	Hinges		5mm SS Black Coloured Power Coated.
5.9	Door Beading		EPDM Rubber
5.10	Noise Level		25 DB Insertion
6	'HIGH SPEED DIESEL STORAGE TANK		
6.1	Type		Horizontal welded
6.2	Installation		Above ground
6.3	Capacity		20KL
6.4	Stored Fluid		High Speed Diesel
6.5	Material		MS -Sizes Bidder to Specify
6.6	Dimensions		As per IS 10987 with latest

Sr. No	ITEM	UNIT	
			amendments -Detailed drawings to be submitted after award of contract
6.7	Type Of Nozzle / Manholes		Bidder to Specify
6.8	Notes for HSD Tank Works: • Tanks and holding down straps shall be corrosion free coated with red oxide and anti-corrosive paint. • Fill up from storage tank to the tanker bay should have NR valve and strainer • The complete design, fabrication and testing of the tank shall be as per IS 10987-1992 & CCOE. • The Dimensions of the Dish and Shell shall as per the storage capacity and as per IS 10987-1992. • The end plates shall be without joints or any welding. • Inside of Tanks should be coated with 2 coats of anti-corrosive rust preventive paint and Outside tank 2 coats of black bitumen paint • Tanks should be tested for water fill and pressure test as per IS 10987. • Should supply Inclusive of all required accessories for completing the installation		

TECHNICAL SPECIFICATIONS FOR HEAT VENTILATION AND AIR CONDITIONING SYSTEMS

TABLE OF CONTENTS

HVAC TECHNICAL SPECIFICATIONS

SECTION I - INTRODUCTION

1.1 SYSTEM DESCRIPTION

The goal of an HVAC system is to provide a healthy, thermally controlled and comfortable indoor environment with acceptable indoor air quality within the space of a building envelope by Designing and Planning a HVAC system for the Project with the objective that the system designed and built is cost-wise economical, energy efficient as well as simple, flexible with regard to its operation & maintenance.

Also, the system must fuse and integrate fully with the Building envelope for natural, normal behavior as a whole, in disposing of the heat gains or off-setting the heat losses to maintain the desired environment inside the space.

1.2 TIDCO FINTECH CITY

The Government of Tamil Nadu has proposed to develop Chennai as Global Financial Centre. Considering the inherent advantages of Chennai, Government of Tamil Nadu through Tamil Nadu Industrial Development Corporation (TIDCO) has conceived the idea of creating a Fintech City with State of Art Infrastructure. This Fintech City is envisaged to be a city of the future with state-of-center for business district with mixed use infrastructure and facilities, in a new era of urban living. TIDCO has appointed TCE as the Design and Project Management Consultant (PMC) for Establishment of Fintech City, Fintech Tower and Start-up Hub in Chennai, Tamil-Nadu.

1.3 TIDCO FINTECH TOWER:

Purpose of this report is to give detailed description of HVAC system for the Proposed Fintech Tower building with 2 basement + 3 podiums and 9 floors, at Fintech City in Nandambakkam Village, Alandur Taluk, Chennai District, Tamil Nadu, developed by Tamil Nadu Industrial Development Corporation (TIDCO).

SECTION II - GENERAL REQUIREMENTS

The Conditions of Contract as described in this document are Intended to amplify the general condition of contract and shall be read in conjunction with Specification of work, drawing and all other document forming part of this contract wherever the context so requires.

The following clauses shall be considered as an extension and not in limitation of obligation of the contractor. Wherever there is dispute in the terms, Specifications, Bill of Quantities, Drawings and Interpretation, the Architects / ACMV Consultant / Project Consultants decision shall take precedence.

Notwithstanding the sub-division of the document into separate sections and volumes every part of each shall be deemed to be supplementary to and complementary of every other part and shall be read with and into the contract.

Wherever it is mentioned in the specification, that the contractor shall perform certain work or provide certain facilities, it is understood that the contractor shall do so at his own cost.

2.1 OBLIGATION OF CONTRACTOR

In addition, the obligations of contractor in fulfillment of ACMV work are stated below:

- Detailed engineering
- Submission of Quality Assurance Plan
- Procurement, fabrication and supply
- Inspection and testing
- Expediting and coordinating with other agencies
- Scheduling and Monitoring
- Erection, checking and testing
- Pre-Commissioning
- Commissioning
- Carrying out performance tests to meet the specification requirement and to the full satisfaction of employer and as per Project consultant's / client's standards, procedures.
- Training the client's representative in the operation and maintenance of the plant and the system
- Providing guarantee.
- Final documentation and submission of as built drawings.
- Maintenance during guarantee / defects liability period
- Removal of scraps / wastages generated in process of work.

2.1.1 Checking up the equipment and other materials to ensure that the same are as per the specifications laid down in description of work and drawings and also to make sure that they are in proper condition to be taken up for erection.

2.1.2 Drawing up a detailed time schedule and to organize the entire work in conformity with the time schedule

2.1.3 Arranging for the procurement and ensuring availability at the site at the required time all the erection tools, necessary tackle, required for the erection work such as cranes, air compressor, welding sets, oxy-acetylene cutters, electric and pneumatic drills, steel wedges for leveling and grouting, scaffolding guy wire testing and cleaning equipment and all other construction equipment's necessary for proper erection.

2.1.4 Arranging for procurement and ensuring availability at site, at the correct time for all consumables, construction materials for erection work such as welding electrodes, oxygen, acetylene and other welding gases, greases, petrol, cotton waste and all temporary fastening such as tack bolts clips, cleats and other materials, chemicals for cleaning and such other materials as may be needed to execute the handling and erection works.

2.1.5 Engaging and allotting adequate number of engineers, erectors of all the required categories Supervisory, skilled and unskilled labour for carrying out different items at different stages of the erection work.

2.1.6 Assembling and installing of all items of machinery / equipment at their proper places at the plant site. The erection work shall cover necessary operations such as, handling, sorting, stacking, unpacking, cleaning, assembling, bolting, welding, riveting, site fabrication, instrument cable laying and jointing, earthing, erecting, treatment for underground pipe protection, painting, thermal insulation and manual / mechanical / chemical cleaning, testing and other operations, provision of inserts, embedded plates in walls / roof for erection of ducting piping etc.

2.1.7 Installation of all instruments measuring and controlling of the plant. All control wiring also forms part of erection work.

2.1.8 Checking up of each individual items of plant equipment as well as each pipeline, to ensure that the erection of these items has been properly carried out in conformity with the technical specification.

2.1.9 After all the installation and assembly works are completed, the entire plant assembly including the pipe lines shall be checked up, by proper tests applicable to ensure that individual items of equipment, including pipe line have been properly installed.

2.1.10 Machines like compressors shall be checked up by actual working to satisfy that their alignment has been properly made and there are no mechanical faults.

2.1.11 Pipe lines shall be checked up by hydraulic tests to make sure that all the items such as valves, flanges etc., have been properly fitted up to, that there are no leakages or wrong connection of interconnecting valves, pipes etc.

2.1.12 Similarly all ductwork shall be tested as per SMACNA standards to ensure that air leakages rates are within the limits prescribed in the specification.

2.1.13 Instruments shall be checked up individually to make sure that they are in proper working order. The testing shall be in accordance with Indian Standards, accepted International Standards. All instruments used for testing and measurements shall be calibrated instruments conforming to National level standards.

2.1.14 The performance of the aforesaid services should conform strictly to the technical specification, which forms an integral part of this contract.

2.1.15 It is only after the entire plant assembly has been thoroughly checked up on the lines indicated above and found satisfactory that erection work shall deemed to be completed and the plant considered ready for commissioning.

2.1.16 The contractor shall submit 6 sets of 'As Built' drawings of services like ducting, piping, as well as equipment layout, wiring diagram etc. and a soft copy of the same on a CD.

2.1.17 Plant and equipment details shall also be prominently displayed in engraved plastic nameplates.

2.2 QUALITY ASSURANCE REQUIREMENTS

2.2.1 GENERAL

Quality assurance (Q.A) requirements form an integral part of the contract and all the contractors / subcontractors are required to comply fully, with the same.

2.2.2 SCOPE

The scope of QA requirements is as follows:

1. Preparation of a Quality Assurance Plan (QAP) by the Contractor for Material / Equipment.
2. Quality Assurance (QAI) and Quality Control (QCI) activities at site for all installations works including:
   - Testing and operation of the system complete as per the validation
   - Procedures and standards.
3. Documentation of the above as per the standards.
4. The requirements to meet fully the standards and validation procedures, protocols.
5. All QAP, QAI & QCI shall be submitted to Architect / Consultant for approval.

2.3 TENDER DRAWINGS

2.3.1 The drawings issued with this Specification are for guidance of the TENDERER and show the approximate positions of all items of equipment, etc. The contractor to ensure that the equipment is located well within the proposed location.

2.3.2 The contractor shall prepare the shop drawings based on these tender drawings and the shop drawing shall be approved by the Consultant / Client. The tender has to ensure that their proposal will meet with all the current rules and regulations of the relevant local / national statutory.

2.3.3 The actual and final position of all items of equipment shall be determined at site after due co-ordination with other disciplines and approved by the Project Consultant / Client

2.4 SHOP DRAWINGS

2.4.1 All shop drawings shall be prepared in Auto CAD, scale not less than 1:100 on standard A1 size.

2.4.2 Before any work is put in hand, the Contractor shall submit two (2) sets of dimensioned drawings showing all details of the equipment, piping, wiring, ductwork and materials etc for the review and approval of the Project Consultant. The Contractor shall not commence the works until the Drawings are reviewed and approved by the Project Consultant / Client.

2.4.3 Approval of Drawings by the Project Consultant / Client does not exonerate the Contractor from any responsibility under the Contract terms and conditions.

2.4.4 The detailed shop drawings, prepared to a minimum scale of 1:100 scale, plus necessary cross sections 1:50 scale, showing complete detail of each item of specially fabricated equipment shall be submitted to the Project Consultant / Client for his review prior to proceeding with fabrication. These Drawings shall be based upon the floor plans and the specifications. These drawings shall include accurately dimensioned details and locations of any special wall openings that are required where items of equipment extend through walls.

2.4.5 If early review is required, the Contractor shall advise the Project Consultant to this effect when submitting the drawings.

2.4.6 The Contractor shall forward six (6) sets of the reviewed approved shop drawings to the Project Consultant for distribution to various parties.

2.4.7 In case of existing building fitted with other services, the vendor shall prepare the shop drawings based on actual site condition and coordinated shop drawing must be prepared in line with existing services.

2.5 WORKING DRAWINGS

The Contractor shall at all times maintain on site, in good order and condition, a complete set of all drawings and documents necessary for the proper execution and checking of the works. These drawings and documents shall be made available on request to the Project Consultant / Client or his / their authorized persons on site. Any amendment shall be indicated on the Drawing, dated and signed by the authorised person in charge, with reasons stated if possible.

2.6 AS-BUILT DRAWINGS

2.6.1 The Contractor shall prepare two (2) sets of paper prints of the as-built drawings, showing accurate record of the work as installed by the Contractor and submit to the Project Consultant / client for approval.

2.6.2 When approved, the Contractor shall submit three (3) sets of paper prints, and one (1) soft copy.

2.6.3 As-installed drawings are for reference and record by the Project Consultant / Client. Such records shall include the preparation of properly dimensioned drawings showing the following:

- General arrangements of all services.
- Cable routes, types of fixings, support and other particulars
- The detailed layout of all equipment, plant etc.,
- Conduit pipe runs, duct work, etc.,
- A system diagram giving means of identification, circuit labeling and mounting level of equipment, etc., provided under the sub contract.

- Schedules of all equipment installed.

2.6.4 All drawings submitted by the Contractor shall have in the bottom right hand corner in addition to the Contractor's name, title, scale and drawing number, the title of the project and subject of the drawings and as per the standards approved by the Project Consultant.

2.6.5 The retention sum or final payment will not be released until all such drawings and records have been received and approved by the Project Consultant / Client.

2.6.6 One copy of the schematic drawing, isometric view of piping layout drawing showing all equipment, component, connections, etc. be framed and hung in the relevant Plant Room or location as directed by the Project Consultant / Client.

2.7 PRE-COMMISSIONING CHECKUPS

Prior to start-up of any unit, system, the contractor shall follow pre-commissioning check-ups. Each pre-commissioning check-ups reports shall be duly signed by project-consultant / client to proceed to the next step.

2.8 TESTING AND COMMISSIONING

2.8.1 GENERAL

Testing shall mean providing that all the systems efficiently meet the performance specified while in operation. The systems shall be tested in the presence of the Project Consultant / Client. The contractor shall provide written requisition to the Project Consultant / Client to witness the test. The notice period shall be not less than 24 Hrs.

The contractor shall arrange for representatives of his own and his Sub- Contractor to be in attendance during the tests.

It shall be the responsibility of the Contractor to supply all necessary testing equipment including pitot tube and manometer, anemometer, newly calibrated pressure gauge, etc. and necessary skilled and unskilled laborers.

Should anyone of the tests reveal a fault, the Project Consultant / Client will order that the fault be corrected and re-tested prior to acceptance. All fees connected with testing of equipment payable by Contractor to any of the relevant Government Authority shall be borne by the Contractor.

In general the testing procedure will be strictly as per QAI/QCI validation procedures, standards.

2.8.2 COMMISSIONING TEST

The complete installation or any part thereof shall be tested, both before and after being commissioned to check the performance in operation. All fees connected with testing of equipment payable by the Contractor to any of the relevant Government authority or expert from the Supplier shall have been included in the Tender by the Contractor.

The contractor shall be represented by a competent person approved by the Consulting Engineers during the whole of the period required for the tests.

All materials and equipment supplied or erected under this Contract, which fails the tests, shall be replaced or rectified at once by the Contractor without any cost to the Client.

The Contractor shall supply all necessary instruments, apparatus, connections, skilled and unskilled labour required for the tests and the results shall be recorded and Project Consultants / Client make accurate records of all tests carried out and furnish the Consulting Engineers with four (4) copies of the test certificates and schedule of test results in approved form.

The contractor shall prepare a detailed and comprehensive checklist for use during commissioning and testing. At least four (4) months prior to the start of commissioning, the Contractor shall commence gathering information required for this checklist. Two (2) months prior to the start of commissioning, the Contractor shall submit to the Consulting Engineer his proposed checklist for approval as under.

- Ensure that all items that should be checked are complete in all respect.
- Produce a permanent record of the commissioning checks-carried out.

Accordingly, the checklist must be built from information contained in the Specification, from Suppliers, Sub-contractor's and Contractor's installation and commissioning similar equipment and systems.

The details of the checklist must be such that it can be completed with a reading or a tick, which means that every device listed, has been checked.

2.8.3 RELIABILITY TESTS AFTER COMMISSIONING

The system installation shall be required to operate within the specified limits of its rating either continuously or intermittently as may be convenient without failure of any kind for a period of one (1) calendar month, before the provisional taking over certificate is issued. Final taking over and acceptance certificate will be issued only after 72 hours performance test in peak summer.

Should any failure occur due to or arising from faulty design, materials or workmanship, but not otherwise sufficient to prevent the commercial use of the installation, the reliability test period of one (1) calendar month shall be recommended after the Contractor has remedied the cause of failure to the satisfaction of the Consulting Engineer. The onus of proving that any failure is due to any other cause shall rest with the Contractor.

2.8.4 TESTING AND ADJUSTMENT DURING THE MAINTENANCE PERIOD

In addition, the Contractor shall perform such test as may be directed at any time during the Maintenance period to satisfy the Project Consultant / Client that the installation complies with the specified requirements.

2.9 OPERATING & MAINTENANCE MANUALS

The Contractor shall prepare & submit an operating & maintenance describing the operation and maintenance of the whole system, for Consultant's approval. The O&M Manual shall include:

- Brief write up on the system installed.
- Operating instruction for all equipment
- Catalogues for all equipment including head/flow curves for all pumps with impeller size marked.
- List of recommended spares for 2 years maintenance.
- Schedule of recommended maintenance for various periods, daily, weekly, monthly etc.

On receipt of approval from the Consultant, the Contractor shall submit 3-sets of (O&M) manual, in a stiff covered ring binder. A soft copy in CD of the O&M Manual shall be also submitted.

Practical completion will be certified only after the receipt of the above operating manual by the Project Consultant.

2.10 IDENTIFICATION AND LABELING

The various parts of the works shall be properly labeled and identified. The Contractor shall carry out the following work:

2.10.1 Machine engraved traffolyte nameplates shall be provided to identify each equipment. Similar labels also be provided on ancillary equipment such as gauges, control Valves, Switches, Indicating lights, Push buttons, relays and other Indicating devices.

2.10.2 Lettering shall be black on while background. Nameplates for major items of Equipment shall be engraved in lettering of at least 6mm. Labels identifying ancillary Equipment shall be engraved in lettering of at least 3mm.

10.1 Identification lettering shall be applied to all pipe work and to all conduit at the following spacing:

- For all concealed runs in walls or ceiling spaces, every 5 metres or at least once.
- For exposed runs, every 10 metres or at least once for each exposed section.
- The identification shall consist of stenciled painted black lettering 25mm high naming the services.

2.11 PLANT OPERATION

The Client shall have free and unrestricted use of the Contract works or any part thereof which the Project Consultant may deem suitable without any interference whatsoever from the Contractor and such use by the Employer shall not relieve the Contractor of any liabilities or obligations in regard to the Contract.

2.12 TESTING

Routine and type tests for various items of equipment shall be performed at the Contractor's/Sub-contractors works and test certificates shall be furnished. The Client or his authorized representative reserves the right to be present during the tests.

After notification to the Project Consultant / Client that the installation has been completed, the Contractor shall make under the direction of Project Consultant such tests and inspection as have been specified or as the Project Consultant shall consider necessary to determine whether or not the full intent of the specifications have been fulfilled and whether further tests shall be considered necessary. The Contractor shall bear all the expenses thereof.

The contractor shall operate test and adjust all air-conditioning, ventilation and exhaust system units, fan motors, all air handling appliances provided in connection with the installation and shall make all necessary adjustments and corrections thereof including the adjustments of all regulating dampers. The detailed record of

the result of these adjustments shall be furnished to and be subject to the approval of the Employer/consulting engineer.

2.12.1 PERFORMANCE TEST

A performance test by keeping the plant / equipment running for a period of 72hrs shall be carried out in peak summer, peak monsoon and peak winters periods. During the tests all necessary readings shall be taken hourly. From the readings so taken, the Contractor shall also establish the Plant, System Equipment capacity. The computed results shall tally with the specified capacities furnished with tender.

The contractor shall install in the system temperature probes, flow meters, pressure gauges etc., to verify the capacity of the various equipment.

All the test instruments labour, operating personnel, oil, refrigerant as required for these shall be furnished by the Contractor at his own cost.

If the test do not show satisfactory result, the Contractor shall at his own cost, rectify/replace all defective installation or part thereof as directed by the Project Consultant / Client within one month. The decision of the Project Consultant shall be final and binding in this respect. Only after all these tests are satisfactory completed and the defects found during these are rectified, the plant will be finally accepted.

2.12.2 TESTING GUARANTEE

All equipment and space conditions shall be tested after carrying out necessary adjustments and balancing to establish the equipment ratings and indoor space conditions. At least **Six** sets of readings shall be taken daily for each item tested and submitted in the form shown separately. Instruments required for testing shall be furnished by the Contractor.

All equipment shall be guaranteed for the specified ratings with a tolerance of 0% on the negative side.

All equipment and the entire installation shall be guaranteed against defective materials and workmanship for a period as stipulated under Section-2 (Special Condition of Contract) from the date, the equipment, installation and the complete system is accepted, and taken over by the client.

2.12.3 SYSTEM BALANCING

The contractor shall leave the system operating in complete balance with water and air quantities as shown on drawings. Set stops on all balancing valves and lock all damper quadrants in proper position. Secure all automatic damper and valve linkage in proper positions to provide correct operating ranges. Proper damper positions shall be marked on ducts with permanent indication.

2.12.4 REPORTS

Provide 3 copies of the complete balancing and testing reports to the Project Consultant and Client for further reference and record. Report shall be neatly typed and bound suitable for a permanent record. Report forms shall contain complete test data and equipment data as specified.

2.13 TRAINING

The Contractor shall conduct a training programme for designated Clients personnel. These courses shall be carried out during normal office hours and for the required duration. The date of commencement of training shall be mutually agreed upon and in any case shall be within one week of hand-over of installation.

The training programme shall cover all operating and maintenance aspects of the system, inclusive of detailed explanation and demonstration of each and every piece of equipment and an overview of the system operation.

The training programme shall consist of both handouts and classroom training, at the job site, or at location agreed upon by the employer.

All instruction manuals, tools, transportation etc. associated with the training programme shall be provided by the Contractor. Such cost shall be deemed to have been included by the Contractor.

2.14 GUARANTEE

The Contractor shall guarantee the inside conditions as stipulated elsewhere. In addition, the Contractor shall also guarantee that all equipment shall be free from any defect due to the defective materials and bad workmanship and that the equipment shall operate satisfactorily and the performance and efficiencies of the equipment shall not be less than the guarantee values.

The guarantee shall be valid for a period as stipulated under Section-2 (Special Condition of Contract) after taking over and any parts found defective shall be replaced free of all costs by Contractor. The services of successful Contractor's personnel if requisitioned by the client during this liability period, the same shall be made available free of any cost.

The Contractor shall without any extra cost carry out all routine and special maintenance of the plant and attend to the defects that may arise in operations of the plant for the aforesaid period after the installation is taken over,.

One month before the end of the defects liability period, the Contractor shall notify the Client of the required inspections for all equipment's and facilities including specific energy consumption and system performance

2.14.1 GUARANTEE PERIOD

a) Guarantee Period starts from the date of successful commissioning of the system duly certified by the consultant / Project manager / client.

All snag points shal be completed within 30 days from the date of commissioning to the satisfaction of consultants / Project managers / client.

The guarantee period shall be extended for an equivalent period of delay of completion of snag points after 30 days from the commissioning date.

b) Contractor shall depute dedicated person / team at clients place on full time basis with necessary tools and spares during guarantee period to maintain and operate the plant.

Regular and break down maintenance are part of the guarantee period maintenance and without extra cost.

c) Response time	:	2-4 hours
Breakdown time	:	12 hours for minor break down 24 hours for all Major Break down except compressor.

d) GUARANTEE PERIOD: Refer Section-2 (Special Condition of Contract)

2.15 MAINTENANCE IN WARRANTY / GUARANTEE PERIOD

Maintenance will consist of monthly maintenance and necessary adjustment and lubrication of the equipment by the Contractor's employee under competent direction and supervision. In addition to the monthly maintenance, special examination between regular intervals and emergency minor adjustment, call back services should be provided during the guarantee period.

Parts that become necessary to be replaced due to normal wear and tear during the guarantee period will have to be replaced free of cost.

In case of any defect or malfunctioning of the equipment during the period of maintenance, immediate attention must be ensured without claim to any extra amount, charges or compensation.

All the maintenance work will be performed during regular hours of regular working days and holidays as convenient to client with prior permission / intimation from client.

The TENDERER shall furnish warranty for the entire system for a defects liability period (DLP) of 18 (eighteen) months after the final official take over date of the installation. This period shall include maintenance replacement of parts, regular

periodic visit by qualified personnel of the CONTRACTOR and attending to emergency call at short notice.

2.16 CONCLUSIONS OF WARRANTY / GUARANTEE PERIOD

Just before the expiry of the warranty / guarantee period 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, sub-systems in the Contract are in accordance to the specifications.

All tests shall be carried out in the presence of the Project Consultant / Client or his / their representative.

The warranty period is deemed to be over if the Client or his representative is completely satisfied with the system performance during the test.

If any defects are found for non performance of malfunction during the test, contractor shall replace / correct the system without extra cost.

2.17ANNUAL MAINTENANCE CONTRACT

The Contractor shall quote separately for comprehensive annual maintenance contract for full three years period after the Defect Liability Period (DLP). The Contractor shall bear the full responsibility for all kinds of maintenance, which includes periodic maintenance, as well as attending to all breakdown and emergency calls at short notice whenever called. During this three year period the scope of annual maintenance contract includes repair and replacement of any or all parts as required. Besides, the replenishment of all consumables shall also to be included in the scope of annual maintenance contract.

The Contractor shall furnish the list of recommended spares along with quantity and unit price schedule to the employer along with the bid. The Client reserves the right to order the required spares during the tenure or on completion of annual maintenance contract at the quoted price which should be valid for the entire maintenance period i.e., three (3) years after DLP.

After completion of guarantee period, client may award the AMC to any other agency or may call for tender as per the client’s policy and choice.

2.18 COMPENSATION FOR SHORT-FALL IN CONTRACT RATINGS

2.18.1 RATINGS/CAPACITIES OF THE PLANT

There shall be no credit to the contractor if the output of the plant is higher than the rated capacity. There will be zero percent (0%) tolerance for the rated capacity on the negative sides.

During performance tests, in case of any shortfall in the contracted system/equipment capacity, the Contractor will be given an opportunity to make adjustments after which the performance test will be conducted again at the Contractor's expense. In case the equipment does not meet the contract rating, the equipment will have to be replaced at free of cost within a reasonable period of time as will be indicated by the Project Consultant / Client and as per Contract Clauses and penalty as per general terms and conditions shall be applied.

2.19 TAKING OVER CERTIFICATE

As soon as the works have been completed in accordance with the contract and have passed the tests on completion, as per validation procedures, the Project Consultant / Client shall certify the date on which the works have been successfully commissioned.

2.20 MOCK-UPS AND SAMPLES

The contractor shall carryout mockups of typical installations of services and common items of equipment as and when directed by the Project Consultant. Mock-ups shall be carried out to ensure proper installation and coordination with all services on site.

Upon approval, mockup shall be used as the basis of installation work for similar areas.

Samples of components, fixture, etc., shall be, submitted to the Project Consultant for approval before supply and installation of the component or work.

2.21 BRAND NAME/MAKE OF EQUIPMENT

The various components, equipment of the ACMV System offered should be only of the 'Brand Make/as indicated elsewhere in the specification to ensure fair evaluation of proposal. It is to be noted by the contractor that materials/equipment for which brand/make has not been specified, the contractor shall use only reputed makes. The contractor shall submit a list of such brands/makes for approval by the Project Consultant / Client.

2.22 SITE MANAGER & SITE ENGINEER

The Manager and Site Engineer posted at site shall have adequate experience for handling a job of this magnitude. The resume of the site manager & engineer shall be submitted along with the Tender for evaluation and approval.

2.23 CONSUMABLE MATERIALS DURING CONSTRUCTION, COMMISSIONING TESTING AND SUBSEQUENT WARRANTY PERIOD

The contractor shall supply at his own cost the following consumable materials as and when required.

- All oils and greases required for lubrication of compressors, fan bearings, motors bearings, pivots and other moving parts.
- All refrigerant required to replace refrigerant losses in the refrigeration system.
- All consumable, filter elements/rolls
- All electrical consumables such as carbon brushes for electric motors, fuses etc.
- All electric contact points required to replace worn electric contact points in switchgears, motor starter gears, electronic control gears and electric relays.
- All cotton waste, soap detergent and other cleaning materials required for cleaning purpose.

After every inspection and service, the contractor shall submit a written report to the Project Consultant with a copy to the Client.

2.24 PAINTING & LABELING

2.24.1 GENERAL

Unless otherwise specified, all exposed surfaces including trunkings and cable tray, ductwork, equipment etc., shall be thoroughly cleaned and painted.

All ferrous metal surfaces without protective finishes shall be painted, exposed surfaces of moving parts, which shall be thoroughly oiled and greased as required.

Non-ferrous surfaces shall be left unpainted unless called for in this specification as required by the Project Consultant for the purposes of colour coding and identification. Aluminum grilles and diffusers shall be powder coated with color approved by Project Consultant.

All bare surfaces requiring painting shall first be given a priming coat followed by an undercoat and two finishing coats.

2.24.2 PAINTING / FINISH

Unless otherwise specified, all exposed surfaces including trunkings and cable tray, duct work, equipment, etc., shall be thoroughly cleaned and painted.

All ferrous metal surfaces without protective finishes shall be painted, except surfaces of moving parts which shall be thoroughly oiled and greased as required.

Non-ferrous surfaces may be left unpainted unless called for in this specification or required by the Architect for the purposes of colour coding and identification. Aluminum grilles and diffusers shall be powder coated with colour approved by the architects.

All bare surfaces requiring painting shall first be given a priming coat followed by an undercoat and two finishing coats.

2.24.3 SIGN WRITING

All major items of equipment shall be identified with approved names and / or numbers of suitable size in proportion to the size of the respective items.

Pipelines shall be painted in contrasting colour directional arrows adjacent connections, valves and branches and at intervals of not more than 2.5 m. These arrows shall be 75 mm long on pipes up to 50 mm diameter and 150 mm long on pipes over 50 mm diameter.

All stop valves and control valves the function of which are not obvious shall be provided with a non-corroding metal or laminated plastic identification tag. The tag shall indicate the service, and the area or items which the valve serves.

2.25 CONTROL OF NOISE & VIBRATION

This section of the specification covers the supply, delivery, installation and testing of Noise and Vibration Control equipment to be used in the isolation of the various Mechanical equipment as called for in this specification.

It is the intent of this specification that noise levels due to mechanical equipment and related services will be controlled to the design objectives stated herein, in all occupied areas. The requirements specified are considered to be the minimum precautions necessary to achieve these objectives. The entire installation shall operate without objectionable noise and vibration as determined by the Architect.

The contractor shall examine all drawings and specifications including architectural and structural sets of working documents, before commencing any work on the project and shall immediately bring to the Architect’s attention any characteristics or properties of the building or any other factors which, in his opinion, would jeopardize or nullify the attainment of the design objectives.

The contractor shall guarantee that the complete plant and installation when operated within the design criteria shall acoustically perform to the noise criteria ratings specified.

2.26 MISCELLANEOUS EQUIPMENT

All equipment located in plant rooms above or under occupied areas and capable of producing noise or vibration shall be isolated from the structure. Acoustical isolation by neoprene/fibreglass, cork pads is required for tanks, electrical switchboards, etc.

2.27 PARTIAL ORDERING

The client Reserves the right to order the equipment and material from any and all alternates, and /or to order high side and /or low side equipment and materials or parts thereof from one or more tenderers through the Architect/Project consultant/ his representatives**.**

2.28 SOFT WATER AND POWER REQUIREMENT

The tendered shall submit along with his offer requirement of soft make up water and power required for various equipment included in his system offered.

SECTION III - CHILLER

3.1 AIR COOLED SCREW CHILLERS – FOR CRITICAL ROOMS

Air Cooled chillers are planned for the critical areas across the building. This tapping shall be given as provision for each tenant with a capacity as mentioned in the critical room AC Heat load data sheet. Centralized chiller plant room space is planned along with all related space provisions for below spaces within the building.
Additional Chiller water tap off provision after isolation valve for critical room AC (working and standby) inside AHU room.

System configuration
Total AC load required in TR = 176TR
Considering diversity of 85% = 150 TR
Proposed Chiller capacity = *150 TR X 2Nos Air cooled chillers (1 W +1 S)*
Below are the locations of high side equipment's

- Air cooled Chiller plant room is in the Terrace
- Multiple CHW shafts from terrace to Basement-02.

3.1.1 SCOPE

The scope of this consists of but is not necessarily limited to the following:

- Manufacture and supply of BMS compatible Air Cooled Screw Chillers with associated motors and accessories.
- All associated items herein to be supplied delivered and installed.
- Assembly of chiller components including connection of coolers, condensers, motors, compressors, purge system for low pressure machine etc. into complete refrigeration machines.
- Provide manufacturer's factory representative's services, including coordination, and start-up and testing supervision.
- Testing (at field), start-up supervision, training and providing necessary documentation and tools for operation.
- Carry out performance test run at site.

3.1.2 TYPE & CAPACITY

The chiller shall be Air Cooled water chilling machine with single or multiple screw compressors and the actual refrigeration capacity and performance requirements at given design conditions of chilling machine shall be as indicated in drawings and Bill of Quantities.

3.1.3 GENERAL

Provide factory-assembled and tested, packaged, air cooled, liquid chillers consisting of Unit mounted VFD with harmonic filter air cooled chilled is preferred, As per IEEE519 standards. screw compressors, compressor motor, air cooled condenser, condenser fans, evaporator, purge unit, refrigeration accessories, instrument and control panel including

gages and indicating lights, auxiliary components and accessories, and motor starters. Construct and rate units in accordance with AHRI Standard 550/590.

3.1.4 CASING

The casing and structure of the machine shall be of robust construction and weatherproof type. The panels shall be of heavy gauge, hot dip galvanized steel and they shall be assembled with folded joints. Where and if ferrous materials are used, whether for supporting structure or for any other system or for components, such materials / components / sections shall be given one coat of epoxy primer and two coats of epoxy paint of approved color.

3.1.5 COMPRESSOR

The compressor shall be a rotary screw type powered by a semi-hermetic / open drive. The compressor shall be suitable for use with refrigerant R134a. The compressor should be supplied by the OEM of chiller manufacturer. It shall be complete with suction and discharge shut-off valves, relief valve, oil filter, suction filter, muffler, dual manual reset type pressure state, oil safety switch, refrigerant suction and discharge pressure gauges, crankcase heaters and relays, direct coupled motor, oil separator ,oil cooler. The compressor shall incorporate automatic capacity control feature. The unit shall be provided with slide valve unloading for partial load operations. The compressor shall have reducing capacity down to 25% of its full load condition. Motor shall be a gas-cooled, hermetically sealed, two pole, squirrel cage induction type. Further, compressors should be in unloaded condition during starting.

3.1.6 EVAPORATOR

Provide evaporator of **ASME U Stamped** shell and tube type, seamless or welded steel construction, with cast iron or fabricated steel heads, integrally finned seamless copper tubes either smooth bore or internally enhanced, rolled or silver brazed into tube sheets. Space tube support sheets approximately 2.5 feet. Design, test and stamp refrigerant and water side for 150 percent of the maximum design working pressure in accordance with ASME SEC 8. Provide machine welded to heat exchanger, with tapped drain and vent connections, mechanical joint connections arranged to permit inspection of tubes from either end without disturbing refrigerant and removable without disturbing water piping.

Factory insulates evaporator surfaces and all other cold surfaces with two layers of 19mm minimum thick closed cell nitrile rubber insulation. Apply insulation so that all joints are staggered and no surface capable of causing condensation is un-insulated. Finish insulation with two coats of vinyl lacquer coating.
Provide thermometer wells for temperature controller and low temperature cutout. Provide refrigerant chambers with baffles to distribute entering liquid and separate liquid from leaving gas. Provide evaporator suitable for circulation of the scheduled fluid quantities; with Scheduled pressure drops from inlet to outlet, including water heads as indicated; with sufficient eliminator area or other means to prevent liquid refrigerant carry- over into compressor; and with a minimum water-side tube-temperature. Provide construction and materials conforming to ANSI B9.1 and ASME SEC 8.

3.1.7 AIR COOLED CONDENSER

The condenser coil shall be made out of copper tube with aluminum fins / aluminum micro channel E-coat. The coils shall be sized so as to optimize performance with respect to air flow rate, pressure drop, condensing temperature, power consumption, etc. Thus the values furnished for the parameters of the coil in the Schedule of Equipment shall be regarded as suggested values rather than specified values. The condenser coils shall provide with protective weld mesh to protect the fins from damage.
The air cooled condenser shall incorporate necessary number of propeller fans of adequate size to obtain the required air flow rate under operating conditions. The fan shall be balanced both statically and dynamically. The fan motor shall be of TEFC squirrel cage construction and to IP-55 protection. Wherever condensers with discharge of hot air in the vertically upward direction are involved, special care must be taken to ensure that the fan motors are suitable for such service. The motor shall be suitable for outdoor installation and also for location in the stream of hot air leaving the condenser coil. The fan motor sets shall be complete with protecting guards.

3.1.8 INTEGRAL CONTROL PANEL & CONTROLS

The control panel shall be provided in accordance with Electrical and Controls Requirements for Packaged Equipment. The unit control panel shall be equipped with the following:

- Electronic display to indicate evaporator, condenser pressures.
- Automatic positioning of inlet guide vanes to control outlet water temperature, limit motor current draw, limit evaporator refrigerant low temperature, and cut down high condenser refrigerant pressures. Inlet vane manual position control for service requirements.
- Motor current draw limit selector switch or key pad input for determining percent of full load current allowed, adjustable between 40 and 100 percent.
- One contact shall be provided for an all-inclusive failure alarm of the chiller. This remote alarm-annunciation contact shall be of fail-safe design (a normally open contact maintained closed in non-alarm conditions) so as to alarm upon the loss of control power or upon any other failures to the chiller. The dry contact is to be rated at 10 amps 120 Vac.
- A chiller operating control mode selector at the chiller control panel for off, local, and remote control mode selections. When in the remote run position, the chiller shall accept two 24 V DC signals, one to start and one to stop the chiller.
- When the chiller is commanded to run (either locally or remotely), the chiller will command the condenser water isolation valves to open and evaporator pumps to run via a dry contact closure (rated 10 amps, 120 V AC) located in the chiller cabinet. Pump control power will be provided from the individual MCC control circuits (24 V DC).
- Safety controls and interlocks for unloaded start, time between starts, refrigerant pressure and temperature, condenser water, and evaporator water flows, pressure switches and proof of status switches, oil pressure and temperature, surge

protection, phase unbalance, phase reversal, electrical distribution protection, high current limit, and high motor temperature. Provide ride-through capability of 6 cycles at 30 percent voltage sag.

- Temperature sensors for the chilled water inlet/outlet lines shall be furnished, installed, and pre-wired with the chiller package.
- Operating hours and number of starts meters. This function may also be provided through the Integral Control Panel software.
- Field interface terminal strip for all field wiring.
- Chiller operating mode, chiller outlet water temperature and set point, current limit set point, and system diagnostic information displays.

The control system shall provide the following chiller control functions:

- Sequencing
- Lead / Lag
- Failure Recovery
- Diagnostics
- Operator Interface
- System Optimization
- Protection against single phasing and under voltage.

It shall be able to perform and program the running time for a minimum 3 months. It shall be capable of equalizing the total running hours of all the compressors housed in the unit. All safety and cycle shutdowns shall be annunciated through the alpha-numeric display and consist of day, time, cause of shut-down and type of re-start required.

Safety shutdowns shall include:-

- High oil pressure
- High compressor discharge pressure
- Low evaporator refrigerant pressure
- Motor fault
- Sensor malfunction

Cycle shut-downs shall include

- Low chilled water outlet temperature
- Low oil temperature
- Chilled water low flow or interruption or chilled water pump failure
- Power fault
- Internal time clock
- Anti-recycle

System operating information shall include:

- Chilled water inlet and outlet temperatures
- Evaporator and condenser temperatures
- Oil pressure and oil filter differential pressure
- Oil temperature and oil level
- Suction and discharge temperatures
- Slide valve position

Chiller package status like Start-up sequence status & Shut-down and operation status

- Number of compressor starts
- Total hours of operation
- Hours since last start
- Time of last start and time of last stop
- Compressor motor current
- Fault history

Security access shall be provided to prevent unauthorized change of set points and to allow authorized local or remote control of chilling package.

The Control panel shall include machine protection shutdown with automatic reset when the condition is corrected for:

- Momentary power loss.
- Under/over voltage
- Loss of evaporator or condenser water flow

Over 100 diagnostic checks shall be made and displayed when a fault is detected. The display shall indicate the fault, the type of reset required, the fault, the time and date the diagnostic occurred, the mode in which the machine was operating at the time of the diagnostic and a help message. A diagnostic history shall display the last 20 diagnostics with the time and date of their occurrence.

Clear language Display Panel:

Factory mounted to the door of the control panel, the operator interface shall have a touchpad for operator input and a display screen. A chiller report, refrigerant report, compressor report, an operator configurable custom report, operator settings, service settings, service tests, and diagnostics may thus be accessed. All diagnostics and messages shall be displayed in “clear language.”

The data contained in the chiller report, refrigerant report, and compressor report shall include:

- All water temperatures and set points
- Current chiller operating mode
- Diagnostic history
- Control Source (ie., local panel, external source, remote BAS)
- Current Limit set points
- Outdoor air temperature
- Saturated refrigerant temperatures and pressures
- Compressor starts and hours running
- Line currents
- Line Voltage
- Approach temperatures.

All necessary settings and set points shall be programmed into the microprocessor controller via touchpad of the operator interface. The controller shall be capable of receiving signals from a variety of control sources (which shall not be mutually exclusive –

i.e., any combination of control sources can coexist simultaneously) and shall be capable of programming at the keypad as to which control source has priority.
Control sources can be:

- The local operator interface (standard)
- A 4-20 mA or 2-10 VDC signal from an external source.

3.1.9 INTERFACE WITH HVAC BUILDING AUTOMATION SYSTEM

All necessary hardware / software to integrate the chiller panel to BAS system shall be provided free of cost by chiller manufacturer / supplier. For the integration of Microprocessor Panel of the chilling machine with the Building Automation System, an Interface Control Document shall be developed by BAS Contractor. It shall be responsibility of Chiller supplier to provide following to BAS Contractor for preparing the interface.

- Hardware Protocol of Chiller Microprocessor panel.
- Software Protocol of Chiller Microprocessor panel.
- Communication structure relating to collection of message / event information.
- Description of the formatted packets / blocks of data which construct controller commands / responses.
- Written permission to BAS contractor to develop the interface without any financial implication.

3.1.10 ELECTRIC MOTOR

Motor shall be energy efficient and suitable for 415±10% volts, 3phase, 50cycles AC supply. Hermetic / semi hermetic motors shall be gas cooled, two pole, squirrel cage induction types. In case of open compressor type motors shall be screen protected drip proof squirrel cage induction type. Motor shall be designed and guaranteed for continuous operation. Insulation of motors shall be `F' class and IP55. Temperature rise of motor under rated service conditions shall not exceed 80 Deg C (by resistance method of measurement) over an ambient of 40 Deg C. the motor shall be provided with a combination of ball and roller bearing. Factory assembled Terminal box of sturdy construction shall provide enough space for terminating, connecting and earthing of XLPE insulated aluminium conductor cable. All terminal boxes shall be located at the same side of the motor and have terminal and cable glands suitable for the specified cables. The total efficiency shall include losses of the auxiliaries such as independent excitation, motor-driven fans, lube-oil pumps etc. Over voltage surge protection shall be provided to protect motor.

3.1.11 STARTER

Solid State starters shall continuously vary the voltage to maintain constant motor current during the start. The starting current should be smooth and continuous. Solid State Starters shall be provided with Silicon Controlled Rectifier (SCR) as the main power handling component of the solid state starter. Logic, overloads, and drivers should provide the controls that make decisions, provide safeties, and protect the motor and control the SCRs. Solid State Starter shall be housed in enclosure with hinged access door with lock and key.

It may be unit mounted or free standing but has to be including all necessary interconnecting control and power cabling / wires.

- The Enclosure shall comply to the NEMA - 1 standards
- Input AC Voltage Tolerance: 415-V ac, plus or minus 10 % tolerance
- Minimum Efficiency shall be 95 percent at 50 Hz, full load
- The LCD / LED display indicator should indicate the status of On / Run / Over voltage / Line fault / Over current / External fault
- Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the status, frequency, current, alarm, voltage etc
- Automatic Reset and Restart: To attempt three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault

3.1.12 INSTALLATION

- Install in accordance with manufacturer's instructions.
- Provide for connection to electrical service.
- Provide for connection of electrical wiring between starter and chiller control panel, oil pump and purge unit.
- Align chiller on concrete foundations, sole plates and sub-bases. Level, grout and bolt in place.
- Provide vibration isolation between unit and structural support.
- Provide evaporator connections to chilled water piping. On inlet, provide thermometer well for temperature controller, thermometer well and thermometer, nipple and flow switch, flexible pipe connector, pressure gage and shut-off valve. On outlet, provide thermometer well and thermometer, flexible pipe connector, pressure gage and shut-off or balancing valve as indicated on the drawings.
- Provide necessary auxiliary water piping for oil cooling units and purge condensers.
- Arrange piping for easy dismantling to permit tube cleaning.
- Provide piping from chiller rupture disc to outdoors. Size as recommended by manufacturer.
- Repair damages to factory finish (including insulation) up to time of acceptance by Owner.

3.1.13 PAINTING

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

3.1.14 NOISE LEVEL

Noise level of the chiller shall be ≤ 85 dB (A) 1 meter from equipment the sound levels shall be within the permissible limits and tolerances while measuring the performance in

accordance with AHRI Standard 575-08, Method of Measuring Machinery Sound within Equipment Rooms.

3.2 WATER COOLED WATER CHILLING MACHINE:

System Selection for commercial space &Common areas:

Based on the calculations and the nature of the application of the building, we are proposing Water Cooled Chiller System for the Office areas and the Shell & core areas in Fintech Tower.

It is proposed to have a dedicated Water-cooled chilled water system for the Office Spaces and Shell and core area with the plant room proposed in the Podium-01 floor. The chilled Water pumping philosophy will be Constant Primary & Variable Secondary pumping system. The total Air-conditioned area for the above-mentioned areas in Fintech tower is around 289343.0 Sqft. and the total air-conditioning requirement will be around 1120.0 TR

Total AC load required in TR = **1120 TR**
Considering diversity of 85% = **952 TR**
Proposed Chiller capacity = **475 TR X 3Nos** water cooled chillers (2 W +1 S)
Approx. The installed Chiller Plant Capacity will be 1425 TR (475 TR x 3 Nos, 2Working+1StandBy), considering diversity of 85% on the total cooling loads

Water Cooled Water Chilling Machine shall be complete with centrifugal compressor, shell and tube condenser, chiller, machine mounted Variable Speed starter & microprocessor panel, all refrigerant piping & fittings, refrigerant feeding devices, valves, strainers, liquid-moisture indicators, suction line insulation, first charge of oil & harmonic filters, gas etc. All the components shall be mounted in an MS casing on robust framework fabricated using MS channels, angles and other sections. The Water chilling machines shall be mounted on vibration isolators.

3.2.1 Compressor

The compressor shall be centrifugal type suitable for use with refrigerant provide ASHRAE A1 safety class refrigerant (R 134a & R 1233zd) for centrifugal. The chiller can be of direct drive / gear drive and to be with multiple-stage compressor with control guide vanes. The compressor shall be incorporate automatic capacity control feature. The Compressor motor shall Refrigerant/Air cooled, hermetically sealed Open drive/ Semi hermatic motor, two-pole, squirrel cage induction type. In case of manufacturer offering Open motor design, suitable SPDP is proposed. (Screen protected Drip proof). For the capacity specified for the chiller model protection need to be offered for motor. The Compressor shall be designed for high efficiency and stability and shall be able to operate at all conditions from 100% down to Down to 20% at Constant Condenser without hot gas by pass.
The compressor shall be of the own make of the chiller manufacturer and any third party / OEM sourced compressors for assembly is not acceptable.

3.2.2 Evaporator-Condenser

Evaporator shall need to be the shell-and-tube, flooded / Falling film type designed on the refrigerant side. Shells shall need to be fabricated from carbon steel plate. Tubes offered are to be individually replaceable and shall be of externally finned seamless copper. The Tubes are to be mechanically expanded into tube sheets. Eliminators are to be installed over entire length of the evaporator tube bundle. A multiple orifice control system shall need to be provided to maintain proper refrigerant flow. Condenser baffle is to be provided to prevent direct impingement of compressor discharge gas upon the tubes Water side is hydrostatically tested at one and one-half times design working pressure, and the water side design pressure shall need to be for 150PSIG. The shell shall be of MS and the tubes of copper. The Evaporator shall be factory insulated with 19 mm thick nitrile rubber insulation. The refrigerant and water side shall be designed, tested and stamped in accordance with ASME Boiler and pressure vessel code, section – VIII division 1.

The evaporator and condenser shall need to be with standard nozzle in head connection. All water boxes need to have 3/4-inch NPTI vents and drain connections are to be provided. Hinged marine water boxes needs to be provided with grooved/flanged con-nections on Condenser.

Sight glass on Evaporator: located such that the proper refrigerant charge is near the center of the glass when the machine is off.

3.2.3 Purge System (For Negative pressure chiller)

The purge offered shall need to include a 1/4 hp 115V/60/1, 100V/50/1 air cooled condensing unit, purge tank, drier elements, a 1/20 hp (.037 kW) 115V/60/1, 110V/50/1 pump-out compressor, a carbon tank, and a heater. The purge is designed with an activated carbon filtration system that includes an auto-regeneration feature which results in automatic high-efficiency removal of non-condensable from the chiller without manual carbon maintenance. The purge is to be rated in accordance with AHRI Standard 580.

3.2.4 Microprocessor Panel

The machine mounted Micro-processor panel & starter panel shall need to provide control of chiller, operation and monitoring of chiller sensors, actuators, contactors, over load relays, single phase preventers, under / over voltage trip, on / off push buttons, auto manual switches to facilitate automatic operation through BMS System or for manual operation to facilitate remote starting & stopping of chiller packages, auxiliary contactors, etc. if any required. The panel shall incorporate the following:

Operating Data including:

* Operating hours
* Number of starts
* chilled water set-point.
* Evaporator and condenser water flow status
* Evaporator entering and leaving water temperatures
* Evaporator saturated refrigerant temperatures
* Evaporator approach temperature
* Evaporator refrigerant pressure
* Condenser entering and leaving water temperatures
* Condenser saturated refrigerant temperatures

* Condenser approach temperature
* Condenser refrigerant pressure
* Oil differential pressure
* Oil tank temperature
* purge mode
* purge average daily pump-out time
* % RLA per phase for motor
* RLA per phase
* Volts per phase
* Power factor
* kw,kwh
* Frequency

The panel also need to contain the dedicated reports of Evaporator, Condenser, Compressor, Motor, Purge etc. Each report is comprised of a detailed listing of operational data relative to that chiller subsystem.

3.2.5 Control functions of the panel shall need to include:

* leaving chilled water temperature
* Percent demand limit
* Chiller water reset (based on return water temperature
* Front panel control type
* set point source
* Differential to start
* Differential to stop

3.2.6 Status data function of the panel to include:

* waiting to start
* running
* run limit
* Run inhibit (adaptive)
* Auto
* Free cooling (option)
* preparing to shutdown
* shutting down (post lube)
* stopped

3.2.7 Safeties to include:

Automatic safety shutdown for:

* Low chilled water temperature,
* Low evaporator refrigerant temperature
* High condenser refrigerant pressure
* Evaporator and condenser flow status
* Low evaporator/condenser differential refrigerant pressure
* Low oil pressure
* Oil pressure overdue
* High or low oil temperature
* High bearing oil temperature (requires enhanced protection option)

* High motor current
* High motor temperature
* Starter function faults
* Critical temperature and pressure sensor faults

The devices are of a latching trip out type requiring manual reset. Non-latching safety trip outs for operating conditions external to the chiller automatically permits unit to resume normal operation when condition is corrected. The chiller shall also need to monitor 3-Phase current to provide latching trip out protection from adverse effects of phase loss, phase unbalance, phase reversal, los of phase reversal protection and electrical distribution faults (momentary power loss) by instantaneous trip out of motor.

3.2.8 Chiller Unit Control Features

The chiller unit control panel capabilities provide for the control/configuration interface to, and the retrieval/display of starter/ current related data. The chiller shall need to have minimum safety feature of

* Motor overload protection.
* Motor over temperature protection.
* Phase loss, reversal, imbalance protection.
* Overvoltage/under voltage protection.

Security

The Microprocessor shall need to have the feature to prevent unauthorized access to the chiller settings. The operator shall need to have option to choose to secure the operating settings with a password. Data and reports are to be accessed once the settings are locked out. The memory for the panel is needed to be of non-volatile type, so if power is lost, operating settings are retained.

Paint

All chiller painted surfaces are to be coated with a primer and an air-dry beige primer-finisher prior to shipment and the Chiller shall need to ship with the unit will be provided with 4 level-adjusting, spring-type vibration isolators with non-skid pads.

For VFD Chiller

Chillers shall need to be offered with Unit mounted factory calibrated. With active harmonic filter to be considered.VFD shall be liquid cooled only, water/refrigerant cooled as per OEM standard. and the starting current shall need to be limited to <1 RLA of the chiller. The chiller shall need to be have circuit breaker / disconnect switch arrangement for electrical isolation for service purpose. The manufacturer (if required by client for the project) shall also need to be able to support for supply of active harmonic filter to comply for harmonic level distortion (TDD) within limits of IEEE519 standard.
AHRI Certified performance sheets should mention VFD with Active Harmonic Filter and Chiller performance should be inclusive of Harmonic Filter Losses.

Unit Mounted Starter VFD Starter

The VFD shall need to be factory mounted on the chiller and ships completely assembled, wired and tested. The control logic is to be specifically designed to interface with the centrifugal water chiller controls. VFD control shall need to adapt to the operating ranges and specific characteristics of the chiller, and chiller efficiency is to be optimized by coordinating compressor motor speed and compressor inlet guide vane position. Chilled water control and VFD control work together to maintain the chilled water set-point, improve efficiency and avoid surge. If a surge is detected, VFD surge avoidance logic feature need to be available to make adjustments to move away from connections.

VFD Design Features

* Simple modular construction.
* NEMA 1 ventilated enclosure with a hinged, locking door.
* Full motor voltage is applied regardless of the input voltage.
* Soft-start; linear acceleration; coast to stop.
* Adjustable output frequency.
* All control circuit voltages are physically and electrically isolated from power circuit voltage.
* 150% instantaneous torque available for improved surge control.
* Output line-to-line and line-to-ground short circuit protection.

Digitally displayed on the panel: output speed in hertz, input frequency, output speed in rpm, input line voltage, output voltage, input line kw, output kw, input line amps per phase, average input line amps, output / motor amps average current in % RLA, load power factor, fault, VFD transistor temperature.

Environmental Ratings for VFD

* 32F to 104 (0C to 40) operating ambient temperature
* Altitude to 3300 feet (1000m), amperage de-rate of 1% per every 300 feet above 3300 feet
* Humidity, 95% non-condensing
* NEMA 1 rated

3.3.1 DETAILED DESIGN SUBMITTALS

On the Award of Contract, the HVAC Contractor / manufacturer shall submit the following for approval.

- Shop drawing on each piece of equipment provided in accordance with the specification.
- Technical Data sheet, GA diagram, wiring diagram, foundation detailed drawings etc.
- Computer selections print out for the chilling unit offered and AHRI certified performance chart.
- Brief description of the system/equipment offered.

- Installation, Operation and Maintenance data sheet/manuals.
- Compliance statement with Tender requirements.

3.3.2 SITE ACCEPTANCE TEST (SAT) & ACCEPTANCE CRITERIA

The vendor shall test and rate the chillers at site prevailing Site conditions. The testing shall be carried out in the presence of the Client / PMC / Consultant's representative. The following test shall be performed and the vendor shall rectify the defects/deficiencies to meet the specified capacity conditions for client's acceptance. The vendor shall provide necessary calibrated measuring instruments (whatsoever required) required for the testing.

- Functional test of the Chiller
- Capacity
- Power performance

Engage a factory-authorized service personal to test the onsite performance of the Chillers. The Water chilling unit should be selected for the duty as specified in "the Tender". The water chilling unit should be selected for power consumption of not more than agreed IKW/TR, shall be tested at the prevailing building load and the condenser entry condition on the test date. The output data of the site test shall be compared with the AHRI certified software selection program simulated by the Vendor for the same conditions at site in presence of Client /PMC /Consultant. The Chiller performance shall be within the tolerance permitted by AHRI. Contractor shall be responsible for ensuring the system performance as requested. If the power consumption in KW/TR of the water Chilling machine at site conditions is found to be more than that offered by the vendor, the vendor has to do necessary corrections in the Chiller or its parts to meet the performance free of cost. In the event that these revisions do not achieve submitted performance, Client reserves the right to reject the equipment or impose the following penalties.

3.3.3 WARRANTY

Provide 24 months warranty for parts, labor and refrigeration from date of handing over. The Chiller Warranty shall also inclusive of manufacturer's parts warranty.

3.3.4 CODES & STANDARDS

The design, materials, construction, inspection, testing and performance of chiller package shall comply with all currently applicable statues, regulations, codes and standards in the locality where the equipment is to be installed. Nothing in this specification shall be construed to relieve the CONTRACTOR of this responsibility. In particular, the screw liquid chilling package shall conform to the latest edition of following standards:

ASHRAE 15 : Safety Code for Mechanical Refrigeration
ASHRAE 23 : Method of testing for rating positive displacement refrigerant compressors and condensing units.
ASHRAE 30 : Methods of testing liquid chilling packages.
ASME SEC 8 : Boilers and pressure vessel code
ANSI B 31.5 : Code for Refrigeration piping.

AHRI 550 / 590 : Water Chilling packages using the Vapour compression cycle.
AHRI 575 : Standard for method of measuring machinery sound within an equipment space.
TEMA : Standards of the Tubular exchanger manufacturers association.
NFPA 70 : National Electrical Code.
ASHRAE 34 : Designation and Safety Classification of Refrigerants

3.3.5 AUTOMATIC TUBE CLEANING SYSTEM (BALL / BRUSH TYPE)

3.3.5.1 AUTOMATIC TUBE CLEANING SYSTEM

It has to be factory fitted on chiller (Mandatory). Filed supply ATC shall not be acceptable

3.3.5.2 Ball Trap

The ball trap shall be mounted between two flanges -(BS Table 10 E) IS2062 Grade B, 15 days 100lbs capacity, at the outlet line of the condenser. The casing shall be made from a MS material of IS2062 Grade B. The Ball trap should be sand blasted, followed by epoxy zinc rich primer and then epoxy based finished paint. The screen inside is made from stainless steel SS304L perforated metal sheet. All fasteners shall be of high-tension grade 9.8, 10.9, 12.9.

The Ball Trap should have pressure drop of less than 300 mm of WC. The body of the Ball trap shall be 2 inches higher in size as compared to the flange size or the pipeline size in which Ball trap must be installed. For example, if the pipeline size is 10 inches the Ball trap body should be of 12 inches.

3.3.5.3 Ball Collector

The ball Collector shall be made of suitable size capable of storing all the sponge balls required and should be made from MS material of IS2062 Grade B. The Ball collector should be sand blasted, followed by epoxy zinc rich primer and then epoxy based finished paint. The Ball Collector should have a big sight glass for monitoring the balls. Toughened glass should be used and should be mounted by Allen key fasteners. All fasteners shall be of high-tension grade 9.8,10.9, 12.9.

3.3.5.4 Skid with Pumps & Valves

The Skid should have pipe and flanges of MS material IS2062 Grade B. All welding of Skid shall be performed by Argon weld. The Skid frame should be of MS material of same IS2062 grade B. The Skid valves should be of diaphragm type or equivalent with all joints to be flanged and bolted. The valves used for injection and collection from respective chillers shall be of actuator type. All fasteners shall be of high-tension grade 9.8, 10.9, 12.9.

3.3.5.5 Control panel

The Control Panel should be PLC based B/W LCD depiction of injection and collection cycle. The display should show system wise running along with pump

running and off condition. The alarms and faults shall be indicated on the screen in case of any issue in operation.

3.3.5.6 Working Principle – Activity Sequence

The operation is based on the circulation of the sponge ball through the condenser tube. The sponge ball must be pushed to the condenser inlet in not more than 5 seconds by a high flow of water(min.7L/S) which can be produced by a high-pressure source atleast 2 bar higher than the injection point at the condenser inlet. The source can be obtained by a single water injection pump in water injection system. Water injection system will be operated by a PLC controller which is pre-programmed to execute the cleaning process in two consecutive steps. They are ball injection cycle and ball collection cycle.

Ø **STEP 1:**

The PLC shall activate the cleaning process by detecting the on/off status of the corresponding chiller. If the chiller is on, the PLC shall command the control valves to open to manage the injection. The check valves shall be installed in the locations shown on the scheme above and as close as possible to the collector to ensure correct water flow direction during the injection cycle and the collection cycle.

Ø **STEP 2:**

The injection cycle, the PLC shall command the injection control valve to open for couple of seconds (the collection control valve kept closed in the cycle) and then close. The water pressure from the pump shall be used to push the water inside the injector to the collector and force all balls in the collector to the condenser.

Ø **STEP 3:**

The cycle shall be completed until the ball passing through the condenser where it should clean all the deposits on internal surface of the tubes. After leaving condenser the balls shall be trapped inside the ball trap unit.

Ø **STEP 4:**

After the injection cycle is finished, the PLC shall command the collection control valve to open for couple of seconds (the injection control valve kept closed in the cycle) and then close. The negative pressure shall let the ball return from the ball trap unit back to the collector where the rinsing of the balls is carried out and then water is discharged to the outlet header of Condenser which goes to cooling tower. The ball shall wait in the collector until then injection cycle. The time of the collection cycle is normally pre-set at 27 minutes.

- A single pump should be on skid and shall be running during injection and collection cycles
- The pressure drop across ball trap shall not be more than 400mm
- The Valves shall give feedback to Control PLC of functioning.
- The Control PLC shall raise an alarm in case of any malfunctioning of system
- The total time of the whole cycle (injection and collection cycle) shall be 3 - 4 minutes

- A maximum number of 3 Condensers should be controlled by single skid and Control Panel. If the number of Condenser increases beyond 4, additional Skid with Control Panel should be considered and should be followed consequently

The ATCS should be CE certified and OEM should confirm to the requirements of ISO 9001:2015. The ISO 9001;2015 certificate & CE certification on name of OEM should be submitted along with offer submission without fail.

3.3.6 CHEMICAL DOSING SYSTEM

Chemical Dosing System is a continuous monitoring & control of Industrial water system such as Cooling Tower boilers & Swimming pool water easy with a use friendly ATM style menu & large 16-line full graphic display that allows complete programming from the keypad. Different Level of Controller gives Techo-Economical comfort to customer.

3.3.7 LOGIC OF OPERATION:

The main functionality of Cooling Tower Controller is to dose requisite quantity of chemicals in a predetermined proportion in to the cooling tower by controlling the dosing pumps.

It receives a pulse type of signal from a flow meter installed in the makeup line. The pulse meter gives out a pulse every 1000 or 5000 or 10000 lit (depending on model and size). The controller counts those pulses and based on the proportion fed into the controller – controls the chemical dosing pump ON-OFF time.

- The controller is capable of controlling up to 3 chemical dosing pumps (optional default is 2 pumps)) and plus 2 biocide dosing pumps (Optional) with a 28 days timer, i.e. after every X No of days the biocide pump will start for certain time and will pump desired quantity of biocide into cooling tower system.

- The controller is also equipped with a conductivity monitor and controller, which is to be connected to a solenoid blow down valve. After setting the conductivity value – the bleed valve will open automatically if the conductivity limit is crossed. The bleed valve is closed automatically once the conductivity is lower than the set point. OPTIONAL – COC control – if a conductivity sensor is installed in make up line – the controller is capable of controlling COC by automatically selecting the Limiting conductivity, i.e. if you set COC = 6 and make up conductivity is 200 the blow down valve will open at 1200 cond. Value. If make up water conductivity changes to 300 the limit will be set to 1800 automatically. Thus the controller will control the COC.

- The main controller also has a auto pH controller which will control Acid dosing and Hypo dosing as per set limits of pH.

- The controller logs and stores on line data value (Conductivity& pH. and flow) every 2 minutes on it on board memory and the same can be downloaded for

analysis through a USB port into a laptop. The controller stores data for previous 6 months in its on board memory.

- Controller has an optional Internet Modem – with a GSM SIM card. If this is installed – the controller then communicates with a server and a web site and all data is loaded on to a web site automatically

3.3.8 BENEFITS OF AUTOMATION

Water Saving

Manual activity of blow down on time Ruther then TDS / Conductivity. Water loss in such blow down is always then the required. With control system solenoid valve will open only when the TDS / Conductivity of circulating water crosses the set point.

Chemical Saving

Water consumption in cooling tower is having direct relation with Evaporation Loss from the tower to achieve the desired cooling. The dosing of Corrosion and Scale inhibitor are based on actual water consumption after installation of V-Sense System. During lower heat load, partial running of Plant chemicals dosing also will reduced by V-Sense technology which will be net saving in terms of costly chemicals.

Optimum use of Biocide

Use of Oxidizing Biocide will be based on standard ORP. V-Sense improves disinfection by avoiding the detrimental side effects of mixing oxidizing and non-oxidizing biocides in the water (e.g. during bleed lock out).

Energy Saving

Biofilm and scale can drastically reduce the heat transfer performance in condensers. V-Sense technology saves energy by minimizing the risk of scale and microorganism accumulations.

Asset Protection

Fluctuations in ORP and pH can potentially damage condensers and heat exchangers. The precise Fuzzy logic of V-Sense ensures maximum protection to your equipment by consistent control to ORP and pH.

Green Technology

Through the combination of these advanced technologies, Ultima sets a high standard in environmental protection by minimizing water & chemical usage & discharge to the environment.

Analytics – Measuring & Assessing Results

It controlled will give the Tread of Water Parameter & Chemicals Dosing Pattern, which will give clear idea on Treatment Methodology**.**

Dosing of Chemicals Directly from Carboys

It will be give feedback to dosing pump & hence no need to prepare the solution of chemicals, acid in drum. These dosing will be accurately controlled by controller. Output & hence plant person can dose chemicals directly from carboys with dosing pump.

SECTION-IV-COOLING TOWER

4.1 SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of cooling towers in accordance with requirements of Drawings and of the Bill of Quantities. The tower selection shall be **CTI Approved** based on the monsoon wet bulb temperature specified in the Design brief report.

4.2 TYPE & CAPACITY

Cooling Towers type and capacity shall be in accordance with requirement of Drawings and Bill of Quantities.

4.3 COMPONENTS OF COOLING TOWER

The basic components of cooling tower are: Frame and casing, twin cell, fill, cold water basin, drift eliminators, air inlet, louvers, nozzles and multiple fans.

4.4 FRAME AND CASING

Cooling towers shall have structural frames that support the exterior enclosures (casings), motors, fans, and other components. The cooling tower shall have at least twin-cell construction. This shall be made out of FRP construction with smooth surface on both sides for minimum resistance to air flow. It shall have sufficient structural strength to adequately withstand high wind velocities and vibration. The casing may be installed in the reinforced cement concrete basin if so identified in drawings, or in Bill of Quantities. The tower supporting structure shall be made out of hot dipped galvanized tubular frame. Air intake shall be all along the sides so that tower can be installed quite independent of prevailing wind direction. Anodized aluminium or PVC louvers integrated with fill and backed up by galvanized bird screen shall be provided at air intake. Sufficient clearance between casing and adjoining structures shall be provided to enable servicing and periodic cleaning. The fan guard shall be designed to prevent contact between fan and human finger.
The tower structure and the components shall be designed to withstand a wind load of 146.5 kg/m2.psf as well 0.3 g seismic load. The fan deck and hot water basin covers shall be designed for 2.4 kpa live load or 90 kg concentrated load. The thickness of the casing shall be 3.0mm minimum.

4.5 FILL:

Fillings shall be made of corrosion proof and rigid PVC film in honey comb design and arranged in square / rectangular form to facilitate heat transfer by maximizing water and air contact. Fill sheets shall be suspended from H.D.G steel structural tubing supported from the lower structure & shall be elevated above the floor of the cold water basin to facilitate cleaning and easy replacement. They shall be arranged in such a manner to ensure negligible resistance to air flow and to eliminate back water spots and prevent fouling

through scales that may form. In order to reduce carry-over losses through entrainment of moisture drops in air stream, PVC drift eliminator shall be installed.

4.6 COLD WATER BASIN:

The cold water basin shall be located at or near the bottom of the tower, to receive the cooled water that flows down through the tower and fill. The basin usually has a sump or low point for the cold water discharge connection. Cold water basin shall be a made of RCC by others .Outlet connections shall be equipment with debris screens. The basin shall be accessible and maintainable while circulating the water. Brass float operated make-up valve and side outlet sump complete with replaceable stainless steel section screen and anti-cavitations device shall be provided.

Basin fittings shall include the following:

- Bottom outlet & Screened suction assembly.
- Drain connected to the side / underside of basin.
- Quick fill & Overflow connected to the side of basin.
- Built-in bleed off attached to inlet header discharging through polyethylene tube into overflow pipe.
- Ball type automatic make up water valve.
- Float Valve
- Equalizing connection and balancing valve for multiple CTs.

4.7 DRIFT ELIMINATORS

Drift eliminators capture water droplets entrapped in the air stream that otherwise would be lost to the atmosphere. Drift eliminators shall be efficient enough to effectively limit drift loss to no more than 0.005% of the designed flow rate.

4.8 AIR INLET

This is the point of entry for the air entering a tower. The inlet may take up an entire side of a tower for cross flow design or be located low on the side or the bottom for counter flow designs.

4.9 LOUVERS

The purpose of louvers is to equalize air flow into the fill and retain the water within the tower. The cross-flow towers have inlet louvers and counter flow tower designs do not require louvers.

4.10 NOZZLES

These provide the water sprays to wet the fill. Uniform water distribution at the top of the fill is essential to achieve proper wetting of the entire fill surface. Nozzles can either be fixed in place and have either round or square spray patterns or can be part of a rotating assembly as found in some circular cross-section towers.

4.11 FAN & MOTOR

The fan shall be axial-flow type, belt driven, multi aerofoil blades with variable pitch. The fan blades shall be made of aluminum alloy and housed within a fan cylinder, design for smooth unobstructed air entry. The fan shall be factory balanced both statically and dynamically. A fan having non-automatic adjustable pitch blades permits the same fan to be used over a wide range of kW with the fan adjusted to deliver the desired air flow at the lowest power consumption. Automatic variable pitch blades can vary air flow in response to changing load conditions. Direct driven fan speed shall not exceed 700 RPM.

The fan motor shall be totally enclosed fan-cooled, weather proof type. It shall be connected through a set of easily adjustable and low maintenance.

Fan shall be driven by 415±10% volts, 3 phase, 50 cycles, AC supply, energy efficient motor, totally enclosed air over (TEAO), fan-cooled, weather-proof construction (IP55), Class F, designed and selected to operate in humid air stream. Fan shall be protected by a fan guard and bird screen of galvanized steel construction to prevent birds from nesting during idling period & shall be easily accessible for inspection and maintenance. G.S.S canopy shall be provided over the fan motor for protection against rain water. Motor terminal box shall be made water tight.

The cooling tower fan motor shall be suitable for operating with Variable Frequency Drive as specified in the BOQ.

4.12 HANDRAIL & LADDER

Hot Dipped Galvanized made Ladder & Handrail should to access to the top of the cooling tower should also be part of scope.

4.13 CONTROL SYSTEMS

It should be possible to hook up to BMS. All necessary hardware & software should be part of the scope

4.14 VIBRATION ISOLATORS

Vibration Isolators of spring open type designed to minimize any vibration from transmitting to other structures to be included in the scope of supply.

4.15 LOW NOISE TYPE

Cooling tower supplied should be of low noise type & noise level at 1.5mtr distance from the tower should not be more than 75 dBA. Please attach computer selection noise transmission data for obtaining approval from acoustic consultants. Cooling tower with FRP cowl piece can also be considered for more sound reduction.

4.16 DISTRIBUTION SYSTEM

Hot water distribution system shall comprise of header and branch arms system with flow balancing system or open pan gravity flow system. No overflow or splash of water shall be allowed at design flow rates.

4.17 SUBMITTALS

Provide the following in addition to the standard requirements with the Bid:

- Structural steel support including dimensions, sizes, and locations for mounting bolt holes, Include weight distribution drawings showing point loadings.
- Total fan BHP (driver output)
- Drift loss (percent of circulating flow)
- Evaporation loss (at design)
- Tower cells (to be provided).
- Thermostat and heater wiring drawings and catalog cut information.
- Control / Operational Logic for CT Fan's VFD
- The cooling tower submittal shall include performance curves in accordance with Section 11 of ATC-105. A manufacturer's guarantee, performance bond, or test by the manufacturer will not be accepted as an alternative to CTI certification or an independent field test.

4.18 PERFORMANCE DATA

Complete performance ratings and power consumption at varying loads and outdoor wet bulb temperatures, shall be submitted and verified at the time of testing and commissioning of the installation.

4.19 TESTING

Capacity of the cooling tower shall be computed from the measurements of water flow, incoming/outgoing water temperatures and ambient air wet bulb temperature using accurately calibrated mercury-in-glass thermometers. Computed ratings shall conform to the specified capacities and quoted ratings. Power consumption for cooling towers shall be computed from measurements of incoming voltage and input current.

SECTION-V- PRIMARY, SECONDARY AND CONDENSER PUMPS

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

5.2 CAPACITY
Capacity of pumps for air conditioning applications shall be in accordance with requirement of Drawings and Bill of Quantities. The pump and motor shall be of weatherproof construction

5.3 CASING
Pump Casing - Cast Iron for working pressure to 12bar at 65°C (PN16 flange rating) and Ductile Iron for working pressures to 25bar at 65°C (PN25 flange rating). Suction and discharge connections shall be flanged and the same size and shall be drilled and tapped for seal flush and gauge connections.

5.4 IMPELLERS
Impeller shall be bronze, enclosed type, hydraulically balanced and passages smooth-finished for minimum friction and maximum efficiency. The impeller shall be secured to the shaft by feather and nut.

5.5 WEARING RINGS
Wearing rings are provided for pump 12” & above to maintain close running clearance and to minimize pressure leakage between suction and discharge chambers of the casing. The casing bearing rings shall protect the casing against wear and shall be locked in pump casing to prevent rotation.

5.6 SHAFT
Shaft shall be steel Stainless Steel SS-304. Pumps shall be fitted with outside balanced mechanical seals (factory fitted). The shaft shall be of high strength steel with optimum diameter to provide maximum strength with minimum shaft deflection.

5.7 COUPLING:
Rigid spacer type of high tensile aluminum alloy. Couplings shall be split to allow removal from pump and motor shafts, leaving space between the shafts sufficient to replace all mechanical seal components without disturbing the pump or motor.

5.8 MECHANICAL SEAL

Seal shall be Stainless Steel outside multi-spring balanced type with carbon Vs silicone carbide faces and Viton secondary seal. Provide stainless steel gland plate with Stainless Steel trim. Provide factory installed flush line with manual vent. All split coupled pumps shall be provided with a lower seal chamber throttle bushing. Seal flush line fittings, if required: Supply in the flush line to the mechanical seal a 50 micron cartridge filter and sight flow indicator, to suit the working pressure encountered. Filters shall be changed, by the installing contractor, after system is flushed and on a regular basis until turned over to the owner. Alternately, for pumps with differential pressures exceeding 200 kPa Supply in the flush line to the mechanical seal a cyclone type separator, with sight flow indicator.

5.9 **DRIVE MOTOR**

Motor shall be energy efficient, totally enclosed, fan-cooled, Class-F insulation. Motor shall be specially designed for quiet operation and its speed shall not exceed 1440 rpm. The motor rating shall be such as to ensure non overloading of the motor throughout its capacity range. Motor shall be suitable for 415±10% volts, 3 phases, 50 cycles AC, power supply. The motor type shall be EFF-1. The motor shall be suitable for VFD operation. The motor and pump shall be designed suitable for operating at 115% of design capacity

5.10 **ALIGNMENT**

The pump and motor shall be aligned by the pump manufacturer. The pump manufacturer shall provide certification to the effect that the pump and motor coupling has been carried out by them and checked by them. No need for realignment after installation.

5.11 PAINTING

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

5.12 INSTALLATION

The pump shall be capable of getting installed with pipe support and without flexible connectors on the suction and delivery side.

5.13 REGULATORY REQUIREMENTS

- Conform to Health/Life Safety Code
- Conform to International Mechanical Code
- Conform to BOCA National Building Code
- Conform to State of Illinois Plumbing Code
- Conform to National Electric Code NFPA 70
- Conform to applicable ANSI/HI standards
- Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

5.14 DELIVERY, STORAGE & HANDLING

- Deliver materials to the site in such a matter as to protect the materials from shipping and handling damage. Provide materials on factory provided shipping skids and lifting lugs if required for handling. Materials damaged by the elements should be packaged in such a matter that they could withstand short-term exposure to the elements during transportation.
- Store materials in clean, dry place and protect from weather and construction traffic. Handle carefully to avoid damage.

5.15 PERFORMANCE TESTS

The Contractor shall after installation carry out commissioning tests and ensure that the specified flow rate and head are achieved, by means of Direct Reading Flow meter.

The following tests shall be conducted at the rated RPM of the pump in the presence of **Client /** Architect / Consultant's representative for performance as per relevant IS Standards.

- Discharge Vs Head
- Discharge Vs Efficiency
- Discharge Vs BHP
- Hydraulic tests for casing at 1.5 times of the design pressure

Performance test shall be conducted at the following operating points.

- Shut Off
- Rated duty point
- 120% rated capacity.

The Contractor shall submit detailed performance curves for the pumps supplied along with the tender.

The pump head given in the BOQ / drawing is minimum required for the system. Actual head shall be calculated and confirmed by the vendor at the time of bidding. The pump head calculation based on the approved shop drawing shall be submitted by the vendor and upgrade the pump & motor to the requirement, without any extra cost to the Client.

5.16 COMPONENTS OF VARIABLE SPEED PUMPING SYSTEM

Pump Logic Controller;

- The technologic pump logic controller factory assembled with UL listed components
- The Equipment should be able to hook up to chiller plant management system (BMS) via software integration either in BacNet / RTU Modbus Protocol. Necessary hardware / software for integration should be part of scope.
- The controller shall be specifically designed for variable speed pumping applications.
- The controller shall function to proven program that safeguards against damaging hydraulic conditions including:
    - Pump flow surges
    - Hunting
    - End of curve
    - System over pressure
- The pump logic controller shall be capable of receiving up to two discrete analog inputs from zone sensor / transmitter as indicated on the plans. It will then select he analogue signal that has deviated the greatest amount from its set point. This selected signal will used as the command feedback input for a hydraulic stabilization function to minimize hunting. Each input signal shall be capable of maintaining a different set point value. Controller shall be capable of controlling up to three pumps in parallel.
- The pump logic controller shall be capable of accepting an additional analog input for a flow sensor. This input shall serve as the criteria for the end of curve protection algorithm.
- The pump logic controller shall be self-prompting. All messages shall be displayed in plain English. The operator interface shall have the following features:
    - Multi-fault memory and recall last 10 faults and related operational data.
    - Red fault light, yellow warning light and Green power on light.
    - Soft-touch membrane keypad switches.
- The display shall have four lines, with 20 characters on three lines and eight large characters on one line. Actual pump information shall be displayed indicating pump status.
- Controller shall be capable of performing the following pressure booster functions:
    - Low suction pressure cutout to protect the pumps against operating with insufficient suction pressure.
    - High system pressure cutout to protect the piping system against high-pressure conditions.
    - No flow shutdown to turn the pumps off automatically when system demand is low enough to be supplied by hydro pneumatic tank. No flow shutdown shall require any external flow meters, flow switches, nor does pressure switch to determine when a No Flow conditions exist.
- The following communication features shall be provided to BAS:
    - Remote system start / stop non-powered digital input.
    - Failure of any system component. Output closes to indicate alarm condition.
    - Four 4-20 mA output with output of

i) Frequency
ii) Process variable
iii) Output current
iv) Output Power

- The following communication features shall be provided to the Chiller Plant Management System (Building Automation system) via an RS-485 port suitable to hookup either in BacNet / RTU Modbus protocol. Necessary hardware / software required for integration should be part of scope.
  - Individual Analog Input.
  - Individual Zone Set points.
  - Individual Pump / VFD on/off status
  - System percent speed
  - System start/stop command
  - System operation mode
  - Individual kW signals
  - System flow, when optional flow sensor is provided.

- The pump logic controller shall be of a high end type i.e. all the parameters available on the logic control panel should be able to monitor / controlled from the remote location and should be housed in a NEMA 1 Enclosure.

5.17 SENSOR / TRANSMITTERS

Provide field mounted differential pressure sensor transmitters as indicated in the BOQ & also in the drawings. Unit shall transmit an isolated 4-20 mA dc signal indicative of process variable to the pump logic controller via standard two wire 24 DC system. Unit shall have a corrosion resistant steel body with 1/8" NPT process connection. It shall have a NEMA 1 electrical enclosure capable of withstanding 450-PSI static pressure. Accuracy shall be within 0.5% of full span.

5.18 SEQUENCE OF OPERATION

- The system shall consist of Technologic pump logic controller, multiple pump / VFD sets, with manual and automatic alternation and pump staging.
- The pumping system shall start upon the closure of customer's contact when pump logic controller mode of operation selector switch is in the REMOTE position.
- When the pump logic controller selector switch is in the LOCAL position, and start command on controller is given via operator interface, the pumping system shall operate automatically.
- Sensor / transmitter shall send a 4-20 mA signal to the pump logic controller, indicative of process variable condition.
- The pump logic controller shall compare each signal to the independent engineer / user determined set points.
- When all set points are satisfied by the process variable, the pump speed shall remain constant at the optimum energy consumption level.
- The pump logic controller shall continuously scan and compare each process variable to its individual set point and control to the latest satisfied zone.

- If the set point cannot be satisfied by the designated lead pump, the pump logic controller shall initiate a timed sequence of operation to stage a lag pump.
- The lag pump shall accelerate resulting in the lead pumps decelerating until they equalize in speed.
- Further change in process variable shall cause the pumps to change speed together.
- When the set point criteria can be safely satisfied with fewer pumps, the technologic pump logic controller shall initiate a timed sequence and continue variable speed operation
- As the worst-case zone deviates from set point, the pump logic controller shall send the appropriate analog signal to the VFD to speed up or slow down the pump/motor.
- In the event of a VFD fault, the pump logic controller automatically initiates a times sequence of events to start the redundant pump/VFD set in the variable speed mode. The redundant variable speed system shall be started through the pump logic controller.
- Upon VFD faults, the pump controller shall display an alarm condition through a plain English message.
- VFD fault indication shall be continuously displayed on the operator interface of the pump until the fault has been corrected and the controller has been manually reset.
- In the event of the failure of a zone sensor/transmitter, its process variable signal shall be removed from the scan/compare program. Alternative zone sensor/transmitters, if available, shall remain in the scan/compare program for control.
- Upon sensor failure a plain English warning message shall be displayed on the operator interface of the pump logic controller.
- In the event of failure to receive all zone process variable signals, a user selectable number of VFDs shall maintain a user adjustable speed; reset shall be automatic upon correction of the zone failure.

5.19 Technical Requirements for Water cooled chiller:

Sl. No.	Description	**Primary Water Pumpsets serving Water Cooled Chillers**	**Condenser Water Pumpsets for Water Chiller**	**Secondary Pump sets**
A	**Design Features**			
01	Pump designation	Vertical Inline & Constant Speed	Vertical Inline & Variable Speed	Vertical Inline & Constant Speed
02	Minimum Design Capacity	As per BOQ.	As per BOQ.	As per BOQ.
03	Head	15 Mtr	40Mtr	35Mtr
04	Location	Outdoor /	Outdoor /	Outdoor / Indoor

		Indoor	Indoor	
05	Maximum rated speed at 50 Hz	1140 GPM & (2W + 1S)	1140 GPM & (2W + 1S)	1662GPM & (2W + 1S)
06	Liquid Handled	Water	Water	Water
07	Quantity Required	As per BOQ.	As per BOQ.	As per BOQ.
B	**Features of Construction**			
01	Type of Pump	As mentioned in BOQ	As mentioned in BOQ	As mentioned in BOQ
02	Impeller	Enclosed	Enclosed	Enclosed
03	Shaft	Coupled	Coupled	Coupled
04	Drive Transmission	Direct	Direct	Direct
05	Seal	Mechanical Seal	Mechanical Seal	Mechanical Seal
06	Prime Mover	AC Electric Motor	AC Electric Motor	AC Electric Motor
07	**Variable Frequency Drive**	Not Required	Not Required	Required including Stand By
08	Logic Control Panel	Not Applicable	Not Applicable	Required. Should be able to transfer the entire signal available on the display panel to BMS. Necessary hardware & software for integration should be part of the scope. Signal should be in ASHRAE Bacnet / RTU Modbus Protocol
09	Differential Pressure	Not Applicable	Not Applicable	Should be considered as

	Sensor / Transmitter with Control Cabling			mentioned in BOQ.
C	**Material of Construction**			
01	Impeller	Bronze	Bronze	Bronze
02	Casing	Cast Iron GR FG 200 / Ductile Iron	Cast Iron GR FG 200 / Ductile Iron	Cast Iron GR FG 200 / Ductile Iron
03	Shaft	EN-8 Steel	EN-8 Steel	EN-8 Steel
04	Shaft Sleeve	EN-8 Steel	EN-8 Steel	EN-8 Steel
05	Impeller Ring	SS 316	SS 316	SS 316
06	Casing Ring	Cast Iron GR FG 200	Cast Iron GR FG 200	Cast Iron GR FG 200
07	Stuffing Box Packing	Graphited Asbestos	Graphited Asbestos	Graphited Asbestos
08	Base Plate	Fabricated MS	Fabricated MS	Fabricated MS
D	**Accessories**			
01	Companion Flanges	Yes	Yes	Yes
02	Foundation Bolts	Yes	Yes	Yes
03	Base Plate	Yes	Yes	Yes
04	**Inertia Blocks with Spring Isolators**	Required. Including civil items like pedestals to be part of scope. Item should be considered compulsorily in the scope of works.	Required. Including civil items like pedestals to be part of scope. Item should be considered compulsorily in the scope of works.	Required. Including civil items like pedestals to be part of scope. Item should be considered compulsorily in the scope of works.
05	**FRP Hood over the Pumps**	Required	Required	Required

5.20 Technical Requirements for Air cooled chiller:

- All the pumps (primary and secondary) are in Terrace. Vertical In-Line Centrifugal type pumps are considered.

- Primary constant and Secondary variable type pumping system is considered.
- Control valves are considered which will modulate the chilled water flow based on the internal load requirement.
- Differential pressure sensors located in the CHW lines shall give signal to Pump PLC to reduce or increase the pump speed based on the line pressure.
    - Multiple vertical risers have been planned for comfort application

Description	Primary Pumps	Secondary Pumps
Flow Rate (GPM) &Qty (Nos)	360 GPM & (1W + 1S)	360 GPM & (1W + 1S)
Head	15 m	40 m
Type	Vertical Inline & Constant Speed	Vertical Inline & Variable Speed
Location	Plant room at Terrace level	Plant room at Terrace
Efficiency Class	IE-4	IE-4

5.21 7.0 DATA TO BE FURNISHED BY THE CONTRACTOR AFTER THE AWARD OF CONTRACT

- Quality Assurance Plan (QAP)
- Dimensioned general arrangement drawing of pumps and driver
- Foundation drawing of pump and driver with static and dynamic loads, details of fixing, grouting and all relevant data required for design of foundation.
- Cross-sectional drawings of the pump with complete part list, material of construction and relevant standards for each part.
- Pump performance curves flow rate Vs head, BKW, efficiency, NPSHR from zero flow to maximum flow and torque-speed curve.
- Scheme for pump sealing, lubrication and cooling.
- Driver dimensional drawing.
- Surface preparation and painting procedures.
- Catalogues, data sheets and drawings for instruments.
- Installation, operation and maintenance manual.

SECTION-VI- EUROVENT CERTIFIED DOUBLE SKIN AIR HANDLING UNITS:

6.1 SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of double skin construction factory assembled air handling units, conforming of these specifications and in accordance with requirements of Drawings & of the bill of quantities.

Unit performance, coil performance and Mechanical Characteristics shall be EUROVENT certified. The EUROVENT **Certified** manufacturer shall provide a detailed computerized software performance printout for overall AHU performance including coil & fan selections for each AHU in project.

6.2 TYPE

The air handling unit's type, capacity, motor HP, cooling capacity, static pressure etc., shall be as shown in the drawing and in the Bill of Quantities (BOQ)

6.3 CAPACITY

The air flow rate, static pressure, motor rating, cooling /heating capacity (TR/KW) shall be as shown on Air Flow Drawing and in Schedule of Quantity.

All the components of Air handling unit should be supplied by AHU manufacturer.

A) Mechanical Characteristics of AHU Casing Construction to be as below:

Casing Strength Classification: D1

The casings to withstand the maximum fan pressure at the selected design fan speed. The maximum relative deflection should not exceed 4 mm/m. No permanent deformation of the structural parts (structures and supports) or damage of the casing may occur.

Casing Air Leakage : L1

Air leakage of the air handling unit should be tested under positive & negative pressure & should not exceed the values given below

Max. Air leak rate at - 400 Pa test pressure : 0.15l/sqm
Max. Air leak rate at +700 Pa test pressure : 0.22l/sqm

Filter Bypass Leakage : F9

The maximum allowable filter bypass leakage rate shall be 0.5% of design flow rate at 400 Pa positive test pressure.

Thermal Transmittance : T2

The unit should be designed to have a heat transfer coefficient given below

- Heat transfer coefficient U: 0.5< U < 1.0 W/sqm.K
- The test should be conducted in an environment chamber of Eurovent accredited laboratory & the readings should be taken after the steady state temperature difference of 20 K is established.

Thermal Bridging Factor : TB2

The unit should be designed to have a thermal bridging factor as given below.

- Thermal bridging factor kb: 0.6< kb < 0.75
- The lowest difference of temperature at any point on the external surface and the mean internal temperature shall be established. The ration between the lowest temperature difference and the mean air to air temperature difference defines the thermal bridging factor.
- The test should be conducted in an environment chamber of Eurovent accredited laboratory and the readings should be taken after the steady state temperature difference of 20 K is established.

B) Air Handling Unit Performance:

The performance of air handling units should be tested in a Eurovent accredited laboratory in accordance with EN 13053.These tests shall be carried out forAir flow Vs static pressure data, power consumption, Heat recovery (if any), Cooling& heating duty, Air / water - side pressure drop.

AHU shall be with CE marking confirming that the manufacturer has verified compliance with the essential health and safety requirements.“Greenpro” certified (An Internationally recognised ecolabelling scheme by the Global Ecolabelling Network) product label will be preferable to demonstrate sustainable and energy efficient products which enables users to choose sustainable products for reducing the environment impacts.

6.4 UNIT COMPOSITION

The AHU shall be of the cabinet type Horizontal / Vertical configuration and shall be of metal construction using best quality galvanized sheet steel treated for rust prevention. They shall be constructed in sections such as fan section, coil section, damper section and filter section suitable for floor installation or ceiling suspension. The unit shall be fitted with unit mounted volume control damper.

6.5 CASING:

The casing for air handling unit shall be of double wall construction with 45±2 mm thick for floor / Ceiling mounted AHU e AHU filled with polyurethane foam or equivalent fire retardant insulation (CFC and HCFC free) sandwiched between the panels. The density of the insulation material shall be 48kg/m3 and the thermal conductivity does not exceed 0.02 W/m2°C. The inner walls of AHU shall be of 0.8mm plain galvanized sheet steel with coating 120GSM. The outer walls of AHU shall be of 0.8mm pre-coated galvanized sheet steel with coating 120GSM. Section frames shall be of hollow anodized extruded Aluminium internally

insulated and mechanically joined. Units shall be with necessary air tight access doors with adjustable locking device for each section. Sections shall be bolted together with special cast Aluminium fittings at the joints with rubber gaskets for air tight operation. The AHU base frame shall be heavy duty GI section.

6.6 FAN SECTION:

Fans shall be direct drive backward curved plenum Radial EC /plug type fan so as to give maximum efficiency for given duty condition. In case of backward curved Radial EC fan (Electronically commutated) with permanent magnet brushless DC motor for steeples variation of speed of fan based on temperature/pressure sensor inputs. The fan section shall be provided with limit switch for safety to shut off fan during Opening of access door.

The entire fan with casing will be certified by a reputed 3rd party internationally acclaimed certifying body like Eurovent and the entire Fan + Motor assembly will be balanced at supplier's works before dispatch.

Fans driven shall be backward inclined irrespective of static pressure value. Fans shall be selected for minimum efficiency of 70% to 75% Fan casing shall be made of galvanized steel sheet. Number of Fans shall be one up to 15000 cmh, two in case of 18000-30000 cmh, three in case of 40000 & 50000 cmh and four in case of 65000 cmh. Fan shaft shall be grounded C40 carbon steel and supported in self-aligning Plummer block operating less than 75% of first critical speed, grease lubricated bearings.

Fan wheels shall be individually tested and precision balanced dynamically. Fan motor assembly shall be statically and dynamically balanced to G6.3 grade as per relevant ISO/AMCA standard. Computerized fan selection print outs shall be submitted along with the offer.

Motors shall be mounted inside the AHU casing on slide rails and be totally enclosed, fan cooled, to be class `F' insulation.

Both fan and motors assemblies shall be mounted on a deep section aluminum alloy or galvanized steel (depending on size) base frame.

Rubber anti vibration mounts shall be provided for isolating the unit casing. Frame retardant, waterproof silicone rubber impregnated flexible connection shall be provided at the fan discharge.

6.7 PLUG FAN WITH EC MOTOR:

The complete EC Fan unit shall be of rugged bolted construction made of sheet steel, statically and dynamically balanced.

Fan: The fan section shall be equipped with a Single Inlet Centrifugal Impeller with High Efficiency Backward curved blades and external rotor EC (Electronically Commutated) motor, energy optimized for operation without spiral housing for high efficiency and favorable acoustic behavior. The high efficiency backward curved impeller with rotating diffuser made of high performance composite material / welded aluminum sheet material,

with external rotor motor balanced together statically and dynamically according to DIN ISO 1940 Part 1.

The EC fan should be capable of being fitted in horizontal or vertical position in the AHU, depending on the application. Inlet cone shall be provided with a nozzle for volume flow measurement of the fan.

Motor: The motor shall be permanent magnet external rotor motor with integrated electronics and suitable for continuous operation. The speed of the motor shall be variable depending on an external control signal. The fans shall be Modbus RTU compatible for communication with BMS (Building Management System). The fan in totality shall be of most efficient type so that the power consumption and noise level is minimal. The EC motor shall have a wide voltage input range: 3~380…480V, 50/60 Hz. The motor shall be minimum IP55 protection class, with Thermal class 155 (Insulation class F). The EC motor shall be provided with suitable protection from moisture & hot climate. The ball bearing shall be provided with long time lubrication for maintenance free operation.

Integrated Electronics: The device electronics shall be protected from overload by the Active Temperature Management, so that if the ambient operating temperature exceeds the design limit then the fan is not switched off immediately. In such a condition the fan should be operational at lower speeds, till the time the operating ambient temperature drops down.
The EC motor shall meet all necessary EMC (Electromagnetic Compatibility) directives. The EC motor should comply with applicable EMC standards: Interference Emission Standard EN 61000-6-3 / 2. EC Motor shall be integrated with VSD (Variable Speed Drive) for speed modulation of fans.
Fan characteristic curves shall be related to measurements on a fan test rig with inlet silencing chamber in accordance with DIN 24163 Part 2 OR ISO 5801.
The performance data of the fan shall correspond to precision class 2 as defined by DIN 24166.
The EC motor shall have the following protective features integrated in the controller:

- Overvoltage protection
- Short Circuit protection
- Under voltage/ Over voltage detection
- Locked rotor protection
- Line fault detection
- Active Temperature Management for thermal protection of motor and electronics
- Alarm relay 250V/2A
- Over temperature protection of electronic and motor
- External LED display shall be provided for indication of the status of the fan

Make : Ziehl-abegg / EBM papst

6.8 ELECTRICAL & CONTROL PANEL:

The air handling unit shall have inbuilt integrated electrical starter panel with AUTO/Manual over ride switch for operation. Control cabinet to be provided with IP 65 enclosure which should be mounted on AHU surface/flushed inside the AHU casing. The electric panel provided for the unit must be equipped with main incoming contactor additionally the unit

must be provided with MCBs with busbar for single incomer provision , additionally SMPS must beprovided for power supply to the unit controller. Potentiometer shall be an integral part of the panel for manual speed control. Each unit shall have an Internal mounted Power cum control marshelling box of IP 65 protection with door and hinges with provision to mount power and control wirings with DDC controllor.
Provision for 24 V DC power supply for PIBCV valve shall be part of the control panel.

6.9 CHW COIL SECTION & MOISTURE ELIMINATOR

The coil section of the AHU shall be of the cartridge type, removable from the side of the casing and supported over the entire length of the coil. The Cooling coil section shall have 12.5 mm to 15 mm dia, 0.41mm wall thickness copper tubes with 0.15mm thick sine wave Aluminium fins firmly bonded to copper tubes assembled in zinc coated steel frame. The coil header shall be copper and the coil fins shall be supplied with Anticorrosive hydrophillic coating. Face and surface area shall be such as to ensure rated capacity from each unit and such that air velocity across each coil shall not exceed 2.4 m/sec. Where required, eliminator shall be provided downstream of the cooling coil to arrest entrained free moisture from the air stream. An appropriate panel of the Coil Section shall incorporate factory made openings for coil inlet & outlet connections. The coils shall be mounted over an adequately sized condensate drain pan. Particular, care shall be taken to ensure that condensate is drained totally without leaving any stagnant pools anywhere in the unit. Each coil shall be factory tested under water. Tube shall be hydraulically expanded for minimum thermal contact resistance with fins. Fin spacing shall be 11 to 13 fins per inch. The Coil shall be mounted on castors to facilitate removal for cleaning. Flanges of resilient isolation material shall be provided both at the inlet and outlet connections of all cooling coils with necessary bushes of similar material to minimize transmission of vibration to connected piping. Coil shall have automatic air vents, the vent outlets beings piped to the drain pan with a copper pipe. Coil performance shall be rated in accordance with ARI Standard 410. Each coil shall be leak tested at 17 bars.

6.10 MICRO PROCESSOR CONTROLLER

The controller should have minimum 20I/O points and RS485 ports for BMS Connectivity using Modbus RTU protocol / BACnet IP connectivity. The power input to the controller shall be 24 v DC and provision shall be made for the same in the control panel by AHU manufacturer. Each Unit shall be equipped with minimum 7'' HMI with touch screen for monitoring and controlling the AHU which shall be IP 65 protection.

Touch screen HMI shall be default option even not specified in the BOQ. As a standard the controller / DDC must be compatible to connect to a laptop or display for configuring or viewing unit performance parameters.
Marshalling box should be factory fitted with termination of all control cables and RS 485 output of fan duly mounted inside the AHU panel. All wiring should be carried out by the AHU manufacture at factory with proper ferule for tagging purpose.
The control panel for EC fans should be in the scope of AHU manufacturer and should be factory fitted.
The controller to have the following inputs / outputs (To be incorporated as per control logic):

- Temperature / RH / Pressure connectivity as per devices options.
- Integration to fire panel
- Provision for fire damper integration
- Fan wall program for EC fans with individual status of fans thru Modbus
- Run hour status of each fans
- Kw / amp consumption of each fan on the fan wall
- CO2/VOC sensor connectivity – optional, if mentioned in the BOQ
- VFD connectivity via Rs485 (Modbus slave) – optional, if mentioned in the BOQ
- I/O summary
- Multiple controller (Slave) connectivity.
- Modbus RTU (485/IP) compatible output to BMS.
- Feedback from sensor etc and regulate the fan speed/ valve opening.
- Automatic load / time and alarm sequencing function to be performed by the unit.
- Microprocessor must have output point for ON/OFF of motorized outlet damper and must be suitable to be integrated with fire point for unit shut off incase receiving signal from fire panel or fire detectors.

Instrumentation: The following sensors shall be part of AHU package for modulation of fan and control valves

1. CHW temperature Sensor
2. Pressure Sensor/ DP sensor for fan speed control
3. DP switch across all filters
4. Co2 sensor for damper modulation
5. Velocity or DP Sensor for Flow measurement, depending upon control philosophy.

6.11 THERMAL BREAK PROFILE

AHU's such as TFA units, AHU with mixing box having return air ducted shall be provided with thermal break profile as indicated in Bill of quantities.

6.12 FILTER SECTION

The Filter Section shall consist of Pre-filters (G4 or MERV-8) & Bag Filter (F7 or MERV-13) as mentioned in BOQ.

The Pre filters shall have an efficiency of 90% down to 10 microns by Gravimetric Test (MERV-8 or better) as per BS EN 779. The filter Pressure drop shall not exceed 6 mm wg when clean and 10 mm wg when fully loaded. Each unit shall be provided with a factory assembled filter sections containing washable synthetic type air filters having GSS frame. The media shall be supported with High Density Polyethylene (HDPE) mesh on one side and aluminum on the other side. Filter banks shall be easily accessible and designed for easy withdrawal and replacement of filter cells. Filter banks frame work shall be fully sealed and constructed from GSS.

Similarly Bag filters shall have an efficiency of 99% @ 3 microns, 85% @ 1 Micron & 55% 0.3 Micron by Gravimetric Test (MERV-13). The filter pressure drop shall not exceed 9 mm of wg when clean and 13 mm when fully loaded. Filter banks shall be easily accessible and

designed for easy withdrawal and replacement of filter cells. Filter banks frame work shall be fully sealed and constructed from GSS.

All filters in the AHUs shall be mounted on powder coated GI holding frame.

6.13 DRAIN PAN / DRAIN PACKAGE:

Extended drain pans for the AHUs shall be fully insulated with minimum 19mm thick nitrile rubber insulation over panel of 20G hot-dipped galvanized sheet steel for comfort air conditioners and stainless steel or plastic corrosion-free pans for precision control units. Condensate drain piping shall be insulated with Nitrile rubber insulation. Drain pan connection shall be provided on both right and left hand sides. External drain piping shall be connected to both sides with suitable air seal trap. Each individual coil in an AHU shall have its own ancillary drain pan. This is to ensure that the condensate of one coil does not drip on to the other.

6.14 SAFETY FEAUTRES

Each Air Handling Unit must have safety features as under:

a) The Fan Access Door shall be equipped with micro-switch inter locked with fan motor to enable switching off the fan motor automatically in the event of door opening.
b) The Access Door shall further have wire mesh screen as an added safety feature bolted on to the unit frame.
c) Fan and motor base shall be properly grounded.
d) EC fan grounding within the fan terminal (if applicable)

6.15 ACCESSORIES

All the accessories shown in the drawings as indicated shall be included. Each air-handling unit shall be provided with manual air vent at high point in the cooling coil and drain plug at the bottom of the coil.

- Inspection Window
- Bulkhead lightning.

The AHU shall be provided with suitable space provision for the field equipments of BAS to monitor the parameters across the AHU elements like filters, coil, heater, ERW, fan, etc

6.16 LIGHTING INSIDE THE AIR HANDLER

Revision elements for fan- and filter components must be equipped with interior lighting. Interior lighting must be wet room execution, with a CFL lamp, terminal box and switch mounted on the unit's outside, wired and ready for operation.

6.17 INSTALLATION:

The AHU shall be mounted on vibration isolation serrated rubber pads

Note: The air conditioning contractor shall supply either horizontal design or vertical design air handling units in order to take care of the space constraints prevails at site without any extra cost. For ceiling suspended AHU, the height shall be restricted within 700mm

6.18 CODES & STANDARDS

The design, materials, manufacture, inspection, testing and performance of the AHU's shall comply with all currently applicable statutes, regulations, codes and standards in the locality where the equipment is to be installed. Nothing in this specification shall be construed to relieve the CONTRACTOR of this responsibility. In particular, the AHU's shall confirm to the latest edition of the following standards:

EN 1886 : Air handling unit mechanical performance.
IS 7613 : Methods of Testing panel type Air Filters for Air-Conditioning and Ventilation Purposes
ASHRAE 33 : Methods of testing – Forced Circulation Air Cooling and Air Heating Coils
ARI 410 : Forced circulation air –air cooling and air heating coils.
ARI 430 : Central-station air handling units.
AMCA 210 : Laboratory methods of testing fans for ratings.
NFPA 90 A : Installation of Air-Conditioning and Ventilation Systems.

6.19 FACTORY VIBRATION BALANCE REPORT:

- Certificate of compliance papers shall be attached to each fan at shipment, and signed by the fan manufacturer's quality control inspector. An additional copy shall be sent to Client.
- All factory balancing test results shall be furnished to certify the fan vibration does not exceed 50 mils per second rms for belt-driven units. Measurements shall be taken in a direction parallel to the shaft in a horizontal plane and in a direction perpendicular to the shaft in both the horizontal and the vertical planes.
- During balancing tests, the fan shall be operating at rated volume flow against the design external static pressure.

6.20 WITNESS TEST

Prior to shipment, AHU machines shall be subjected to inspection and witness of performance tests by Client / Architect / Consultant's representative to verify various performance parameters as confirmed by vendor earlier at the time of award of contract. Performance test shall be carried out for one in each type of AHUs as per procedure laid down by AHRI and as per consultant specified parameter. The cost towards the travel and accommodation shall be included in the bidder scope. The AHUs should not be dispatched from the factory unless these have been witnessed and accepted by the Client / Project Manager / Consultant on the performance.

6.21 PERFORMANCE DATA:

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

Factory Acceptance Test (FAT)

The contractor/manufacturer shall describe the test that will be conducted at their works on the air handling units. They shall be furnish a test certificate to the effect that such test have been duly performed on the AHU'S units. One of each type of unit shall be inspected at factory

- Run Test for Air quantity v/s static pressure
- Vibration test
- Cabinet deflection test
- Sound level
- Casing Leak Test as per DW 143 standard
- Pneumatic pressure test of Heat Transfer coil at 21Kg/sq.cm
- Power consumption
- Dimensional check of unit
- Verification of Test certificates of components / calibration certificates of all instruments used during inspection.

Contractor shall consider 4 People to & fro charges for and testing experience in his quote. test shall be conducted on all AHU'S at factory for measurement of delivery vs static pressure, total pressure,BKW,efficiency & noise level at 100%,80%.50%& 40% speeds. The PMC/Client shall be intimated advance of the date of the test, which they will witness there at their option

6.22 ULTRA VIOLET GERMICIDAL IRRADIATION (UVGI) SYSTEM

Ultra Violet Germicidal Irradiations (UVGI) System with advanced active purification for maintaining indoor Air Quality in AHU unit having following features and technical specifications as reqd.

1. The system shall be applied on the coil side of the AHU to ensure no mold growth.
2. Installation of UVGI frame in the AHU shall be with factory provided Guide Rails and Installation Rails. Cover Plates and all necessary hardware required for installation shall be factory provided by Manufacturer "All wetted parts shall be Stainless Steel to render it suitable for use in Hospitals, Health Care Facilities, and in Food Processing Plants. All non wetted parts shall be powder coated.
3. The Lamps shall be 9000 hrs. Life with not less than 25% derating provides Rated Average Life of 9000 hrs. Lamps shall be environmentally friendly with special coating for 80% reflectance. The tube sizes should T5 only, other than that will not be permitted.
4. Ballasts shall be electronic type and should be self contained to tube with life rated for greater than 15,000 starts. Separate ballast shall not be permitted.
5. The Ultra Violet Germicidal Irradiation system should be interlocked with Photo Hydro Ionized Oxidation Plus (PHIO+) and to be installed in the supply air duct for maintaining the Volatile Organic Compounds and Microbial Growth in the indoor

environment. The PHIO+ should have strict conformity to the follows specifications

- It should produce friendly ion plasmatic hydrogen based oxidizers. The PHIO+ tube should consist of a honey comb structured hydrated catalyst with UV light of C waveband.
- It should produce friendly ion plasmatic oxidizers like hydro peroxides, super oxide ions, ozonide ions, bi polar ions and hydroxide ions.
- It should be capable of reducing microbial growth, VOC (Volatile Organic Compounds), Odor, Smog, Particulate Matter.
- It should be equipped with advanced active air purification system Plasma cells for actively reducing the pollutants. The plasma cell shall operate on 12VDC and draw 30mA to produce 10.0 e9 Bipolar Ions/sec. The plasma cells shall conform to UL 867 and CSA-C22.2 No. 187. Low output cells shall not be acceptable. The unit shall be installed to ensure laminar airflow over the plasma cells.
- There should have an indicator that will show whether the unit is ON/OFF. The unit should be designed to run 24x7.
- The ballast shall be instant start with the indicator and it should not exceed a diameter of 5.5 inches.
- The unit should be effective against 273 chemical gasses and the same list need to be submitted.
- The unit should be designed to work on an input of 220V AC, 50Hz and in operating conditions of 0°F (-18°C) to 140°F (60°C), RH 0 to 90%
- A mounting plate of 8” by 8” along with a detachable power chord shall be provided for ease of installation.
- PHIO+ need to be installed in the supply air stream in accordance with the selection chart in respect to each application so that the indoor space is taken care off in respect of microbial contamination (bacteria, virus & spores) and gaseous contamination (VOC’s & Odors)
- A test certificate from an internationally accredited lab (EMSL) must be provided about the performance of the technology on E. Coli kill rate in air.
- All parts and support must be locally available to ensure optimal performance at all times. The unit should be designed for installation on the supply airside of the duct.

Design Basis	Supply Air side application.(within the AHU)
UV Tube	Broad Spectrum C waveband
Metal casing enclosure	Honey comp structured catalytic matrix Cell
Support system	Locally from India
Time to reduce specific odors up to 80%.	Less than 05 hrs.
Triple effect Function	Germicidal +VOC+ Particulate matter
Minimum catalyst life	18000 hours
Capability to generate	Hydro peroxide ions, super oxide ions, Ozonide ions, bi polar ions, hydroxides.

- **Optional:** After installation of the units, and optional IAQ test for parameters such as VOC, CO2 and bacteria count shall be made available on site on additional cost.

6. It should be designed to achieve Kill Rate not less than 90% per pass.
7. Appropriate Safety and Caution Notice shall be screen printed on the cover plate of UVGI frame and on the electrical box. Placing adhesive labels shall not be accepted, so as not to compromise on safety

6.23 TECHNICAL DATA SHEET NEED TO BE FILLED BY BIDDER

Sl.No.	Description	Remark
	Please furnish	
	a) leaflet and	
	b) details noted below for all AHUs	
	c) Noise Spectrum from at various frequencies from 16 Hz to 8000 Hz	
A	**General**	
01	Manufacturers name	
02	Whether medium pressure unit?	
03	State nature of machinery used for Manufacture.	
04	Whether motor is within the unit?	
05	Model & Size	
06	Overall dimensions - mm x mm x mm	
07	Overall weight (including cooling coil & fan)	
08	Is AHU suitable for Outdoor Installation? If so Weather Proof Canopy is Considered (Please refer BOQ where ever it is called)?	
B	**Casing**	
01	**Panels**	
a	Material of outer skin	
b	Material of inner skin	
c	Thickness of outer skin	
d	Thickness of inner skin	
e	Finish of outer skin	
f	Finish of inner skin	
g	Panel thickness	
02	**Frame**	
a	Description	
b	Material of frame	
c	Describe frame - panel joints	
03	**Panel Insulation**	

a	Material	
b	K value - W/m. °C	
c	Density - Kg/cum	
04	**Access Doors:**	
a	List sections for which Access doors are included	
b	Door material	
c	Construction details	
d	Type of hinges	
e	Type of handle	
C	**FAN AND FAN MOTOR :**	
01	Type of fan	
02	Number of fan drums	
03	Diameter of fan drum - mm	
04	Length of fan drum - mm	
05	Number of blades	
06	Type of blades (i.e., whether forward curved or backward curved or of aerofoil section)	
07	Delivery - CMH	
08	Total Static Pressure - mm wg (to be considered at dirty condition)? Please give details for pressure drop for various sections like Mixing Box Pre Filter Section Bag Filter Section Moisture Eliminator Cooling Coil A/W Section Fan Section Plenum for SA Dampers at inlet & outlet Others	
09	Maximum static pressure capability - mm wg	
10	Speed – rpm	
11	Critical speed - rpm	
12	B K W	
13	Motor selected	
14	Type of motor	
15	Motor speed - rpm	
16	Type of starter	
17	Fan Noise Level? Please ensure that noise levels at various frequencies are attached along with quote (starting from 16 Hz to 8 K Hz)	

18	Whether impellor and shaft dynamically (and statically) balanced?	
19	Vibration level	
D	**FILTER SECTION :**	
01	Overall dimensions - mm x mm x mm	
02	Number of filters - Nos.	
03	Nominal dimensions of each filter – mm	
04	Type of filter	
04	Media used	
05	Efficiency of filter (State the test method)	
06	Manufacturer's name	
07	Resistance of filter when clean-mm wg	
08	Maximum resistance of filter - mm wg	
09	Dust Holding Capacity (Per & bag Filter) – gms	
10	Is the media cleanable?	
11	Is 2 sets of spare filters considered in the quote apart from one set in the AHU	
12	Is one set of commissioning filters considered in the Quote?	
E	**COOLING COIL / DX COIL**	
a)	Please specify the type of Coils considered in the scope?	
b)	Material of Construction for Coil / Tubes	
c)	Material of Construction for Fins	
d)	Is special quoting specified in the Specs for Fins considered in the Scope	
e)	Is Moisture eliminator considered after coil section?	
f)	What is the material of construction for moisture eliminator	
g)	No of Rows	
h)	Bypass Factor	
F	**MIXING CHAMBER**	
a)	Is mixing box considered in the scope?	
b)	Is it with dampered outlets? If yes is it considered for 2 return air & 2 fresh air outlets?	
c)	Is material of construction in terms of thickness & material same as other panels?	
d)	Is AHU is of Thermal Break Construction?	
G	**SAFETY FEATURES**	
	Please specify safety features considered in AHU?	

6.24 TECHNICAL SPECIFICATION FOR CASSETTE UNIT:

Chilled water CASSETTE unit shall consists of fan, motor with three speed control, CHW cooling coil, filter, additional insulated drip tray, with necessary supporting arrangement, controls, decorative panel, power wiring from nearest power socket to indoor unit control wiring from indoor, to temperature sensor & CHW Valve, ball valve for outlet, ball valve with strainer for inlet & combined balancing & 2 Way on/off valve with spring return actuator. Cordless remote, control cables etc., with inbuilt drain pump. The unit shall be equipped with BMS interface control module for controlling the unit. In built integration card with inbuilt Thermostat.

REQUIREMENTS:

Sl. No.	Description	Unit	As per Tender	Vendor to fill
1	Manufacturer			
2	Model			
3	Airflow (H / M / L)	CFM		
4	Cooling Capacity	TR	1 / 2 / 3 / 4	
5	Cooling Capacity	kW		
6	Fan Type		Centrifugal, Forward curved Blades	
7	Power Input	W		
8	Noise Level (H / M / L)	dBA	Max 40 dB	
9	Power Supply	V/ Ph/ Hz	220 - 240 V / 1 Ph / 50 Hz	
10	Indoor Unit Dimension (W x H x D)	mm		
11	Water Inlet / Outlet pipe connection (OD)	mm		
12	Drain Pipe Size (OD)	mm		

6.25 SPECIFICATIONS FOR FAN COIL UNITS

6.25.1 Type

The fan coil unit shall be of the factory assembled and of integral fan type with chilled water cooling coil and shall be made for recessed mounting.

6.25.2 Mountings

The connected fan coil unit shall be securely attached to the building structure and shall be set dead level in both directions

6.25.3 Coils

Coil shall be constructed of aluminium fins mechanically bonded to copper tubes. The minimum fin thickness shall e 0.008” and tubes dia shall be not less than 12 mm OD and minimum wall thickness shall be 25G. Provide air vent and drain plug in the coil. Coil shall be tested at 17 bar while submerged in water

6.25.4 Drain Pan

Drain pan shall be provided under the cooling coil, supply and return lines, and control valves. The pan shall be of sufficient size to catch all drippage of condensation from any part of the unit. The drain pan shall be fabricated by 16 gauge galvanized steel with all corners welded. The pan shall be insulated with not less than 12 mm thick thermocole / polyurethane sheet / glass fibre / nitrile rubber insulation to effectively prevent condensation from the pan.

6.25.5 Motor

Sl. No.	DESCRIPTION	REQUIRED	REQUIRED	REQUIRED	TENDERER
01	Type of unit	Ductable FCU	Ductable FCU	Ductable FCU	
02	Area Serving	As per BOQ / drawinsg	As per BOQ / drawing	As per BOQ / drawing	
03	Capacity – TR	3.0 TR	4.0 TR	5.0 TR	
04	Total air flow rate – cfm	1200 Cfm	1600 Cfm	2000 Cfm	
05	Dehumidified air flow rate – cfm	1200 Cfm	1600 Cfm	1600 Cfm	
06	Cooling coil face area - sqm	0.22 Sqm	0.30 Sqm	0.37 Sqm	
07	Coil face velocity – m/sec	2.5 m/s	2.5 m/s	2.5 m/s	
08	No of rows	3RD / 4RD	3RD / 4RD	3RD / 4RD	
09	Entering chilled water temp	5.55 deg C	5.55 deg C	5.55 deg C	
10	Leaving Chilled Water Temp	13.33 deg C	13.33 deg C	13.33 deg C	
11	Chilled water flow rate - lps	0.40 Lps	0.43 Lps	0.54 Lps	
12	Fan static pressure – mm wg	40 mm	40 mm	40 mm	
13	Suggested Fan motor - KW	0.55	0.55	0.55	
14	Type of fan motor	TEFC Squirrel Cage	TEFC Squirrel Cage	TEFC Squirrel Cage	
15	Rough Filter	Required	Required	Required	
16	PIBCV / 2-way Motorized valve Package	Required	Required	Required	
17	Ball Valve with Strainer	Required	Required	Required	
18	Ball Valve without Strainer	Required	Required	Required	
19	Room Thermostat	Required	Required	Required	

Motor shall be of split capacitor type and shall have sufficient torque to start on low speed. The motor shall suitable for the current characteristics set out. The motor shall have built-in-thermal over load protection.

6.25.6 Fan Speed Control

The unit shall be complete with fan speed control switch (high – medium – low – off)

6.25.7 Temperature Control

The unit shall have temperature control by the way of a PIBCV / 2 way modulating operated by a thermostat valve.

6.25.8 Filter Section

Pre filter (90% efficiency down to 10 microns)

SECTION-VII- VENTILATION FANS

7.1 SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of ventilation fans conforming to these Specifications and in accordance with the requirement of Drawings and Bill of Quantities.

7.2 TYPE & CAPACITY

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

7.3 CENTRIFUGAL CABINET FAN

Centrifugal fan shall be DWDI / SWSI type complete with access door, squirrel-cage induction motor, V-belt drive, belt guard and vibration isolators, direction of discharge / rotation, and motor position shall be as per the Approved-for-Construction shop drawings. Fan contained within the cabinet shall be AMCA Air and Sound Certification.

- Casing - The casing for air handling unit shall be of double wall construction with 25±5 mm thick polyurethane foam or equivalent fire retardant insulation (CFC and HCFC free) sandwiched between the panels. The density of the insulation material shall be 40±2kg/m3 and the thermal conductivity does not exceeds 0.02 W/m2°C The inner wall shall be of 0.6mm plain galvanized sheet steel. The outer wall shall be of 0.6mm galvanized sheet steel. It shall be rigidly reinforced and supported by structural angles. Split casing shall be provided on larger sizes of fans, however neoprene / asbestos packing should be provided throughout split joints to make it air-tight. The minimum space between the fan inlet and panel shall be one fan dia.
- Filter Section - Each fresh air fan unit shall be provided with factory assembled filter section containing filter having anodized aluminium frame. Filter bank shall be easily accessible and designed for easy withdrawal and renewal of filter cells. Filter framework shall be fully sealed and constructed from aluminium alloy. The filter shall be EU-4 (MERV-9) or better. The filtration efficiency shall be as per ASHRAE 52.2 standards. Necessary access door shall be provided for accessing the filter sections.
- Housing shall be provided with standard cleanout door with handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.
- Fan Wheel shall be forward / backward-curved non-over loading type. Fan wheel and housing shall be statically and dynamically balanced. For fans upto 450 mm dia, fan outlet velocity shall not exceed 550 meter/minute (1800 fpm) and maximum fan speed shall not exceed 1450 rpm. For fans above 450 mm dia, the outlet velocity shall be within 670 meter/minute (2200 fpm) and maximum fan speed shall not exceed 1000 RPM. High static pressure fan speed shall be as per manufacturer
- Shaft shall be constructed of steel, turned, ground and polished.
- Bearings: shall be of the sleeve / ball-bearing type mounted directly on the fan housing. Bearings shall be designed especially for quiet operation and shall be of the self-aligning, oil / grease pack pillow block type.

- Motor: Fan motor shall be energy efficient and suitable for 415±10% volts, 50 cycles, 3 phase AC power supply, high efficiency (EFF-1) squirrel-cage, totally enclosed, fan-cooled motor, provided with class F insulation, and of approved make. Motor name plate horsepower shall exceed brake horsepower by a minimum of 10%. Motor shall be designed especially for quiet operation and motor speed shall not exceed 1440 rpm. The fan and motor combination selected for the particular required performance shall be of the most efficient (smallest horse power), so that sound level is lowest.
- Drive to fan shall be provided through belt with adjustable motor sheave and a standard belt guard. Belts shall be of the oil-resistant type.

7.4 INLINE FAN SPECIFICATIONS

- **INLINE FANS** shall be preferably be single inlet/ double inlet centrifugal fan with forward curved blades & external rotor motor. These fans shall be complete with casing, motor & impeller.

- **CASING** shall be constructed of GSS sheet metal construction. The casing shall be double skin internally acoustically lined and constructed of Galvanized Steel. The fan shall be SISW (dia 100 to 160) / DIDW (dia 200 to 500) with forward curved impeller fitted with maintenance free external rotor motor. Fans should have an outer casing of hot-rolled galvanized sheet steel complying with EN 10142/ 10147. The sheet steel must have a layer of 20µm of zinc for protection against corrosion. Indication showing rotation arrow and make, model number and duty conditions of the fan shall be mentioned on fan casing.

- **FAN Impellers** should be backward curve/ forward curved having aluminum blades. The impellers should be press fitted directly onto the rotor of the external rotor motor. The motor and impeller should be balanced dynamically in two planes in accordance with DIN ISO 1940.

- **MOTOR -** Fan motor should be external rotor type motor with built in thermal contacts for protecting against overheating. Compact in size and its construction should allow motor to be cooled by transported air. Motor and impeller assembly should be mounted on a plate to facilitate easy removal and servicing.
- Fan should be speed controllable in five steps.
- **Noise level** of fan should not be more than 40 dB(A) at 3 mtr distance.
- **Insulation** – Fan should be thermally and acoustically insulated with 50mm layer of rockwool with a surface liner which prevents the migration of fibers into the air stream.
- **Installation** – Fan must be able to install in any position and must be provided with mounting clamps to connect to duct.
- All fans shall be selected for the lowest operating noise power levels. Capacity ratings, power consumption, with operating points clearly indicated, shall be submitted and verified at the time of testing and commissioning of the installation. All the technical data of fans should be approved as per AMCA & ISO standards.

7.5 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 gauge 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 or steel. Fan hub shall be of heavy welded steel construction with blades bolted to the hub. Fan blades and hub assembly shall be statically and dynamically balanced at the manufacturer's works.
- Shaft shall be of steel, accurately ground and shall be of ample size for the load transmitted and shall not pass through first critical speed thru the full range of specified fan speeds.
- Motor shall be standard (easily replaceable) permanent split capacitor or shaded pole for small sizes, totally enclosed with pre-lubricated sleeve or ball bearings, designed for quiet operation with a maximum speed of 1000 rpm for fans 60 cm dia or larger and 1440 rpm for fans 45 cm dia and smaller. Motors for larger fans shall be suitable for 415±6% volts, 50 cycles 3 phase power supply, and for smaller fans shall be suitable for 220 ± 6% volts, 50 cycles single phase power supply. Motors shall be suitable for either horizontal or vertical service as indicated on Drawings and in Bill of Quantities.
- Accessories : The following accessories shall be provided with propeller fans :
  - Wire guard on inlet side and bird screen & rain protection cowl 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 preventors for 3 phase fans.

7.6 AXIAL FANS

Fans shall be of the type, size, arrangement and capacity as indicated in the schedule and/or as shown on the drawings.

- Unless specified, fan performance rating data shall be tested accordance with AMCA Standard 210-85 (Air Moving and Conditioning Association), ANSI/ASHRAE Standard 51-1985 "Laboratory Methods of Testing Fans for Rating". Sound ratings shall conform to AMCA Standard 300-85, "Reverberant Room Method for Sound Testing of Fans".
- A computer printout of fan performance rating corresponding to the AMCA licensed data, with corrected ratings for altitude and temperature, fan operating speed, bearing life, etc. shall be submitted for approval.
- All fans shall be dynamically trim-balanced to ISO1940 and AMCA 204/3 - G2.5 quality grade after assembly. A computer printout with the vibration spectrum analysis shall be attached to the fans.
- Fan motors shall comply in all respects with continuous rating in accordance with IEC34 or equivalent. Motor bearings shall be of ball or roller type, grease or

lubricant sealed for life. Fan and drive shall be earthed to prevent accumulation of static charge.

- Fans shall be installed at staircase or lobby where fresh air intake is free from any obstruction and shall be energized only by fire alarm system. Fan shall be of Axial Flow Fan. Protective grille at the suction of the fan is required.
- Fans for elevated temperature (Smoke Extraction Fans) with components rated for high temperature (250 deg C for 2Hrs) service, with belt drive assemblies exposed to the air stream are not acceptable.
- For Smoke Extraction Fans where motor is in the air stream with electrical/electronic temperature limit switch for motor protecting shall not be used.
- Fan should be of G.S.S. , the Steel sheet should be JFE Galva zinc (Base metal cold rolled), JIS G3302, SGCC with Z22 (minimum coating weight on both sides @ 220 g/m2) zinc coating & Zero Spangle, skin passed, chromate and dry.
- If fan is open to atmosphere, Fans shall be with pure polyester powder coating for minimum thickness of 60 microns.

Axial fans shall be complete with casing, motor, with impeller, Casing made of Galvanized steel Direction of discharge and rotation position shall be as per the job requirement and shall be marked on the fan assembly.

Casing: Casing shall be constructed of Galvanized steel 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.

Impeller: Hub and blades shall be constructed of die cast aluminium alloy. Impeller should have aerodynamic profile to guarantee high efficiency and low noise level.

Motor: Motor shall be suitable for 415V/ 50HZ/ 3Phase. Motor shall be specially designed for quiet operation. The speed of the fans shall not exceed 1440 RPM for fans with impeller diameter above 450 mm, and 2880 RPM for fans with impeller diameter 450 mm and less. For lowest sound level, fan shall be selected .for maximum efficiency or minimum horsepower.

Drive: Drive of fan shall be direct driven.

Temperature Range: 45degC for standard ventilation / 250 deg / 2H for smoke evacuation.

7.7 TECHNICAL SPECIFCATIONS OF JET FANS AND CFD.

7.7.1 JET FANS

Jet Fans shall be completely assembled at factory and then supplied to the site. Each jet fan shall be complete with motor, motor mount, silencers at inlet and outlet discharge, terminal box and mounting brackets to vibration isolation type suspension arrangement.

a. **CASING** of JET fans shall be constructed of heavy gauge sheet steel as per DIN EN ISO 1641. Fan casing and motor mount shall be of welded steel construction. Casing shall be hot dip galvanized to protect against corrosion.

b. **IMPELLER** of JET fans shall be constructed from die cast aluminum. Profiles of impeller blade should be of aerofoil type to have high efficiency and low noise levels. Aerofoil Fan impellers shall have a unique aerodynamic section blade to optimize the efficiency of performance and minimize the generation of noise. Impeller must be statically and dynamically balanced as per ISO 1940 grade 6.3

c. **Temperature Rating -**The complete fan assembly with its casing, impeller and motor (not only motor or one of the item) shall be sourced from one manufacturer and certified and tested as per EN12101-3- 300 degree (572 F) for 2 Hrs operation. The fan shall have a non-overloading characteristic. The peak power inputs occurs within range of normal operating pressures and is always exceeded by motor rating.

d. **FAN Motor** shall be energy efficient, squirrel cage, thermally enclosed, Class H insulation, continuous duty, Dahlander winding for dual speed applications suitable for 400V/3 Ph/ 50Hz, AC power supply. Motor shall comply with IEC34-a.

e. **Terminal Box**- Motor conduit box shall be mounted on exterior of fan casing, and lead wires from the motor to the conduit box shall be protected from the air stream by enclosing in a flexible metal conduit. It shall be sealed with fire rated sealant.

f. **Inlet Cone**- Jet fans shall have Inlet cone made of Galvanized steel

g. **Protection Guard** should be provide at inlet side of Jet fan.

h. **Silencers**- Noise level from Jet fan shall not exceed 52 dB(A) at 1 mtr distance. Silencers Casing should be rolled, pre-galvanized sheet steel with spun end rings incorporating tapped inserts for fixing. Absorbent material used should be of acoustic grade mineral fibre with a layer of erosion resistant facing and must be further protected by a sheet of pre-galvanized perforated steel.

i. Minimum length of silencers should be 900mm.

j. **Mounting Brackets**-Jet fans shall be supplied with mounting brackets for ceiling suspension.

k. **Data Sheet** –

SL NO	DESCRIPTION	UNIT	Asper Design	Offered by Tenderer
1	Overall dia	mm		
2	Impeller Dia.	mm	350mm	
3	Capacity of fan	Cfm	Low/High speed - 1405/2815 CFM @ Low/High speed - 2900/5900	
4	Tip Velocity	m/s		
5	Phase	Ph	3 Phase	
6	Voltage	V	415 ± 10%	
7	Frequency	Hz		
8	Revolution	RPM		
9	Ampere	A		
10	Sound Level	dB(A)	52 dB(A) at 1 mtr	
11	Weight	Kg	60	
12	Power Consumption	KW	0.3/1.3 kw @ 4/2 Pole	
13	Depth of unit	Mm	Silencer min. length shall be 2 times of dia.	
14	Thrust	Nm		
15	Motor weather proof rating		IP20	
16	class of insulation		Class H	
17	Fire rating		300 Deg. C for 2 Hours	
18	Noise		57/71 @ Low/High speed @ 3m	
19	Motor & Fan Efficiency			

7.7.2 CFD Analysis-

CFD (Computational Fluid Dynamics) is in a simplified version, a dynamic simulation of the behavior/ development of smoke, air speed, visibility and others, inside the car park, given certain conditions (airflows, temperatures etc.,).

Computational fluid dynamics (CFD) can simultaneously predict airflow, heat transfer and contaminant transport in and around buildings. A CFD model is built upon fundamental physical equations of fluid flow and energy transfer. The technique is capable of providing time dependent and as well as steady state solutions to the coupled differential equa

7.8 NOISE AND VIBRATION

Noise level produced by any rotating equipment individually or collectively shall not exceed 65 dB (A) measured at a distance of 1.5 meters from the source in any direction. The overall vibration level shall be as per zones A and B of ISO 10816-1. Balance quality requirement shall be G 6.3 conforming to ISO 1940/1.

7.9 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.

7.10 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.

SECTION –VIII - POWER & CONTROL CABLES AND CABLE INSTALLATION

8.1 SCOPE

This specification covers the design, manufacture, testing, inspection at Manufacturer's works and supply of power and control cables as detailed in Data Sheet conforming to specific requirements mentioned in this specification. The estimated quantities are given in the price schedule. However the Contractor shall recheck the quantities and supply according to the requirements.

8.2 CODES AND STANDARDS

The design manufacture and performance of cables shall comply with the requirements of the latest editions of the codes and standards.

8.3 SPECIFIC REQUIREMENTS - POWER CABLES

3.1 **11KV Power Cables**

11 kV Unearthed/ earthed grade, single / multicore, stranded aluminium conductor, armoured / unarmoured, XLPE insulated with PVC inner sheath and overall PVC sheathed. The system is non-effectively earthed. These cables shall confirm to IS-7098-Part-I (1988)/IEC-502 (1983) in all respects.

The cable shall be provided with both conductor and insulation screening with semi-conducting compound. For multicore cables, fillers used to fill in the space between the phases shall be non-hygroscopic, chemically inert and non-putrescent. The cables shall conform to IS 7098 Part - II (1985)/ IEC 502 (1983) in all other respects. Cables laid outside the building, either buried or in trench shall be of armoured type.

3.2 **433V Power Cables**

The cables shall be 1100V grade, single / multicore, stranded aluminium conductor, unarmoured, PVC insulated, with PVC inner sheath and outer sheath of PVC. The cables for emergency services shall be with additional FRLS properties. The cables shall conform to IS-1554 - Part - I (1988). For multicore cables, fillers used to fill in the space between the phases shall be non-hygroscopic, chemically inert and non-putrescent.

3.3 Cables laid outside the building, either buried or in trench shall be of armoured type.

8.4 SPECIFIC REQUIREMENTS - CONTROL CABLES

1100V grade multicore, 1.5 sq.mm stranded copper conductor, PVC insulated and extruded PVC inner sheathed and extruded PVC outer sheathed of PVC. FRLS cables, which have outer sheath of specially formulated FRLS PVC cable, shall be used for cables connected to Emergency services. The cables shall conform to IS 1554 Part- I (1985) / IEC 502 (1983) in all other respects.

Cables laid outside the building, either buried or in trench shall be of armoured type.

8.5 DESIGN CRITERIA FOR CABLE SIZING

5.1 Power cables shall be selected on the following basis:

a) Power cable shall carry the full load current of the circuit continuously under site conditions considering the various derating factors like ambient air temperature (40 deg C), grouping, laying methods etc.

b) Power cables shall be sized to restrict the voltage drop to 5% and a voltage dip of 10% for motors.

c) Power cable shall withstand the fault current of the circuit for the duration not less than the maximum time taken by the primary protective system to isolate the fault.

8.6 DATA TO BE FURNISHED BY THE VENDOR AFTER THE AWARD OF CONTRACT

8.6.1 TECHNICAL DATA

Following additional data shall be furnished by the Contractor for all cables, after placement of letter of intent of order.

Continuous current rating of the cable:

a) In ground at soil temperature at 30deg.C and soil thermal resistivity of 150 deg.C cm/watt and depth of burial about a meter : A

b) In air at 40 deg.C : A

c) Overload capacity and duration : A, Hr

d) Derating factors for :

Soil temperature and thermal resistivity
Ambient temperature

Single core cables laid

8.6.2 **General Technical Data (Power cables)**

8.6.2.1	Equivalent star impedance per km Of 3 ph, circuit at power frequency at maximum conductor temperature	:	Ohm
8.6.2.2	Maximum electrostatic capacitance per Core per km of cable	:	F
8.6.2.3	Maximum charging current per conductor per km at nominal voltage	:	A
8.6.2.4	Loss tangent at normal frequency and rated voltage		
8.6.2.5	Maximum dielectric loss of cable per km at normal voltage and frequency	:	Watts/km
8.6.2.6	Short circuit capacity for 1 sec.	:	kA (cms)
8.6.2.7	Maximum dielectric strength at core screen	:	kV /cm
8.6.2.8	Maximum overall dia. of cable	:	mm

8.6.3 **INSTRUCTION MANUALS**

8.6.3.1 Four copies of instruction manuals, descriptive bulletins etc. as indicated in the distribution schedule shall be furnished prior to despatch of cables. The manual shall include amongst others, the following particulars.

8.6.3.2 General information.

8.6.3.3 Principal technical data.

8.6.3.4 Description of insulation, sheathing and screening. This should include data on resistance to attach by chemicals, fungus, termites, rodents, water and ultra-violet radiation.

8.6.3.5 Installation and termination instructions.

8.6.4 **TEST CERTIFICATES**

8.6.4.1 Type/Routine test certificates for all types of cables included in the order and special tests on FRLS/FS cables.

8.6.4.2 Specified number of copies of the approved test certificates shall be furnished to the Employer before despatch of cables.

8.6.4.3 Any other information specifically called for by Employer subsequent to order.

8.6.5 Following additional data shall be furnished by the Contractor for all cables

Sl.No	ITEM	UNIT	BIDDER TO INDICATE
1	Name of the Manufacturer		
2	Conductor		
3	Nominal diameter	mm	
4	Effective cross sectional area	Sqmm	
5	Type of end sealing		
6	Conductor		
7	Conductor screen		
8	Insulation		
9	Insulation screen		
10	Fillers and binders		
11	Metal sheath		
12	Inner sheath		
13	Armour		
14	Outer sheath		
15	Any other features		
16	FRLS Cables		
17	Critical oxygen index value at 250° C when tested for temperature index.		
18	Total acid gas generation by weight.		
19	Percentage of light transmission under fire for assessment of smoke generation when tested.		
20	Will the cables offered against this specification pass the flammability tests as per -		
	a) Class-F3 - Swedish	Yes/No	

	Standard S5-424-14-75		
	b) IEC 332 - 1	Yes/No	
	c) IEC 331 - 1	Yes/No	
21	Any other details the VENDOR would like to furnish?		

8.7 CABLE INSTALLATION NOTES

1.1 These notes in general apply to installation of cables upto and including 11KV grade.

1.2 Electrical installation work shall comply with all currently applicable statutes, regulation and safety codes in the locality / country where the installation is to be carried out.

1.3 Installation of cables shall be carried out generally as per IS: 1255 or relevant applicable standards of any other country specified in the specification and as per the instructions contained in specification, enclosed standard drawings and relevant project drawings.

1.4 Installation of cables include storing, laying, fixing, jointing, termination, and all other work necessary for completing the job. Supply of glands and lugs, together with other necessary materials for joining and termination shall also be included in the Contractor's scope.

1.5 Construction of cable trenches, provision of embedment and similar work involving civil items shall be coordinated with Civil Contractor by Electrical Contractor. However when such work is required to be done by the Electrical Contractor, it shall be carried out as per the instruction / notes on the relevant project drawings and installation specification of the project.

1.6 Cables shall be installed in trenches, trays, racks, tunnels, conduits, and ducts or directly buried. The actual cable layouts shall be shown on the relevant project drawings. Changes if necessary, after obtaining prior approval of the Employer shall be carried out at site by the Contractor and shall be clearly indicated in "As Built Drawings" by him and forwarded to the Employer

1.7 Cables to each circuit to be laid in one continuous length. Cable joining if necessary shall be done only after obtaining prior permission from Employer

8.8 OUTDOOR CABLE INSTALLATION

2.1 Directly buried cables shall be laid as per drawings and cable markers shall be provided. At least one cable marker shall be provided if the length of the buried

cable is less than 15 meters. Buried single core cable laid in trefoil formation shall be tied by plastic tapes or 3mm dia. Nylon cord every 750mm.

2.2 Joints in directly buried cable shall be identified by joint markers at each joint location. For details of joint markers refer drawings.

2.3 In each outdoor cable run greater than 60 meters, some extra length of cable shall be kept at a suitable point to enable a straight through joint to be made, should the cable develop fault at a later date.

2.4 Where cable cross roads and water / oil / gas / sewage pipes, the cable shall be laid in hume or pipes. For road crossing the pipe for the cable shall be buried at not less than 600mm depth unless otherwise noted in the drawings. Hume pipe shall be preferred to steel pipe from the point of view of corrosion.

2.5 Control cables and small power cables in trenches, tunnels and racks shall be run in ladder type cable trays (Maximum tray width 600mm) supported on trench/ tunnel/ rack carrier arms. The cables shall be tied to tray rungs by means of 3mm dia. Nylon cord at an interval not exceeding 3000mm and also at bends.

2.6 For good sealing arrangements at entry points, suitable pipe sleeves, adequate in number and adequate in sizes shall be provided in building walls / slabs for passage of cables into building from cable trays/ racks/ cable trenches located outside the buildings. Details of sleeves and exact location of such entry points will be available on relevant project drawings.

8.9 <u>CABLES IN TRAYS / ON RACKS</u>

3.1 Different voltage grade cables shall be laid in separate trays when trays are arranged in tiers. HV cables shall be laid in top trays and cables of subsequent voltage grade in lower tier of trays.

3.2 The power cables of 1.1KV and above shall be laid in trays / on racks as follows

(a) In single Layer only without exception.

(b) 3 core cables shall be laid in touching formation

(c) Single core cables shall be laid in trefoil groups with a spacing equal to the diameter of the cable between the edges of the trefoils

(d) Cables in trefoils groups of the same circuit shall be laid as indicated below so as to ensure balanced current distribution

Y Y Y Y

R B B R R B B R

(1) (2) (3) (4) and so on.

3.3 1100V grade power cables of 120 sqmm size and above shall normally be laid in single layer in trays or on racks. In exceptional cases, these may be laid in double layer, if shown on the drawings or with the permission of the Employer.

3.4 Control and instrumentation cables can be laid upto maximum of three layers in each tray / Rack.

3.5 Single core power cable of 3 phase AC circuits laid in trays/ racks/ trenches in trefoil group shall be held in trefoil clamps placed at an interval not exceeding 3 meters. The trefoil group of cable additionally be tied by means of 3mm dia. Nylon cord as follows.

a) At an interval not exceeding 1 meter when laid in cable tray / Racks.
b) At an interval not exceeding 750mm when laid in trenches without cable trays.

3.6 Cables in vertical raceways shall be clamped by saddle type cleats / cable binders to the horizontal slotted angles. Cleats shall be fabricated from 3mm aluminium strip at site by Electrical Contractor to suit the cable groups. Single core cables shall be clamped with trefoil clamps.

8.10 BENDING RADIUS FOR CABLES.

4.1 The bending radius for various types of cables shall not be less than those specified below, unless specifically approved by the manufacturer.

Type and voltage grade of the cable.	**Minimum Bending Radius**	
	Single core	Multi core
a) Paper insulated upto 1.1KV	20 D	15 D
b) Paper insulated above 1.1KV and upto 11KV	20 D	15 D
c) Paper insulated above 11KV	25 D	20 D
d) PVC & XLPE insulated upto 1.1KV	15 D	12 D
e) PVC & XLPE insulated above 1.1KV and upto 11KV	15 D	15 D

f) PVC & XLPE insulated above 1.1KV	20 D	15 D

Where “D” is the overall diameter of the cable.

(For other types of cables, recommendation of manufacturers shall be followed.)

4.2 The values may be reduced to the extent of 70% when making only one bend such as in case of installing the termination.

8.11 TERMINATIONS, CLAMPING & MISCELLANEOUS DETAILS

5.1 Cable entry to the motors, Push button stations and other electrical devices shall be from the bottom as far as possible or from the sides. Top entry shall be avoided particularly for outdoor equipment.

5.2 Identification tags made from aluminium sheet shall be attached to each end of the each cable by means of GI binding wire. Tags shall be additionally put at an interval of 30 meters on long runs of cable and in pull boxes.

5.3 All cable terminations shall be solderless crimping type. Whenever lugs are to be supplied, adequate size crimping lugs for approved make shall be used by the contractor. The crimping tools shall be adequate for the size of the lug

5.4 Saddle type clamps to suit number of cables to be clamped at a particular location shall be used for clamping cables running along the walls, ceilings, structures etc. The interval between adjacent clamps shall be shown on the relevant enclosed drawings

5.5 Wooden cleats when required for supporting vertical runs of one or more single core cables per phase, such as near transformer cable boxes, shall be made of well seasoned wood and shall be painted with two coats of fire retardant paint of approved quality

8.12 TESTING AND COMMISSIONING OF CABLES

6.1 Cables shall be checked for insulation resistance before Laying and after laying and termination/ jointing of the cable. The voltage rating of the megger for cables of different voltage grade as indicated below.

Voltage Grade of cable	**Megger Rating**
1.1 KV	500V

3.3 KV, 6.6 KV and 11 KV	1000V
33 KV	2.5KV motorized megger

6.2 **High voltage Testing**

6.2.1 All cables of 11KV grade 400 & 95 sqmm HV cables shall be subjected to DC or AC high voltage test after jointing and terminating but before commissioning as per relevant standards. Testing with DC voltages should be preferred as test equipment required is compact, easily portable and requires low power. The DC test voltages applicable in India in accordance with IS:1255. The cable cores must be discharged on completion of DC high voltage test and cable shall be kept earthed until it is put into services.

6.2.2 DC test voltages for the old cables shall be 1.5 times rated voltage or less depending upon the age of the cable, repair work or nature of jointing work carried out.

6.2.3 In each test, Metallic sheath/ screen/ armour shall be connected to earth.

6.3 Continuity of all the cores, correctness of all connections as per wiring diagrams, correctness of polarity and phasing of power cables and proper earth connection of cable glands, cable boxes, armour and metallic sheath shall be checked.

8.13 EARTHING

- Metallic sheaths, screens and armour of all multi core cables shall be earthed at both equipment and switchgear end.
- Sheath and armour of single core power cables shall be earthed at switchgear end only. If specially indicated in the project specification / drawings, for long lengths of cables, multiple earthing may have to be adopted to safeguard against the presence of standing voltages under normal as well as under faulty conditions.
- Earthing of power cable with core balance CT shall be in accordance with latest IS standards.
- Earthing of CT and PT neutral lead shall be done at one end only.

8.14 PAINTING

Whenever M.S. items are supplied by the contractor as indicated in the installation specification, these shall be painted as follows.

a) For indoor installation: One shop coat of red oxide zinc chromate

Primer (site coat for exposed surfaces of

embedded steel) and two site coats of aluminium alkyd paint or paint as specified.

b) For outdoor and corrosive atmosphere indoor : Painting with two pack epoxy coating.

Where any cuts or holes are made on the finished steel work or welding is done, the effected portion of steel work shall be painted as stated above. Galvanised structures if damaged, during welding, cutting etc., shall be touched up with two coats of zinc-rich paints.

SECTION –IX - PIPES AND FITTINGS

9.1 SCOPE

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

9.2 PIPE SIZES

Pipe sizes shall be as required for the individual fluid flows. Various pipe sizes have been indicated on the Drawings, these are for Tenderer's guidance only and shall not relieve tenderer of responsibility for providing smooth noiseless balanced circulation of fluids.

9.3 PIPING

- The pipes and fittings shall be Mild Steel (MS) Class `C' (Heavy Class) conforming to IS:1239 Code for pipes upto 150mm dia. Factory rolled pipes 150mm dia & above shall confirming to IS:3589. The pipes of 200mm and 250mm diameter shall have min 6.3 mm wall thickness, 300mm dia pipe shall be min 7.1mm wall thickness, 350mm & above pipes diameter shall have min 8.0mm wall thickness. All jointing in the pipe system shall generally be by welding, unless otherwise mentioned, or directed at site. All welding shall be done by qualified welders and shall strictly conform to IS Code of practice for manual metal arc, welding of Mild Steel.
- All welded joints (except pipe welded end-to-end) shall be made by use of forged one-piece welding flanges, caps, nozzles, elbows, branch outlets and tees of approved make. For pipes upto 200mm diameter, readymade pipe fittings shall be used. Fabricated fitting shall not be used for pipes upto 200mm. Cut samples shall be submitted for approval, if directed. All such fittings etc. shall be of a type which maintain full wall-thickness at all points, simple radius and fillets, and proper bevels or shoulders at ends. All job welding shall be done by the electric arc welding process in accordance with the following :
- All joints shall have 45 degree bevel type, pipe mill-bevelled or machine-bevelled
- All scale & oxide shall be removed with hammer, chisel/file & bevel left smooth and clean.
- Pipe lengths shall line up straight with abutting pipe ends concentric.
- Both conductors from the welding machine shall be extended to locations at which welding work is being done. The leads from welding machine to location of welding work shall be held together with tape or other approved means so as to prevent induced current in structural steel, in piping or in other metals within the building. The ground lead shall be connected to length of pipe through joints in pipe, structural steel of building or steel pipe supports.
- All pipes and their steel supports shall be thoroughly cleaned and given one primary coat of red oxide paint before being installed. For vibration isolators pre-moulded polyurethane pipe sections of 160 Kg/m3 density with adhesive shall be fixed between

pipe and MS support. 10 mm thick MS 'U' clamp shall be fixed on the pipe so that the pipe is kept in position. All welded piping shall be subject to the approval at site.

- Fittings shall be malleable casting of pressure rating suitable for the piping system. Fittings used on welded piping shall be of the weldable type. These shall form part of piping and are not separately identified in Bill of Quantities.
- Tee-off connections shall be through equal or reducing tees, otherwise ferrules welded to main pipe shall be used. Drilling and tapping of the walls of the main pipe shall not be resorted to.

9.4 PRE INSULATED PIPES

The pipes and fittings shall be Mild Steel (MS) Class `C' (Heavy Class) conforming to relevant IS:1239 Code. Factory rolled pipes 150mm aid & above shall confirming to IS:3589. The pipes of 200mm and 250mm diameter shall have min 6.3 mm wall thickness, 300mm dia pipe shall be min 7.1mm wall thickness, 350mm & above pipes diameter shall have min 8.0mm wall thickness. The pre-insulated pipe shall be covered with 24 Gauge aluminium spiral casing. The insulation shall be Rigid Polyurethane foam having density of 38 Kg/m3 & Thermal Conductivity less than 0.023W/mK@25 ºC

Pipe Dia	Insulation thickness (mm)
Upto 32mm dia	30mm
40mm to 100mm dia	40mm
125mm to 300mm dia	50mm
350mm dia & above	75mm

Codes and Standards

IS 1239	:	MS ERW Class C [upto 150 mm dia]
IS 3589	:	MS ERW [above 150 mm]
ASTM A53 Gr.B	:	Carbon steel pipes
BS 5422	:	PUF insulation by injection method
ASTM C 1029	:	PUF insulation by spray method
ASTM C 518	:	Insulation thermal conductivity, 'K' factor
ASTM D 1621	:	Compressive Strength of insulating foam
ASTM D 1622	:	Density of insulating foam

9.5 JOINT INSULATION

Joint insulation shall be carried out by the same supplier who supplies the pre insulated pipe to maintain the uniformity and stand guarantee for the performance of the pre insulated pipes.

9.6 II) UV Protection.

Exposed insulated pipes are prone to heavy weathering, They must be withstand summer , monsoon and winter, Providing UV Protection enhances its life manifold, UV coating must be done bu a compound which is a specially

formulated water based coating suitable for protection of flexible thermal insulation materials against sunlight. To increase its resistance coating can be further strengthened by sand witching a glass fiber mesh between two coats of rubber adhesive over insulated pipes.

9.7 BUTTERFLY VALVES

Butterfly valves shall be of slim seal, short wafer type with standard finish. The valves shall be suitable for mounting between flanges drilled to ANSI 125. The valve body shall be cast iron and the disc shall be of cast iron or ductile iron. The disc shall consist of disc pivot and driving stem. The disc shall move in bearings on both ends with 'O' Ring to prevent leakage. The seat shall be moulded black nitrile rubber or EPDM. The valves shall be suitable for a working pressure of 16.5 kg/scm and shall be complete with flow control lever and notches, factory machined companion flanges, bolts & nuts. Valves above 200 mm dia shall be gear driven.

9.8 FLOW CONTROL VALVES - Pressure Independent Dynamic Control Valve

9.8.1 Valve Body and Characteristics:-

- Pressure Controller Device shall maintain the Pressure irrespective of Fluctuation with the help of Diaphragm self adjusting type and should not be in contact with each other.
- Valve shall be Globe Type in Construction and not with cylinder type cartridge. Globe construction valves are accepted as the most accurate characteristics valves.
- Control valve shall accurately control the flow, with help of Modulating Actuator
- All Valve Sizes shall have a Testing Port Device for verifying accuracy of flow performance with respective of Differential Pressure.
- Flow regulation unit shall consist of stainless steel Material 316.

9.8.2 Valve Actuator and Housing:-

- The Valve + Actuator must have ability to undertake both Logarithmic Control Characteristics and Linear Control Characteristics. This ensures compatibility for both Water/Air and Water/Water Heat Exchange.
- Valve Actuator housing shall made of non Corrosive (Aluminum) Material. Valve actuator housing shall be IP Protection (Weather Proof: Dust & Water Protected). Valve actuator housing shall be acceptable to IP 42 Till 40mm and above shall be IP54.
- Control/Dip Switch Setting shall be easy to Manual Access to avoid Manual Contact to directly with Integrated IC Circuit of the system.
- Actuator shall not play a part in balancing process. This will ensure that even an operational issue in the actuator will not lead to loss of Balancing.
- Only Liner characteristics shall not be acceptable as with this valve + actuator characteristic, the resultant energy characteristic will not remain linear and this shall lead to improper control leading to overflow/underflow phenomenon.

9.8.3 Valve Flow Balancing:

- Balancing & Control: Balancing shall be accomplished by the Diaphragm and Control shall be taken care by Actuator receiving signals from Room Thermostats or BMS.
- Manual Override Flow Balancing shall only be done in Valve, not in actuator and shall not involve opening of actuator Body.
    - Flow Setting Balancing (Commissioning) for the Valves shall be simple and fool proof.
    - Shall not involve opening of the actuator.
    - Shall avoid direct Manual Contact with Integrated Circuit (IC) of the actuators.

Flow control valves (FCV) shall automatically control flow rates with + 5% accuracy. Maximum flow setting shall be adjustable to 51 different setting within the range of the valve size. It shall be BMS compatible. The suitable size step down transformer shall be included in the scope of work as required.

9.9 BALL VALVES

The ball valve shall be made forged brass and suitable for test pressure of pipe line. The valve shall be internally threaded to receive pipe connections upto 40NB dia. The ball shall be made from brass and machined to perfect round shape and subsequently chrome plated. The ball and the shaft shall be of brass / stainless steel. The seat of the valve body-bonnet gasket and gland packing shall be of Teflon. The handle shall be provided with PVC jacket. The handle shall also indicate the direction of 'open' and 'closed' situations. The gap between the ball and the teflon packing shall be sealed to prevent water seeping. The handle shall also be provided with a lug to keep the movement of the ball valve within 90°. The lever shall be operated smoothly and without application of any unnecessary force.

9.10 BALANCING VALVES

Double regulating balancing valves shall be provided at chiller, condenser, various tap-offs line as indicated in Bill of Quantities. These valves shall have built-in pressure-drop measuring facility to compute flow rate across the valve. The test cocks shall be long enough to protrude out of pipe insulation. To enable accurate and practical operation, measurement of flow and differential pressure shall be made with a computerised balancing instrument which shall enable the operator to read the flow directly without the use of diagrams or tables. In addition to measuring flow rate, differential pressure and temperature, computerised balancing instrument shall have a computer programme to provide the following functions:

- To balance the HVAC installation and calculate the necessary valve settings, based on system measurements.
- To store the results of balancing.
- To log measured values from a valve (differential pressure, flow rate or temperature).
- To print out saved data in computerized measurement protocol (CMP) consisting of :

- Name and size of Balancing Valve (BV)
- Presetting position of BV
- ΔP at BV

- Flow at BV
- Design Flow

9.11 CHECK VALVES (NRV)

Check Valve shall be of High Grade Cast Iron epoxy coated, suitable for PN 16 bar service as specified. The valve shall be of dual plate wafer design suitable to mount between the flanges. The disc shall be of stainless steel grade SS 304. The spring shall be of Stainless Steel. The Seal shall be of EPDM elastomer.

9.12 STRAINERS

Strainers shall be of cast iron body. Strainers shall incorporate a removable SS-316 screen with 3mm perforations and a permanent magnet. Strainers shall be provided with matching flanges at both ends for connecting with brine / chilled water pipes. They shall be designed to enable blowing out the accumulated dirt and facilitate removal / replacement of screen without disconnecting the main pipe. The types of the strainers are as specified in the BOQ.

9.13 FLANGES & UNIONS

Sufficient number of flanges and unions shall be provided as required to facilitate the maintenance work after the piping is installed. Mild steel ANSI 125 flanges shall be used for pipes of 65mm dia and above. Flanges shall be of approved make. The supply of flanges shall form part of piping (not separately identified in Bill of Quantities) and shall also include supply of bolts, washers, nuts and suitable asbestos fibre / rubber insertion gaskets (min 3 mm thick).

9.14 PRESSURE GAGES AND THERMOMETERS

- Both pressure gauge and Thermometer shall be made of stainless steel body and stem. The gauges shall be weather proof and water proof. The valve shall have the accuracy of +/- 1% of the reading
- Pressure gauges shall be not less than 150 mm dia. They shall be selected for appropriate range and shall be complete with siphon and cock, etc. Pressure gages as specified shall be provided at brine / chilled water supply and return at each air handling units shown on the Drawings and included in Bill of Quantities. Care shall be taken to protect pressure gages during testing. Pressure gage sockets on insulated pipes and accessories shall be extended upto insulation to avoid damage of insulation for replacement of gages.
- Thermometers as specified shall be provided at brine / chilled water supply and return at each air handling unit, at each chiller and condenser, and as shown on Drawings and included in Bill of Quantities. Thermometers on CHW lines shall be with long stem. Thermometer socket shall be extended upto insulation thickness so that the thermometer shall be removable without damaging the insulation.

9.15 AIR SEPARATORS

Made out of MS operating based on principle of centrifuge to remove dissolved air and micro bubbles from sealed chilled water system including all accessories.

9.16 SUCTION DIRT SEPERATOR

Suction Dirt separator shall be constructed of Mild steel. The flanges shall be as per IS -6392-1971 standard.

The filtration media shall be stainless steel Pall rings, to slow down the flow of water and thus separate suspended impurities. The Pall rings shall be encased in stainless steel wire mesh.

A drain plug shall be provided at top of suction dirt separator to drain out impurities lighter than water. A drain plug shall also be provided at bottom of suction dirt separator to drain out impurities which are lighter than water. The bottom drain plug shall be of brass construction with SS encased high power magnet to catch magnetic debris.

Flow straightened shall be also provided at the outlet of suction dirt Separator to ensure smooth flow of water into suction of the pump.

The suction dirt separator shall be of PN 25 rating and hydraulically tested at 1.5 times of pressure rating for one hour.

9.17 CLOSED EXPANSION TANK

- The closed expansion tank will be of Mild Steel construction with interchangeable EPDM-BUTYL rubber membrane. The expansion tank shall be complete with safety relief valve, pressure reducing valve and pressure gauge. The quoted price shall be inclusive of structural support for the tank.
- The tank will be of pressure rating to suit the system pressure and will be sized to adequately compensate for water expansion due to operating temperature variations. The tank shall be fabricated as per IS 2825 for “non-fired pressure vessels” and the flanges shall be as per IS 6392.
- For chilled water application, it will be insulated as per BOQ
- The expansion tank shall be supplied along with pressurization unit. The pressurization unit shall consist of two nos. (1 working + 1 stand-by) high pressure pumps of suitable pressure rating mounted on M.S. frame, complete with interconnecting piping, isolation valves, NRV, Y-strainer, pressure gauge, pressure transmitter, auto-logic panel (IP 55) with dry-run protection, electrical MCB and interconnecting wiring. The unit shall be housed in powder-painted canopy suitable for external installation, if required.

9.18 AUTOMATIC AIR VENTS

The float shall be of synthetic material and shall keep the venting valve closed under normal condition. When air is collected inside the float chamber, the water level inside the auto air vent shall decrease and the venting valve shall be opened. The collected air then shall escape through the venting valve and the water level inside the float chamber shall increase again, closing the venting valve. This process shall continue as long as air is collected in the float chamber. There shall be a check valve at the bottom to seal the system when the auto air vent is removed for servicing.

9.19 PIPING INSTALLATION

- Design Drawings indicate schematically the size and location of pipes. The Tenderer, 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, and hangers as specified and as required. The Tenderer shall adequately design all the brackets, saddles, anchors, clamps and hangers and be responsible for their structural sufficiency.
- All pipes in HVAC plant room shall be supported with pipes and channels from floor only with necessary PUF pipe supports and isolation of vibration.
- 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. Spacing of pipe supports shall not exceed the following :

Pipe size	Spacing between supports	Rod Size
15 to 25 mm	2.0 meter	8 mm
30 to 80 mm	2.0 meter	10 mm
100 mm & above	3.0 meter	MS Channel

- Vertical pipes passing through floors shall be plumb and parallel to wall. Pipes shall be supported on alternate floor. MS cleats shall be wleded on pipes and rest on MS channel placed on the floor with 15 mm thick vibration isolation pads between the cleat and channel. U clamps with vibration isolation sheet shall be provided to keep the pipe in position.
- Bull heading in water/refrigerant piping shall be avoided.
- Pipe sleeves atleast 3mm thick, 50mm / 100mm larger in diameter than chilled water pipes respectively shall be provided wherever pipes pass through retaining wall / slab. Annular space shall be filled with fibreglass and finished with retainer rings welded on the ends of sleeve.
- Wherever pipes pass through the brick or masonry / slab openings, the gaps shall be sealed with fire barrier caulks.

- Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation. 20G metal sheet shall be provided between the insulation and the clamp, saddle or roller, extending atleast 15cm on both sides of the clamp, saddles / roller.
- All piping work shall be carried out in a workman 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. Tenderer shall carefully examine the cut-outs provided and clearly point out where the cut-outs shown in the Drawings do not meet with the requirements.
- The Tenderer 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 bevelled and burrs removed before laying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter. Where reducers are to be made in horizontal runs, eccentric reducers shall be used for the piping to drain freely. In other locations, concentric reducers may be used.
- 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.
- Auto purge valves shall be provided at all highest points in the piping system for venting air. Air valves shall be 15 mm pipe size with screwed joints
- Discharge from the air valves shall be piped through an equal sized mild steel or galvanized steel pipe to the nearest drain or sump. These pipes shall be pitched towards drain points.
- All piping and fittings shall be pressure tested, painted and then insulated as described under the section “Insulation”.
- All pipes supports shall have vibration isolation arrangement.
- Necessary sockets and nipples with suitable brass thermo well for mounting sensors / transmitters on pipe line to interface the BMS system.

9.20 TESTING

- During construction, the tenderer shall properly cap all lines, so as to prevent the entrance of sand, dirt, etc. Each system of piping shall be flushed thoroughly after completion (for the purpose of removing dirt, grit, sand etc. from the piping and fittings) for as long a time as is required to thoroughly clean the system.
- All piping shall be tested to hydrostatic test pressure of atleast two and half times the maximum operating pressure, but not less than 10 kg/sq.cm gage for a period of not less than 48 hours. All leaks and defects in joints revealed during the testing shall be rectified, retested and gotten approved.
- Piping repaired subsequent to the above pressure test shall be re-tested in the same manner.
- Piping may be tested in sections and such sections shall be securely capped, then re-tested for the entire system.

- The Tenderer shall give sufficient notice to all other agencies at site, of his intention to test a section or sections of piping and all testing shall be witnessed and recorded by Client / Consultant's site representative.
- The tenderers shall provide temporary pipe connections to initially by-pass condenser / chiller and circulate water through condenser/chilled water pipe lines for min 8 hours. Water should be drained out from the lowest point. The temporary lines shall be removed and blanked with dead flanges. Pot strainers and Y strainers shall be cleaned and fresh water filled in the circuits.
- The Tenderer shall make sure that proper noiseless circulation of fluid is achieved through all coils and other heat exchange equipment in the system concerned. If proper circulation is not achieved due to air bound connection, the Tenderer shall rectify the defective connections. He shall bear all expenses for carrying out the above rectifications including the tearing up and re-finishing of floors and walls if required.
- After the piping has been installed, tested and run for atleast three days of eight hours each, all insulated exposed piping in plant room shall be given two finish coats, 3 mils each of approved colour, conforming to relevant BIS Codes. The direction of flow of fluid in the pipes shall be visibly marked with identifying arrows. For painting of insulated and clad pipes refer to Insulation section.
- After testing, all systems shall be chemically cleaned. After cleaning, the pipe work should be rinsed multiples times until the system is neutral.
- Before handover Client / Architect / Consultant's representative shall be provided with certificate of cleaning of pipe systems, signed by the Tenderer.
- The Tenderer shall provide all materials, tools, equipment, instruments, services and labour required to perform the test and to remove water resulting from cleaning and after testing.

9.21 BALANCING

- After completion of the installation, all water system shall be adjusted and balanced to deliver the water quantities as specified, quoted, or as directed.
- All balancing valves, Automatic control valves and two-way diverting valves shall be set for full flow condition during balancing procedure. Each water circuit shall be adjusted thru balancing valves provided for this purpose; these shall be permanently marked after balancing is completed, so that they can be restored to their correct positions, if disturbed.
- Complete certified balancing report shall be submitted for evaluation and approval by Client / Consultant's site representative. Upon approval, four copies of the balancing report shall be submitted with the as-installed drawings and completion documents.

9.22 VALVE IDENTIFICATION

Provide 30 mm dia brass valve tag, with embossed letters and number for each valve and attach the tag to valve handle by "S" hook or by suitable means. Tenderer shall provide valve tag schedule and valve chart for each piping system, consisting of schematic drawing of piping layout, along with a valve list, showing and identifying each valve by number, service and location and describing its function.

The tenderer shall frame under glass in the air-conditioning plant room or as directed by Client / Architect / Consultant's representative two copies of valve chart. Two additional uncounted copies shall be supplied to the Client / Consultant's site representative. Tags shall correspond with the valve schedule and record drawings. In back of house areas, where ceilings are installed and the valve or valve tag is not visible, a self adhering tag with the valve number shall be installed on the wall or directly under the ceiling. For public area ceiling valves, these tags are to be installed in the service corridor, leading to the public areas.

9.23 BTUH METERS WITH MATCH PAIR SENSORS

10.24.1 EQUIPMENT SPECIFICATIONS FOR BTUH METERS WITH MATCH PAIR SENSORS

BTU Meter Specification:

ULTRASONIC BTU METERS cooling meter, PT500 2-wire with integrated ultrasonic flow sensor with 2.5 m signal cable incl. power supply option of 13 Years Battery Backup or 230v AC, a set of short direct or pocket sensors with 1.5 m cable and 2 nipples or 2 stainless steel pockets (65 or 90 mm/140mm).Both Ultrasonic Flow Part & Calculator should be from Same company only. All meters should be Flange Connection only.

Flow / Dia Selection:

When dimensioning meter, two major conditions must be stated: pipe dimension and maximum flow of the system. Regarding pipe dimension, going one dimension up or down in meter size will in general cause no problems, as long as the second parameter, the maximum flow does not exceed the nominal flow of the flow meter. Maximum flow of the system must be obtained without exceeding the nominal flow.

Approved meter data

EU-directives

– MID (Measuring Instruments Directive)
– LVD (Low Voltage Directive)
– EMC (Electro Magnetic Compatibility Directive)

Cooling meter

– Temperature range: 2°C...50°C
- EN 1434 designation Environmental class A and C

MID designation

– Mechanical environment Class M1

– Electromagnetic environment Class E1 and E2

Calculator data

Typical accuracy

– Calculator Ec □(0.15 + 2/Δ□)%
– Sensor set Et □(0.4 + 4/Δ□)%

Display LCD – 7 (8) digits with a digit height of 7.6 mm

Resolution 9999.999 – 99999.99 – 999999.9 – 9999999
Energy units MWh – kWh – GJ – Gcal

Data logger (Eeprom)

Standard 1392 hours, 460 days, 36 months, 15 years, 50 info codes
Option Data loggers with programmable interval
Clock/calendar Clock, calendar, leap-year compensation, target date, Real time clock with battery back-up
Data communication KMP protocol with CRC16 used for optical communication and for top and base modules

Mains supply

230 VAC +15/-30%, 50/60 Hz
D-Cell Battery -13 Years

Battery Life: When used with Tenant Billing System/BMS, if the data is retrieved from BTU meter, following conditions shall apply

- Hourly Data Retreivel-9 Years
- Monthly- 12 Years

Communication: Mbus

1. Complete chiller package including compressor, motor, drive, evaporator and condenser.
2. Refrigerant piping.
3. Charge of refrigerant and oil.
4. Controls and control panel.
5. Chilled water / Chilled Brine connections.
6. Condenser water connections.
7. Auxiliary water connections.
8. Purge unit.

9. Motor control panel including disconnect and starters.
10. Electrical power connections.
11 Isolators.

SECTION –X - AIR DISTRIBUTION SYSTEM

10.1 SCOPE

Supply, Fabrication, Installation, Testing and Commissioning of Sheet Metal Ducts, Supply, Installation, Testing and Balancing of Grilles and Diffusers, in accordance with these specifications and the General Arrangement shown on the Tender Drawings. The air distribution system shall be designed to convey correct quantities of conditioned air to provide the design air flow rate and environmental condition, while maintaining suitable area pressurization requirement within the conditioned space

10.2 DUCT MATERIALS & SIZES

All ducts shall be fabricated with zinc coating and Lock Forming Quality prime material along with mill test certificates. GI sheet metal shall conform to IS:277 with a zinc coating grade of 120GSM (both side inclusive) and aluminum sheets conforming to IS:737, Grade 31000. All fasteners shall be galvanized. The duct construction shall conform to IS 655 and the sheet metal thickness to be used for various duct dimensions shall be as under:

Rectangular Ducts			**Spiral / Flat Oval Ducts**		
Longest Side (mm)	**Min. Sheet Thickness (mm)**		**Longest Side (mm)**	**Min. Sheet Thickness (mm)**	
	G.I	**AL.**		**G.I**	**AL.**
Upto 750	0.6	0.8	Upto 600	0.6	0.8
751 to 1500	0.8	1.0	651 to 1200	0.8	1.0
1501 to 2250	1.0	1.5	1201 to 1750	1.0	1.5
2251 and above	1.2	1.8	1751 and above	1.2	1.8

Supporting of Ducting shall be provided by the Air Conditioning Contractor, it shall be generally supported from Roof Slab, Beams, Bottom Members of Truss and OR Additional MS Structural frame work as per the site conditions. MS Angles and threaded rods shall be utilized for supports. Further, anchor grip bolts shall be utilized wherever the supports are to be taken from concrete members. The support MS Structures should be duly painted with two coats on zinc chromate primer and two coats of black enamel paint. The spacing of hangers shall be as IS: 655

10.3 DUCT CONSTRUCTION

The duct shall be designed as per “equal friction method” as far as possible. All ducts shall be fabricated and installed in workmanlike manner, conforming to relevant SMACNA codes.

- Ducts so identified on the Drawings shall be acoustically lined and insulated from outside as indicated in Bill of Quantities. Duct dimensions shown on drawings, are

overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in Bill 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.

- 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.
- 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.
- 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.
- All sheet metal connection, partitions and plenums, required to confine the flow of air to and through the filters and fans, shall be constructed of 18 gauge GSS / 16gauge aluminum, thoroughly stiffened with 25mm x 25mm x 3mm galvanized steel angle braces and fitted with all necessary inspection doors as required, to give access to all parts of the apparatus. Access doors shall be not less than 45cm x 45cm in size.
- 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.
- 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.
- All ducts shall be installed generally as per tender Drawings, and in strict accordance with approved shop drawings to be prepared by the Contractor. The contractor shall also carryout the feasibility study at site, coordination with other services and interior drawings before fabrication of duct. Any fabricated duct rejected due to these reasons shall not be paid and only final measured and installed duct shall be certified for payment.
- 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 Client / Consultant ’s site representative in all its parts and details.
- 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.
- 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 Client / Consultant’s site representative. Fabrication of duct shall be commenced only after verifying the feasibility at site.
- All duct work 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

under ducts at no greater than 2 meter centre. All vertical duct work shall be supported by structural members on each floor slab. Galvanized steel cleat with a hole for passing the hanger rods shall be welded to the plates. Trapeze hanger formed of galvanized steel rods and angles/ channels shall be hung through these cleats. 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.

- Ducting over furred ceiling shall be supported from the slab above, or from beams, after obtaining approval of Client / Consultant's site representative. In no case shall any duct be supported from false ceiling hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other Contractor's work in the building. All supports of pipe shall be taken from structural slab/wall by means of fastener.
- Where ducts pass through brick or masonry openings, it shall be provided with 25 mm thick TF quality expanded polystyrene around the duct and totally covered with mortar for complete sealing. Contractor shall ensure that contact between metal duct and mortar is avoided.
- All ducts shall be totally free from vibration under all conditions of operation. Whenever duct work is connected to fans, air handling units or blower coil units that may cause vibration in the ducts, ducts shall be provided with a fire resistant double flexible connection, located at the unit discharge. Flexible connections shall be constructed of fire retarding flexible heavy canvas sleeve at least 10 cm long securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting duct work rigidly held by independent supports on both sides of the flexible connection. The flexible connection shall be suitable for pressure at the point of installation.
- Duct shall not rest on false ceiling and all the supports shall be provided from slab only
- Suitable arrangement shall be provided in duct for fixing of duct smoke sensor (supplied by other vendor).
- Toilet exhaust duct shall be provided with goose necking as shown in design drawings and exhaust shall continue operation in case of fire.
- PVC washers shall be provided at two different metallic joints to avoid bi-metallic corrosion

10.4 DAMPERS

- All duct dampers shall be opposed blade louver dampers of robust 16 G GSS construction and tight fitting. The design, method of handling and control shall be suitable for the location and service required.
- Dampers shall be provided with suitable links levers and quadrants as required for their proper operation. Control or setting device shall be made robust, easily operable and accessible through suitable access door in the duct. Every damper shall have an indicating device clearly showing the damper position at all times.
- Dampers shall be placed in ducts at every branch supply or return air duct connection, whether or not indicated on the Drawings, for the proper volume control and balancing of the air distribution system.

10.5 SUPPLY AND RETURN AIR DIFFUSERS & GRILLS

- Supply and return air diffusers shall be as shown on the Drawings and indicated in Bill of Quantities. The diffusers shall be powder coated & made from extruded aluminium section as specified in Bill of quantities.
- Supply air diffusers/grills with volume control dampers shall be provided for all air-conditioned areas. Return air diffusers/grills of air conditioned areas shall be without VCD. Diffuser neck velocities shall be restricted below 2 m/s.
- Rectangular Diffusers shall be steel / extruded aluminium construction, square & rectangular diffusers with flush fixed pattern for different spaces as per BOQ these shall be selected in consultation with the Client / Architect / Consultant's representative. These shall be procured only after obtaining written approval from Client / Architect / Consultant's representative for each type of diffuser.
- Supply air diffusers shall be equipped with fixed air distribution grids, removable key-operated volume control dampers, and anti-smudge rings as required in specific applications, and as per requirements of Bill of quantities. All extruded aluminium diffusers shall be provided with removable central core and concealed key operation for volume control damper.
- Linear Diffuser shall be extruded aluminium construction with removable core, one or two way blow type. Supply air diffusers shall be provided with volume control / balancing dampers within the supply air collar. Diffusers for different spaces shall be selected in consultation with the Client / Architect / Consultant's representative, and provided as per requirements of Bill of quantities. All diffusers shall have volume control dampers of extruded aluminium construction anodized in mat black shade.
- Slot Diffuser shall be extruded aluminium construction multislot type with air pattern controller provided in each slot. Supply air diffusers shall be provided with Hit & Miss volume control dampers in each slot of the supply air diffusers. Diffusers for different spaces shall be selected in consultation with the Client / Architect / Consultant's representative and provided as per requirement of Bill of Quantities.
- All the supply air diffusers shall be provided with acoustically insulated plenum box. The insulation material for the supply air diffuser plenum box shall be 12 mm thick open cell cross linked polyolefin insulation.
- Design of all diffusers and grills shall be matching with the lighting fixture, false ceiling and other fittings. Prior approval of Purchaser shall be obtained for the location, type & colour code of diffusers/ grills.

10.6 FIRE & SMOKE DAMPERS (UL 555 LISTED & CERTIFIED)

- All supply and return air ducts crossing fire rated walls, and floor crossings shall be provided with Motor operated Fire & smoke damper of **180 minutes** fire rating as per UL555 listed and certified damper. These shall be of multi-leaf type and provided with Spring Return electrical actuator having its own thermal trip for ambient air temperature outside the duct and air temperature inside the duct. Actuator shall have Form fit type of mounting, metal enclosure and guaranteed long life span. The damper shall shut automatically in case of power failure.
- Fire damper blades and outer frames shall be of 16G galvanized steel construction fitted with 18 gage extended sleeves on both sides. The damper blade shall be

pivoted on both ends using chrome plated spindles in self lubricated bronze bushes. Stop seals shall be provided on top and bottom of the damper housing made of 16G galvanized sheets steel. For preventing smoke leakage metallic compression seals will be provided.

- The electric actuator shall be energized either upon receiving a signal from smoke detector. The fire damper shall also close upon sensing temperature rise in supply air ducts thru the electronic temperature sensor.
- Each damper shall be provided with its own control panel, mounted on the wall within the AHU room and suitable for 240 VAC supply. This control panel shall be suitable for spring return actuator and shall have atleast the following features:
  - Potential free contacts for AHU fan ON/ OFF and remote alarm indication.
  - Accept signal from external smoke / fire detection system for tripping the electrical actuator.
  - Test and reset facility.

  Indicating lights / contacts to indicate the following status:
  - Power Supply On
  - Alarm
  - Damper open and close position.
- Actuators shall be mounted on the sleeve by the damper supplier in his shop and shall furnish test certificate for satisfactory operation of each Motor Operated Damper in conjunction with its control panel. Control panel shall be wall mounted type and located in AHU room or nearest electrical room.
- The control panel of the fire damper shall suitable for independent and series connection operation. The panel shall be configured Master/Slave concept to receive the signal for all actuator thru master panel. The internal control wiring shall be part of fire damper scope.
- It shall be HVAC Contractor's responsibility to co-ordinate with the Fire Alarm System Contractor for correctly hooking up the Motor Operated Damper to Fire Detection / Fire Management System. All necessary materials for hooking up shall be supplied and installed by HVAC Contractor under close co-ordination with the fire protection system contractor.
- HVAC Contractor shall demonstrate the testing of all Dampers and its control panel after necessary hook up with the fire protection / fire management system is carried out by energizing all the smoke detectors with the help of smoke.
- HVAC Contractor shall provide Fire retardant cables (FRLS) for satisfactory operation and control of the Damper.
- HVAC Contractor shall strictly follow the instructions of the Damper Supplier or avail his services at site before carrying out testing at site. Installation of damper shall be as per manufacturer recommendation or as per CLIENT Instructions. Damper shall be provided with GI sleeves extending on either side of wall up to 3 inches to 6 inches. The damper shall be supported with structural wall by providing 32 mm x 32 mm angle frame on all sides of sleeve. Damper shall be supported with structure using a fastener. Installation details in form of sketch shall be submitted prior to execution and gotten approved from Client / Architect / Consultant's representative.
- Fire/smoke damper shall be provided with factory fitted sleeves; however, access doors shall be provided in the ducts in accordance with the manufacturer's

recommendations. The location of actuator shall not foul with the fire rated wall. However, damper shall be placed on the fire rated wall.

- Filling-up the annular gap between wall and duct / smoke damper with fibre glass and applying fire sealant
- AMCA Certification need to provided for air performance of fire damper.

10.7 FLEXIBLE DUCTING

The flexible ducts used to tap supply air shall be of high quality thermally insulated duct. The insulation material shall be fiberglass and thickness of the insulation shall be minimum 25 mm thick. The density of the insulation shall be not less than of 16 kg / cum with a minimum R Value of 4.2. All thermal performance (R-Values) shall be certified by Underwriters Laboratories in accordance with ADC Flexible Duct Performance and Installation Standard (1991) using ASTM C-518 (1991), at installed wall thickness, on flat insulation only. Flexible duct shall also comply to the following standards and third party certification UL 181, NFPA 90A & 90B

The inner core of the products shall be air-tight and designed for low-to-medium operating pressures in HVAC systems. A double lamination of tough polyester shall encapsulate a steel wire helix to form the air-tight inner core. The double-layer core of each product shall be wrapped in multiple thicknesses of fiberglass insulation. The product shall be sheathed in a rugged and durable tri-directionally reinforced, metalized polyester jacket. Flexible ducts shall be cut to the required size to ensure a curved connection between the main duct and the air terminal plenum. The contractor shall not join any small flexible pieces by any foreign materials before installation. The minimum length of the flexile duct shall not be less than 750 mm in length. A groove of 2 mm shall be made on the round collars to ensure that the spiral wire inside the flexible duct shall be fitted ahead of the groove. Stainless steel metal clamps, which are made out of 8-mm wide band with lifted edges, shall be used to tighten the connection of the flexible ducts on the round collars of the plenums. On the flexible ducts, the clamp is fitted with a flip up and quick locks tightening ahead of ease of fixing. The contractor shall ensure that all the flexile ducts wherever installed shall follow the above procedure. The contractor has to obtain the approval from the CLIENT managers before starting the actual installation. The flexible duct should not be rested on false ceiling frame / tiles / boards. The flexible ducts shall be hanged from the roof slab.

10.8 TESTING AND BALANCING

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

SECTION – XI - INSULATION

11.1 SCOPE

The scope of this section covers the supply and application of insulation of various type insulation materials with various types of application as specified in the drawings and BOQ for sheet metal ducting - acoustic lining and thermal, refrigerant and drain pipes, etc.,

11.2 FIBRE GLASS INSULATION

Insulation material for Duct insulation shall be glass wool. The duct insulation shall have self adhesive backing with a peal-off cover for easy installation at site. Thermal conductivity of fibre glass insulation shall not exceed 0.03 W/m^{o}K at an average temperature of 25°C for a density of 32 Kg/m3. The product shall have temperature range of –195°C to 230°C. The insulation shall have fire performance such that it passes minimum CLASS 1 as per BS476 part 7 for surface spread of flame. Water absorption shall not exceed 2% as per IS 3144.

Insulation material for Duct Acoustic Lining shall be processed with 48 kg/cum density, fire resistant resin bonded fiber glass rigid board acoustic insulating material faced on the inside with non woven Black fibre glass tissue over the insulation material and covered with perforated 24G aluminium sheets having 40% perforation. Thermal insulation shall be 32 kg/cum density, fire resistant resin bonded fiber glass insulating material with aluminium foil (foil scrim script) on the external surface of the ducts. Ducts so identified and marked on Drawings and included in Bill of Quantities shall be provided with acoustic lining for a distance of minimum 5 meters. The inside surface for the ducts shall be covered with adhesive recommended by the manufacturer.

11.3 NITRILE RUBBER INSULATION

Insulation material for Duct insulation shall be Elastomeric Nitrile Rubber having anti-microbial protection. The anti-microbial product protection shall be an integral part of insulation that is built-in during the manufacturing process and the product protection should not allow the microbes to function, grow and reproduce. The duct insulation shall have self adhesive backing with a peal-off cover for easy installation at site. Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.035 W/m^{o}K at an average temperature of 20°C. The product shall have temperature range of –40°C to 105°C. The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class ‘O’ Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990. Water vapour permeability shall not exceed 1.74 x 10^{-14} Kg/m.s.Pa, i.e. Moisture Diffusion Resistance Factor or ‘μ’ value should be minimum 10,000 according to EN 12086

Insulation material for Duct Acoustic Lining shall be processed Open cell Nitrile Rubber foam having anti-microbial protection. The material should be dust and fibre free. The density shall be within 140-180 Kg/m3. Insulation material for Duct thermal lining shall be processed closed cell Nitrile Rubber foam having anti-microbial protection. The density shall be within

45-60 Kg/m3. Ducts so identified and marked on Drawings and included in Bill of Quantities shall be provided with acoustic lining for a distance of minimum 5 meters. The inside surface for the ducts shall be covered with adhesive recommended by the manufacturer. Cut Foamed sheets into required sizes apply adhesive on the foam and stick it to the duct surface

11.4 INSULATION - APPLICATION

Duct surfaces shall be cleaned to remove all grease, oil, dirt, etc. prior to carrying out insulation work. Measurement of surface dimensions shall be taken properly to cut the insulation sheets to size 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.

Each lot of insulation material delivered at site shall be accompanied with manufacturer test certificate for thermal conductivity values and density. Samples of insulation material from each lot delivered at site may be selected by Client / Consultant's site representative and gotten tested for thermal conductivity and density at Contractor's cost. All joints shall be sealed properly with adhesive, which shall provide similar vapour barrier as the original insulating material.

11.5 RECOMMENDED ADHESIVE:

In all cases, the manufacturer's recommended Adhesive should be used for the specified purpose. The adhesive shall have low VOC and shall confirm with LEED/IGBC guidelines.

11.6 EQUIPMENT INSULATION

Chilled water pump, expansion tank, etc shall be insulated minimum 32mm thick nitrile rubber insulation. Care shall be taken to apply insulation in a manner as to allow the dismantling of pumps without damaging the insulation. The insulation shall be covered with 24 Gauge aluminium spiral casing for exposed application and 26 Gauge GI spiral casing for indoor application.

11.7 PROTECTIVE COATING OVER INSULATION

To provide mechanical strength and protection from damage & UV rays all exposed duct insulation as indicated in BOQ shall be covered with woven glass fabric cloth. The glass fabric shall be applied with one coat of fire proof epoxy or acrylic compound. The coat shall be allowed to cure to non stick state. Subsequently second coat of compound shall be applied to give a tough and smooth finish to the insulated surface.

11.8 ACOUSTIC LINING OF MECHANICAL ROOMS

The walls of the air conditioning plant room and air handling unit rooms may be provided with acoustic lining of fiberglass as per Bill of Quantities and as shown on the Drawings. The surface shall be cleaned and frame work of 22 gauge GI fabricated Channels 25 mm x 50 mm screwed back to back at 60 cm centres shall be provided vertically and horizontally so that 60 x 60 cm squares are formed. The gaps between frames shall be filled with 48kg/cum density, 50 mm thick about 60 cm x 60 cm cut panels of polyester fibre wool. The entire surface shall then be covered with Tissue paper and then 26 gauge perforated aluminium sheet, 60 cm or 120 cm wide having atleast 40 percent perforations with 3mm dia holes, fixed with sheet metal screws. Over-lapping of sheets shall be covered with Aluminium beading. Acoustic lining of walls shall be terminated approximately 15 cm above the finished floor to prevent damage to insulation due to accidental water-logging in plant/AHU rooms.

The walls of the air conditioning plant room and air handling unit rooms may be provided with acoustic lining of fibre-glass as per Bill of Quantities and as shown on the Drawings. Modular removal type wall acoustic paneling system with 0.8 mm thick 600mm x 600 mm Aluminium hydraulic pressed panels by Clip on type method and insulated with 48 Kg. /m3 density, 50 mm thick Fiberglass wool including Clips and consumables complete

Installation Procedure:

- Fix “U” Clamp on to the wall /ceiling, made out of 1.0 mm thick GI with the help of fasteners/Rawl plugs
- Fix pre-fabricated compressed G.I. Carriers having a thickness of 0.6 mm and fixed in to the “U” Clamp by friction fit method horizontally over Wall/Ceiling at an interval of 600 mm to receive pre fabricated panels.
- Fix Fiberglass wool having density of 48 Kg./m3, 50 mm thickness along with Fiberglass tissue on to the wall / ceiling.
- Fix pre-fabricated Aluminium panels of 0.6 mm thickness perforated modular type wall acoustic removal type panels with a dimension of 600 mm x 600 mm with clip on lock arrangements on the compressed clip already fixed on wall / Ceiling
- The sides of the panels are raised suitably to lock in to the clips by friction fit method.

SECTION –XII - VARIABLE FREQUENCY DRIVES FOR HVAC SYSTEM

12.1 GENERAL SPECIFICATIONS:

1.1 The VSD must comply with Equipment Standard IEC/EN 61000-3-12: Limits for harmonic currents produced by equipment connected to public low voltage systems.

1.2 All VSDs shall have the same customer interface, including multilingual control panel, I/O connections and software, regardless of power rating, voltage or enclosure (IP class).

1.3 The control panel must always be delivered with the drive and shall include the following functionalities:

- 1.3.1 Full-text messages. Panels with only message codes are not accepted.
- 1.3.2 Removable without tools
- 1.3.3 Hand-Off-Auto functionality & Dedicated Help button
- 1.3.4 Parameter copy function from one drive to another

1.4 The VSD must not be a limiting component in the drive-motor package. All VSDs must produce enough current to provide rated motor (IE3) kW power at -15 up to +50 °C ambient temperature continuously (24/7/365) even when mounted side by side.
Manufacturer's statement on output currents available 24h/day at 40°C and 50°C must be provided in writing.

1.5 The VSD should have the capability to be configured without VSD power supply by using an optional configuration device. Also, there shall be a possibility to configure or adjust VSD parameters even if the VSD power is switched off.

1.6 The VSD should have the capability for programming load curves. Under-load and over-load curves must be user defined.

1.7 The VSD shall have an override function. Motor rotation direction shall be selectable in override mode. The manufacturer's description on override function must be provided in writing.

1.8 Electronic boards must be coated to support longer lifetime of the drive. The manufacturer's statement must be provided in writing.

1.9 Supply Voltages:3 phase, 380 to 480 V, +10/-15%
Supply Frequency: 48 to 63 Hz.

12.2 PROTECTION CLASS & ASSEMBLY METHOD

2.1 VSDs must be IP20 in case of panel mounting

2.2 Side-by-Side mounting must be possible

12.3 **ENVIRONMENTAL LIMITS**

3.1 Ambient temperature: Transportation and storage -40 to 70 °C
3.2 Ambient temperature: Operation -15 to 50 °C (no frost allowed)
3.3 Altitude: Rated output current available at 0 to 1000m; reduced by 1% per 100m over 1000m up to 2000m.
3.4 Relative humidity lower than 95%(without condensation)

12.4 **STANDARD FEATURES**

4.1 The VSD must have inbuilt EMC filters as standard. The range of VSDs shall conform to the European Union Electro Magnetic Compatibility (EMC) Directive, a requirement for CE marking. VSDs must comply with EMC Directive 89/336/EEC with supplements and Product Standard EN 61800-3
4.2 Changed parameters list shall be available in order to assist commissioning and troubleshooting. Also, the VSD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to reduce energy consumption by up to 10% and lower audible motor noise.
4.3 The VSD shall include an over modulation feature, which will automatically increase the output voltage. It shall have programmable “Sleep” and “Wake up” functions to allow the drive to be started and stopped from the level of a process feedback signal.
4.4 For smooth output waveform, the switching frequency of VSD shall be default 4kHz and shall be selectable from 1kHz to 12kHz.
4.5 If the input reference (4 to 20mA or 0 to 10VDC) is lost, the VSD shall give the user the option of: (1) stopping and displaying a fault; (2) running at a programmable preset speed and displaying an alarm; (3) hold the VSD speed based on the last good reference received and displaying an alarm. The drive shall be programmed to signal this condition via a control panel warning, relay output and/or over the serial communication bus.
4.6 The overload rating of the VSD shall be 110% of its rated current for 1 minute every 10minutes and with a minimum of 130%.
Overload ability must be available at all times – not only at start.
4.7 The VSD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to set point (flying start) without safety tripping or component damage.
4.8 The VSD shall have the ability to automatically restart after an over current, over voltage, under voltage, or loss of input signal protective trip. The number of restart attempts minimum 5, trial time from 1s to 600s and delay time of up to 120 sec shall be programmable.
4.9 The VSD shall have cooling fans that are designed for easy replacement without removing the VSD from the wall or removal of circuit boards. The VSD cooling fans shall operate only when required, to extend the fan and bearing operating life. Operating temperature will be monitored and used to cycle the fans on and off as required.
4.10 There shall be a flux breaking capability, where the VSD increases the motor magnetization to dissipate the extra energy whenever small braking

power is required. It shall be possible to use the braking to decelerate the motor from one speed to another – not only for stopping the motor.

4.11 Power Loss Ride – Through shall be available. If the incoming supply voltage is cut off, the VSD continues to operate using the kinetic energy of the rotating motor. The drive continues to be operational as long as the motor rotates and generates energy

4.12 The VSD shall have the following minimum I/O features for connectivity

4.12.1 The number of digital inputs required is 4
4.12.2 The number of analog inputs required is 2
4.12.3 The number of analog outputs required is 1
4.12.4 The number of relay outputs required is 1
4.12.5 The number of digital outputs required is 1

12.5 PRODUCT COMPLIANCE

5.1 Low Voltage Directive 73/23/EEC with supplements
5.2 Machinery Directive 98/37/EC & EMC Directive 89/336/EEC with supplements
5.3 EN 61800-3, IEC/EN 61000-3-12 & Quality assurance system ISO 9001
5.4 Environmental system ISO 14001
5.5 CE, UL and cUL approvals
5.6 GOST R certificate, RoHS Directive 2002/95/EC

12.6 PROTECTION FUNCTIONS

6.1. The following protection functions shall be available:
6.2 Overvoltage controller & Under voltage controller
6.3 Earth-leakage supervision, Motor short-circuit protection & Overcurrent protection
6.4 Output and input switch protection
6.5 Phase-loss detection (both motor & line)
6.6 Under load supervision
6.7 Overload supervision & Stall protection

12.7 USER INTERFACES – DETACHABLE CONTROL PANEL

7.1 The control panel shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate “bumpless transfer” of speed reference when switching between “Auto” and “Hand” modes. There shall be a fault reset button and a dedicated “Help” button on the control panel. The Help button shall include “on-line” assistance for programming and troubleshooting.

7.2 The control panel shall include a backlit LCD. The display shall be in complete words, for programming and fault diagnostics (alphanumeric codes are not acceptable). The keypad shall utilize the following interactive assistance to guide the user:

- Start-up/ Programming assistants
- Diagnostic assistant

7.3 The VSD shall be utilize pre-programmed application macros, specifically designed to facilitate start-up in typical Pump applications such as supply and return fans, condensers and booster pumps. The application macros shall provide one command to reprogram all the relevant parameters and customer interfaces for a particular application to reduce programming time. The VSD shall have two user macros to allow the end user to create, save and change between custom settings like winter/summer or day/night.

7.4 The control panel must be detachable IP20 protection class without tools to allow easy commissioning and programming of multiple VSDs.

7.5 Dedicated features for pumps and fans which include

- Supervision of inlet/outlet pressure
- Pump cleaning functions
- Pipe fill functions
- Detection of underload/overload

12.8 **USER INTERFACES – SERIAL COMMUNICATIONS**

8.1 The VSD shall have an EIA-485 (RS-485) port as standard. Protocol always available as embedded into the VSD memory shall be MODBUS RTU.

8.2 Serial communication capabilities shall include, but not limited to: run-stop control, speed set adjustment, proportional/integral/derivative (PID) control adjustments. PID set point adjustment, current limit, acceleration/deceleration time adjustment and lock/unlock keypad. The drive shall have the capability of the allowing the DDC to monitor feedback such as process variable feedback, output speed/ frequency, current, torque, power(kW), kilowatt hours (resettable), operating hours (resettable), drive control location (hand or auto) and drive temperature.

The DDC shall also be capable of monitoring the VSD relay output status, digital input status and all analog input and analog output values. All the diagnostic warning and fault information shall be transmitted over the serial communications bus. DDC shall be able to activate VSD fault-reset via fieldbus. A minimum of 15 fieldbus parameters shall be capable of being monitored.

8.3 The VSD shall allow the DDC to control the drive's digital and analog outputs via serial interface. This control shall be independent of any VSD function (Free I/O). For example the analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive's digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all the drive's digital and analog inputs shall be capable of being monitored by the DDC system

8.4 The VSD shall include two PID loops one for control of motor and one independent PID loop for customer use. The independent PID loop may be used for cooling tower bypass valve control, chilled water valve control etc. Both the VSD control PID loop and the independent PID loop shall continue functioning even if the serial communication connection is lost. The VSD shall keep the last good set-point command and last good DO & AO

commands in memory in the event that the serial communications connection is lost.

12.9 WARRANTY

All VSDs must be covered with a worldwide warranty of minimum 24 months from the date of commissioning.

SECTION – XIII - MODE OF MEASUREMENT

For variable items like sheet metal ducting, insulation, piping works, cabling etc., the following measurement procedure shall be adopted for billing purposes.

13.1 DUCTING

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

- Duct Work shall be measured on the basis of external surface area of ducts. Duct measurements shall be taken before application of the insulation. The external surface area shall be calculated by measuring the perimeter comprising overall width and depth, including the corner joints, in the centre of each duct section, multiplying with the overall length from flange face to flange face of each duct section and adding up areas of all duct sections. Plenums shall also be measured in similar manner.
- For tapered rectangular ducts, the average width and depth shall be considered for perimeter, whereas for tapered circular ducts, the diameter of the section midway between large and small diameter shall be adopted, the length of tapered duct section shall be the centre line distance between the flanges of the duct section.
- For special pieces like bends, tees, reducers, branches and collars, mode of measurement shall be identical to that described above using the length along the centre line.
- The quoted unit rate for external surface of ducts shall include all wastage allowances, flanges and gaskets for joints, nuts and bolts, hangers and angles with double nuts for supports, rubber strip 4 mm thick between duct and support, vibration isolator suspension where specified or required, inspection chamber / access panel, splitter damper with quadrant and lever for position indication, turning vanes, straightening vanes, and all other accessories required to complete the duct installation as per the Specifications. These accessories shall NOT be separately measured nor paid for.
- Special Items for Air Distribution shall be measured by the cross-section area perpendicular to air flow, as identified herewith:
- Grilles and registers - width multiplied by height, excluding flanges. Volume control dampers shall form part of the unit rate for registers and shall not be separately accounted.
- Diffusers - cross section area for air flow at discharge area, excluding flanges. Volume control dampers shall form part of unit rate for supply air diffusers and shall not be separately accounted.
- Linear diffusers - shall be measured by cross-sectional areas and shall exclude flanges for mounting of linear diffusers. The supply air plenum for linear diffusers shall be measured with ducting as described earlier.

13.2 DUCT INSULATION

The measurements for insulation of ducts shall be made in actual square metres of bare uninsulated duct surface through all dampers, flanges and fittings. In case of bends the area shall be worked out by taking an average of inner and outer lengths of the bends. Measurements for the dampers, flanges, fittings shall be measured for the surface dimension. The overlapping of insulation shall not be measured separately for billing purpose. In case of acoustic lining of air ducts, measurements of the bare inside duct surface in square meters, shall be final for billing purposes. The acoustic insulation of plenum boxes shall not measured separately as it is part of plenum box supply as specified in Spec / BOQ. The insulation/acoustic panels shall include cost of battens, supports, adhesives, vapour proofing, finished tiles/boards sheets as well as additional labour and material required for completing the work.

13.3 CHLLED WATER PIPING

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

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

The quoted rates for centre line linear measurements of piping shall include all wastage allowances, pipe supports including hangers, PUF supports, nuts, check nuts, vibration isolator suspension where specified or required, and any other item required to complete the piping installation as per the Specifications. None of these items will be separately measured nor paid for. However, all valves (check / balancing / purge / butterfly / drain etc), strainers, thermometers, pressure gages shall be separately counted and paid as per their individual unit rates, which shall also include their insulation as per Specifications / BOQ description.
All the extra CI & CM flanged valves shall be measured according to the nominal size in mm and shall be measured by number. Such valves shall not be counted as part of pipe length hence deduction in pipe length will be made wherever valves occur. All valves shall include two Nos. of flanges and two numbers 150mm long MS nipples, with one side threaded matching one of the valves, and other welded to the M.S. slip-on-flange. Rate shall also include the necessary number of bolts, nuts and washers, 3 mm thick insertion gasket of required temp. grade and all items specified in the specifications.
The rates quoted shall be inclusive of making connections to the equipment, tanks, pumps etc. and the connection made with an installed pipe line shall be included in the rates as per the B.O.Q. Tenderer shall get pressure testing of pipes / measurements etc verified by the Client / Architect / Consultant’s representative at site.

13.4 REFRIGERANT PIPE MEASUREMENTS

The pipe lengths specified in the BOQ shall deemed to be inclusive of all fittings like Bends, Elbows, Reducers, Pipe supports, clamps, etc. These will not be measured

separately and paid for. The pipes shall be in unit length rounded off to the nearest centimeter and measured along the centre line of the pipe and fittings. The quoted unit rate for all pipes shall inclusive of all wastage allowances and also inclusive of necessary painting as per the standard color code.

13.5 PIPE INSULATION

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

13.6 **ACCESSORIES INSULATION**

The insulation for accessories such as expansion tank, pumps, chillers, valves, etc. shall be considered in the respective items and hence shall not be measured separately.

13.7 CABLING

Payment for Cabling works shall be effected on the basis of linear measurement measure from gland to gland. Any looping provided in cables near to the terminations shall also be measured and paid for. However, such looping shall not exceed 2 RMT per termination. No payment shall be made for left out and installed cut cable pieces. The rates quoted for underground cable laying shall include excavation charges, sand cushioning, standard burned brick protection, refilling, consolidating etc., The rates for cable termination works shall include the costs of copper / aluminium termination sockets of suitable type, brass single compression cable glands, copper earth clamps for glands, taping, crimping, yellow pasting, all labour charges etc., The payment for cable trays shall be effected based on the linear measurement of the cable trays of different sizes. The cost shall be inclusive of basic cable tray, suspenders and labour for tray fitting, fabrication and erection.

STRUCTURAL SUPPORTS

Structural supports like rods, clamps, bolts & nuts, etc for pipes and ducts shall be considered as part of pipe and ducts hence no separate payment will be made. Rates shall be inclusive of hoisting, cutting, jointing, welding, cutting of holes and chases in walls, slabs or floors, painting supports and other items as described in specifications, drawings and bill of quantities or as required at site by Engineer in Charge. The MS supports like plate, channels, angles, etc shall be measured separately as described in BOQ.

SECTION – XIV - TESTING AND COMMISSIONING

14.1 SCOPE

The following quality assurance, inspection, testing and commissioning procedures shall be required to be carried out upon award of work.

- Provide quality assurance program (QAP), works quality assurance program (WQAP), field quality assurance program (FQAP) and quality plan.
- Tests at manufacturer's works.
- Perform site tests and commissioning.

14.2 SUBMITTALS

- After award of work following information shall be submitted.
  - Quality Assurance Program (QAP)
  - Works Quality Assurance programme (WQAP)
  - Field Quality Assurance Programme (FQAP)
- For inspection and testing, submit inspection and testing procedures, programme, and record sheets applicable at each hold point.
- After completion of testing, submit test records, packaging, transportation and storage instructions and methods.
- For site installation and commissioning, submit installation methods or procedures, notification and procedures for pre-commissioning and commissioning.
- After commissioning, submit site test records, as-built drawings, manufacturer's operation maintenance manuals and list of recommended spares and tools.

14.3 QUALITY ASSURANCE CONCEPT AND CONTROL

- Minimum requirements for establishing and implementing a quality assurance programme shall be applied to all aspects of the work necessary for carrying out the contract. Quality assurance shall extend to material parts, components, systems and services as a means of obtaining and sustaining the reliability of critical items, operating performance, maintenance and safety.
- Acceptance of the Tenderer's quality assurance programme does not relieve the Tenderer's obligation to comply with the requirement of the contract document. If the programme is found to be ineffective, then the Client / Consultant's site representative reserves the right to request for necessary revisions of the programme.
- The Tenderer is required to produce readily identifiable documentary evidence covering the extent and details of both his own and his sub tenderer's quality assurances system as follows :
  - Quality Assurance Program (QAP)
  - Works Quality Assurance programme (WQAP)
  - Field Quality Assurance Programme (FQAP)
  - Quality Plan.
- These documents shall be prepared separately and submitted to the Client / Consultant's site representative at the time of starting the work.

- Quality Plan and Manual shall be prepared by the Tenderer for all items and services to be supplied, after the contract has been placed, but before commencement of fabrication, and shall be subject to evaluation and acceptance by the Client / Consultant's site representative before start of work.

14.4 QUALITY ASSURANCE MANUAL (QAM)

- The QAM shall be a general comprehensive document outlining the Tenderer's basic organization, policies and procedures. The information to be given in the QAM shall include but not limited to :
    - Quality Policy.
    - Quality Assurance Programme
    - Organisation Structure showing inter relationships.
    - Functional responsibilities and levels of authority.
    - Lines of communication.
    - Customer relations.
    - Laboratory Facilities.

14.5 WORKS QUALITY ASSURANCE PROGRAMME (WQAP)

- The WQAP shall identify the Tenderer's Quality Assurance Programme at works applicable throughout all phases of Contract performance, including design, procurement, manufacture, inspection and testing. It shall identify each of the programme elements to be designed, developed, executed and maintained by the Tenderer for the purpose of ensuring that all supplies and services comply with these specifications.
- The information to be given under this programme shall include but not limited to:
    - Organisation and Responsibility.
    - Contract Review.
    - Design and Document Control.
    - Procurement Control.
    - Production Control.
    - Control on Sub-tenderers.
    - In-process Quality Control and Traceability.
    - Inspection and Testing.
    - Control of Non-conformances.
    - Corrective Action.
    - Control of Inspection, Measuring and Test Equipment.
    - Handling, Storage, Packaging and Delivery.
    - Records.
    - Quality Audits.
    - After - Sales Servicing.

14.6 FIELD QUALITY ASSURANCE PROGRAMME (FQAP)

- This programme shall identify the Tenderer's Quality Assurance Programme at site applicable throughout site construction, erection and commissioning. It is the underlying philosophy that the quality built into the product at works shall be maintained throughout the construction and commissioning stages.
- While, in principle, the FQAP shall include the items discussed in WQAP, it shall, however, be approached differently to take into account site conditions.
- The FQAP shall include, but not limited to the following information :
    - Organisation and responsibility.
    - Control of Drawings and Documentation.
    - Product Checklist.
    - Control and Traceability of Purchased materials and services.
    - Receipt Inspection of materials at site.
    - Material Storage Control.
    - Inspection and Examination Procedures.
    - Control of Painting and Insulation Works.
    - Pre-commissioning.
    - Commissioning.
    - Control of Non-conformances.
    - Corrective Action.
    - Control of Inspection, Measuring and Test Equipment.
    - Records.
    - Completion Documents.
    - List of recommended spares and tools.
    - Personal Training.
    - Servicing during Defects Liability Period

14.7 QUALITY PLAN

- The tenderer shall be required to prepare manufacturing and construction/erection quality plans for all equipment items and services. The quality plan shall also define the involvement of Client / Consultant's site representative in the inspection and test programmes.
- The Quality Plan shall incorporate as appropriate :
    - Charts indicating flow of materials, parts and components through manufacturing quality control inspection and test to delivery and erection.
    - The charts shall indicate the location of hold points for quality control, inspection and test beyond which manufacture shall not continue until the

action required by the hold point is met, and the documentation required is generated.

- The control documents associated with each hold point, i.e. drawings, material, specification, Works Process Schedule (WPS), Process Quality Records (PQR), quality control methods and procedures and acceptance standards.

14.8 SITE QUALITY CONTROL SECTION

- The Tenderer's Quality Control (Q.C.) section shall be headed by an experienced Quality Control Engineer. He shall be assisted by other supervisors. The section shall be an independent one, reporting to the tenderer's Site Manager only on administrative matters, but otherwise under full control by the Tenderer's Corporate Quality System Management.
- The Tenderer's Q.C. Section shall liasise closely with the Client / Consultant's site representative in charge of Quality Assurance/Quality Control, and to whom it shall give fullest cooperation. It is the underlying principle of this contract document that while the Tenderer's Q.C. Engineer implements the Tenderer's Quality Programme, the adequacy and effectiveness of that implementation shall be audited by the Client / Consultant 's site representative whose recommendations on improving or maintaining quality shall be acted upon promptly by the Tenderer's Q.C. Section.

14.9 INSPECTION AND TESTING

The contractor shall carry out all performance / acceptance tests to the satisfaction of Client / Project Manager / Consultant's representative at factory as well as on site. All such performance tests carried out shall be recorded and submitted for approval to the Client / Project Manager / Consultant's representative

The tests at site shall be performed to indicate freedom from vibration, unbalance, leakage and to establish the designed performance of the equipment. The contractor shall submit the producer for site tests to Client / Project Manager / Consultant's representative for approval.

After the complete installation of Air-conditioning System with ductwork, pipe-work, insulation etc. is completed, these shall be tested as per the applicable codes (unless otherwise specified), to check, and assess the functional performance. These tests to be conducted at site in the presence of Client / Project Manager / Consultant's representative, shall include, but not limited to the following equipments in summer, monsoon and in winter seasons respectively.

Screw chiller factory inspection and test as per IS, BS, ARI & relevant standards.

- Visual inspection.
- Designed Pressure test:- Refrigerant circuit and water circuit of chiller.
- Designed Pressure test:- Condenser
- Refrigerant suction pressure, Refrigerant Discharge pressure and Oil Pressure.
- Brine / chilled water inlet outlet design temperatures.
- Condenser Water inlet outlet design temperatures.

- Electrical Motor (Compressor motor) insulation test, RPM, voltage, current, full load and part load.
- Vibration and Noise level
- Chiller capacity test.
- Condenser capacity test.
- Brine / chilled water and Condenser Water flow rates
- Chiller part loads and full loads test.
- Chiller starting current and full load current test.

Water Pumps factory inspection and test as per IS, BS & relevant standards.

- Visual inspection.
- Pump MOC inspection and testing.
- Designed capacity test (discharge and head).
- Motor insulation test.
- R.P.M. of Pumps.
- Vibration and Noise level
- Starting current and running current test.

Pipes and valves factory inspection and test as per IS, BS & relevant standards.

- Visual inspection.
- MOC inspection and testing.
- Designed Pressure tests.

Thermal and acoustic Insulations factory inspection and test as per IS, BS & relevant standards.

- Visual inspection.
- MOC inspection and testing.
- Designed thermal resistivity.

14.10 TESTS AT MANUFACTURER'S WORKS

- All tests to be performed during manufacture, fabrication and inspection shall be agreed with the Client / Consultant's site representative prior to commencement of the work. The Tenderer shall prepare the details of the schedule and submit these to the Client / Consultant's site representative for approval. It must be ensured that adequate relevant information on the design code/standard employed, the manufacture /fabrication/assembly procedure and the attendant quality control steps proposed are made available to the Client / Consultant's site representative who will mark in the appropriate spaces his intention to attend or waive the invited tests, or inspections. Tenderer shall arrange inspection and factory witness test for screw chiller.
- A minimum of twenty-one days' notice of the readiness of equipment for test or inspection shall be provided to the Client / Consultant's site representative by the Tenderer (whether the tests be held at the Tenderer's of Sub-tenderer's works). The subject items should remain available for Client / Consultant's site representative inspection and test up to a minimum 10 days beyond the agreed date of witnessing the test. Every facility in respect of access, drawings, instruments and manpower shall be provided by the Tenderer and sub-tenderer to enable the Client / Consultant's site representative to carry out the necessary inspection and testing of the Plant.
- No plant shall be packed, prepared for shipment, or dismantled for the purpose of packing for shipment, unless it has been satisfactorily inspected, all tests called for have been successfully carried out in the presence of the Client / Consultant 's site representative or approved for shipment, or alternatively inspection has been waived.
- Functional electrical, mechanical and hydraulic tests shall be carried out on completed assemblies in the works. The extent of these tests and method of recording the results shall be submitted to, and agreed by, the Client / Consultant 's site representative in sufficient time to enable the tests to be satisfactorily witnesses, or if necessary for any changes required to the proposed programme of tests to be agreed.
- The Client / Consultant's site representative reserves the right to visit the Manufacturer's works at any reasonable time during fabrication of equipment and to familiarize himself with the progress made and the quantity of the work to date.
- Within 30 days of completion of any tests, triplicate sets of all principal test records, test certificates and correction and performance curves shall be supplied to the Client / Consultant's site representative.
- These test records, certificates and performance curves shall be supplied for all tests, whether or not they have been witnessed by the Client / Consultant 's site representative or not. The information given on such test certificates and curves shall be sufficient to identify the material or equipment to which the certificate refers and should also bear the Contract reference title.
- When all equipment has been tested, the test certificates from all works and site tests shall be compiled by the Tenderer into volumes and bound in an approved from complete with index and four copies of each volume shall be supplied to Client / Consultant 's T site representative.
- Stage wise inspection of equipment in factory in waived.

14.11 PERFORMANCE TESTS AT MANUFACTURER'S WOKS

- All equipment may be subjected to routine performance tests at the Manufacturer's Works in accordance with the relevant ANSI, ASME, ASTM, BIS standard including operating tests of complete assemblies to ensure correct operation of apparatus and components.
- Pumps, fans, compressor, and other rotating equipment shall be given full load tests, and run to 15% overspeed for 5 min to check vibration. Main and auxiliary gear boxes shall be subjected to shock load tests and a six-hour endurance run at rated speed and maximum torque.
- The Tenderer shall submit single line diagrams including the layout of the Plant together with the location of test instrumentation and the principal dimensions of the layout. All calculations to derive performance data shall be made strictly in accordance with format given in the approved standards. Any alterations or deviations from the approved standard test layout or formulae shall be subjected to the prior approval of the Client / Consultant's site Representative.
- The performance test shall be conducted over the full operating range of the pump to a closed valve condition and a minimum of five measurement points covering the full range shall be taken. Curves indicating Quality vs. Head, Quantity vs. Power absorbed, and Quantity vs. Pump efficiency shall be provided. In addition a curve of the NPSH required vs. Quantity shall be provided except when the suction conditions do not require this test. Any proposal for the omission of this test shall be to the approval of the Client / Consultant's site representative.
- On completion of the tests the Tenderer shall submit a report showing the test results obtained together with the curves corrected to the site operating conditions.

SECTION – XV - TESTING, ADJUSTING AND BALANCING

15.1 SCOPE

- Testing, adjusting and balancing of heating, ventilating and air-conditioning systems at site.
- Testing, adjusting and balancing of HVAC Hydronic system at site.
- Testing, adjusting and balancing of exhaust system at site.

Comply with current editions of all applicable practices, codes, methods of standards prepared by technical societies and associations including:

ASHRAE : HVAC Application.
SMACNA : Manual for the Balancing and Adjustment of air distribution system.

15.2 PERFORMANCE

- Verify design conformity.
- Establish fluid flow rates, volumes and operating pressures.
- Take electrical power readings for each motor.
- Establish operating sound and vibration levels.
- Adjust and balance to design parameters.
- Record and report results as per the formats specified.

15.3 DEFINITIONS

- Test : To determine quantitative performance of equipment.
- Adjust : To regulate for specified fluid flow rates and air patterns at terminal equipment (e.g. reduce fan speed, throttling etc.)
- Balance : To proportion within distribution system (sub mains, branches and terminals) in accordance with design quantities.

15.4 TESTING, ADJUSTING AND BALANCING (TAB) PROCEDURES

The following procedures shall be directly followed in TAB of the total system. Before commencement of each one of the TAB procedure explained hereunder, the contractor shall intimate the Client / Consultant's site representative about his readiness to conduct the TAB procedures in the format given in these specifications.

15.5 DESCRIPTION OF SYSTEM AND REQUIREMENTS

Adjust and balance the following system to provide most energy efficient operation compatible with selected operating conditions.

- All supply, return and outside air systems.
- All exhaust air systems.
- All brine / chilled water systems.
- All cooling tower (condenser) water systems.
- Emergency purge systems.

15.6 AIR SYSTEMS

15.6.1 Air Handlers Performance

The TAB procedure shall establish the right selection and performance of the AHUs with the following results:

- Air-IN DB and WB temperature.
- Air-OUT DB and WB temperature.
- Dew point air leaving.
- Sensible heat flow.
- Latent heat flow.
- Sensible heat factor.
- Fan air volume.
- Fan air outlet velocity.
- Fan static pressure.
- Fan power consumption.
- Fan speed.

15.6.2 Air distribution

Both supply and return air distribution for each AHU and for areas served by the AHU shall be determined and adjusted as necessary to provide design air quantities. It shall cover balancing of air through main and branch ducts utilizing telescoping probes of Electronic Rotating Vane Anemometers (Air Flow Hood with type)

15.6.3 The Preparatory Work

To conduct the above test, following preparatory works are required to be carried out including the availability of approved for construction shop drawings and submittals:

- All outside air intake return air and exhaust air dampers are in proper position.
- All system volume dampers and fire dampers are in full open position.
- All access doors are installed & are air tight.
- Grilles are installed & dampers are fully open.
- Provision and accessibility of usage of TAB instruments for traverse measurements are available.
- All windows, doors are in position.
- Duct system is of proper construction and is equipped with turning vanes and joints are sealed.

15.7 HYDRONIC SYSTEM BALANCING

- The Hydronic system shall involve the checking and balancing of all water pumps, piping network (main & branches), the heat exchange equipment like cooling and heating coils, condensers and chillers and cooling towers in order to provide design water flows.
- The essential preparation work, must be done by the HVAC contractor prior to actual testing, adjusting and balancing of HVAC system and ensure following :
    - Availability of co-ordinated drawings and approved submittals and system sketch with design water flows specified thereon.
    - Hydronic system is free of leaks, is hydrostatically tested and is thoroughly cleaned, flushed and refilled.
    - Hydronic system is vented.
- The contractor or his nominated TAB (Testing, Adjusting & Balancing) agency shall confirm completion of the basic procedures and prepare check lists for readiness of system balance.
- Check pumps operation for proper rotation and motor current drawn etc.
- Confirm that provisions for TAB measurements (Temperature, pressure and flow measurements) have been made.
- Open all shut-off valves and automatic control valves to provide full flow through coils. Set all balancing valves in the preset position, if these values are known. If not, shut all riser balancing valves except the one intended to be balanced first.

Balancing work for both Brine / chilled water System and Condenser Water System shall be carried out in a professional manner and test reports in the specified format shall be prepared and presented to the Client / Consultant's site representative for approval.

15.8 READINESS FOR COMMENCEMENT OF TAB

Before starting of any of the tests, the readiness to do so should be recorded as per the prescribed check list.

15.8.1 TAB INSTRUMENTS

- Air Measuring Instruments
  - ✓ For measuring DB and WB temperature, RH and dew point, microprocessor based TSI USA make VelociCalc Plus Meter, Model 8386, or equivalent shall be used. This instrument shall be capable of calculating the sensible, latent total heat flows, sensible heat factor and give printouts at site and have data logging/downloading facility.
  - ✓ For measuring Air velocity, DB temperature and Air volume, TSI USA make VelociCalc meter model 8345 or equivalent shall be used. It shall be able to provide instant print out of recorded Air volume readings.
  - ✓ Pitot tube.
  - ✓ Electronic Rotary Vane Anemometer TSI make or equivalent.
  - ✓ Accubalance Flow Measuring Hood TSI make or equivalent.
  - ✓ [All above instruments shall have NIST testification (US Institute of Science and Technology) Calibration Certificate]
- Hydronic Measuring Instruments - For measurement of water flow, differential pressure and temperature, CBI Measuring instrument (Tour & Anderson AB Sweden or equivalent) shall be used. The instrument shall have a built-in microcomputer capable of giving readings for pressure differential, flow rate and temperature.
- Rotation Measuring Instrument - Electronic Digital Tachometer.
- Temperature & RH Measuring Instrument - TSI VelociCalc model 8386 and VelociCalc model 8345 or equivalent.
- Electrical Measuring Devices - Clamp on Volt ammeter & Continuity Meter.
- Vibration and Noise Levels

Vibration and alignment field measurements shall be taken for each circulating water pump, water chilling unit, air handling unit and fan driven by a motor over 10 HP. Readings shall include shaft alignment, equipment vibration, bearing housing vibration, and other test as directed by the Client / Consultant's site representative. Sound level readings shall be taken at ten (10) locations in the building as selected by the Client / Consultant's site representative. The readings shall be taken on an Octave Band nalyzer in a manner acceptable to him. The contractor shall submit test equipment data and reporting forms for review. In order to reduce the ambient noise level the readings shall be taken at night. All tests shall be performed in the presence of Client / Consultant's site representative.

SECTION-XVI- DATA SHEETS

16.1 DATA TO BE FURNISHED BY TENDERER ALONG WITH OFFER FOR CHILLING MACHINES

DESCRIPTION	VENDOR SPECIFICATION
GENERAL:	
Make & Model	
Country of Origin	
Refrigerant Used	
Capacity - TR @ Tender Condition Chiller : 240 TR CHW in/out: 12 degC / 6 degC CDW in/out: 32 degC / 37 degC Fouling factor: Chiller side: 0.0005 FPS units Condenser side: 0.001 FPS units	
Capacity - TR @ ARI Condition	
COP and kW / TR @ Tender Condition	
COP and kW / TR @ ARI Condition	
No. of Compressors / Machine	
No. of Condensers / Machine	
No. of Chillers / Machine	
Overall dimensions (mm x mm x mm)	
Operating Weight - Kg	
Shipping Weight - Kg	
Overall IPLV @ ARI condition	
Part Load Characteristics – ARI condition	
100% Load	
75% Load	
50% Load	
25% Load	
Overall NPLV @ Tender condition	
Part Load Characteristics – Tender condition	
100% Load	
75% Load	
50% Load	
25% Load	
Minimum clearance required from adjacent Structures - m	

DESCRIPTION	VENDOR SPECIFICATION
Minimum clearance required between two Machines – m	
Whether any platform or pedestal required for Installation? If so, furnish details.	
Noise level at a distance of 1 m from the machine at intervals of 1 m along the perimeter - db	
Noise level when all the machines are working – db	
Finish details i.e., hot dip galvanized, Corrosion resistant etc.	
Whether factory fabricated?	
Is necessary Integrator with necessary hardware & software considered along with chiller package for integrating with CPM / third party BMS System	
COMPRESSOR – MOTOR UNIT	
Make & Model	
Compressor Type	
a. Whether hermetic or semi-hermetic?	
b. Whether Vertical or Horizontal Cylinder?	
Capacity at operating conditions - TR	
Total Power Consumption – KW	
Drive losses – KW	
Motor efficiency - %	
In put KW	
KW / TR	
Unloading Steps	
Capacity Control Type	
Electrical Characteristics	
Insulation Class	
Protection Class	
Motor Type	
Full current – amps.	
Starting current – amps	
Starter type	
Type and method of oil cooling	
CONDENSER:	

DESCRIPTION	VENDOR SPECIFICATION
Type of condenser (DX or Flooded)	
Water flow rate (gpm)	
Heat Rejection Capacity(BTU/Hr)	
Entering Water Temperature – Deg C	
Leaving Water Temperature – Deg C	
Fouling Factor	
Pressure Drop	
Material of Tube	
Tube OD - mm	
No of Passes	
Material of fin	
Test pressure - Kg	
CHILLER:	
Type of chiller (DX or Flooded)	
Shell OD – mm	
Overall length – mm	
Overall weight – Kg	
Number of tubes	
Tube OD – mm	
Nature of tubes (whether integrally finned or Whether tubes carry inserts)	
Length of tube between tube sheets	
Material of tube	
Material of shell	
Water side surface area - sqm	
Refrigerant side surface area - sqm	
Minimum operating charge of refrigerant – Kg	
Water Flow rate – lpm	
Leaving water temperature - deg C	
Entering Water temperature - deg C	
Refrigerant temperature - deg C	
Leaving temperature difference - deg C	
No. of passes	
Tube velocity - mps	

DESCRIPTION	VENDOR SPECIFICATION
Pressure drop – Kg/sqcm	
CONTROL PANEL	
How Many Chillers can it Handle?	
Is all the parameters, which are possible to view in the graphic screen mounted on chiller, are possible to view & modify from remote location?	
If yes, has it been included in the offer?	
Is necessary hardware & software required for integration included in the offer?	
UNIT MOUNTED STARTER	
Is unit mounted star delta starters included in the offer?	
Is additional features like circuit breakers and mechanical non-fused disconnects are included in the offer?	
ARI / Eurovent Certification	

16.2 DATA TO BE FURNISHED TOWARDS PUMPSETS ALONG WITH OFFER
VENDOR TO SUBMIT THE DATA SHEETS FOR EACH TYPE OF PUMP ALONG WITH PERFORMACE CURVE

DESCRIPTION	VENDOR SPECIFICATION
Make	
Model	
Origin	
Design Flow rate (gpm)	
Head (m)	
Pump Efficiency	
Motor Efficiency at duty point	
Motor Rating	
Rated Speed	
Motor Efficiency type	
Motor IP and Insulation Class	
Material of construction as per specification - indicate deviations if any	
Impeller make & type	
Weatherproof construction for pump and motor	
Is Logic Control Panel for Variable Pumping System included, wherever specified	
Is logic control panel compatible to hook up to CPM / BAS? If so necessary hard ware & software included in scope of work? What is the protocol considered for Integration? Is it suitable for Outdoor Installation	
Shipping Weight (kg)	
Operating Weight (kg)	

16.3 DATA TO BE FURNISHED BY THE CONTRACTOR FOR THE DOUBLE SKIN AHU'S

VENDOR TO SUBMIT THE DATA SHEETS FOR ALL THE AHUs ALONG WITH COIL SELECTION AND FAN PERFORMACE CURVE

DESCRIPTION	VENDOR SPECIFICATION
General	
Manufacturers name	
Model No	
Capacity – TR & Cfm	
Frame	
Material of frame	
Describe frame - panel joints	
Panel Insulation	
Material	
Panel thickness (mm)	
Inner skin thickness (mm) and coating (GSM)	
Outer skin thickness (mm) and coating (GSM)	
FAN AND FAN MOTOR :	
Make	
Type of fan	
Type of blades (i.e., whether forward curved or backward curved or aerofoil section)	
Air Delivery - cfm	
External Static Pressure (mm)	
Total Static Pressure - mm wg (to be considered at dirty condition)	
Maximum static pressure capability - mm wg	
Speed – rpm	
Type of motor	
Motor speed - rpm	
Motor efficiency	
Type of starter	

DESCRIPTION	VENDOR SPECIFICATION
Fan Noise Level?	
Whether impellor and shaft dynamically (and statically) balanced?	
Vibration level	
FILTER SECTION :	
Overall dimensions - mm x mm x mm	
Type of filter	
Media used	
Efficiency of filter (State the test method)	
Manufacturer's name	
Resistance of filter when clean-mm wg	
Maximum resistance of filter - mm wg	
Dust Holding Capacity (Per & Fine Filter) – gms	
Is the media cleanable?	
Is one set of commissioning filters considered in the Quote?	
COOLING COIL	
Please specify the type of Coils considered in the scope?	
Material of Construction for Coil / Tubes	
Material of Construction for Fins	
Is special quoting specified in the Specs for Fins considered in the Scope	
Is Moisture eliminator considered after coil section?	
What is the material of construction for moisture eliminator	
No of Rows	
Bypass Factor	
ENERGY RECOVERY WHEEL (wherever applicable)	
Make & Type	
Sensible recovery efficiency (%)	

DESCRIPTION	VENDOR SPECIFICATION
Latent recovery efficiency (%)	
Purge Section details	
Wheel Motor rating	
Air leak losses make up details	
SAFETY FEATURES	
Is safety switch (fan limit switch) considered in AHU?	
Physical properties	
Overall dimensions - mm x mm x mm	
Overall weight (kg)	
Is AHU suitable for Outdoor Installation? If so Weather Proof Canopy is Considered (Please refer where ever it is called)?	
OTHERS	
Is Mixing boxes considered in the scope	
Is SA / RA damper included in the scope	
Is Canvass connection at outlet included	

TECHNICAL SPECIFICATIONS
ELV & IBMS WORKS

CONTENTS

1.1 General Requirements

1.1.1 General Scope of Works:

Work to be performed under this contract consists of supply, installation, testing, commissioning & warranty of below listed system & equipment in other section of this document

- Intelligent Addressable Fire Alarm system - FAS
- IP Based Public Address System - PAS
- IP CCTV Surveillance System – IP CCTV
- Security Access Control System - ACS
- Parking guidance & Management system - PGMS
- Integrated Building Management System - IBMS
- Data Networking & Telecom system - ICT
- Integrated Command & Control System – ICCC

Intelligent Addressable Fire Alarm system - FAS:

- The proposed Fire Alarm System shall comply with NBC-2016 requirements & NFPA-72 standards.
- Analogue Addressable intelligent Fire Detection & Alarm System with Integrated Digital Voice Communication System is proposed.
- Multi-Criteria Detectors are proposed throughout the building. Heat / Thermal Detectors are considered in Kitchen area and car parking area. Special Application detectors like Duct detectors (AHU's Return air duct)/ Hydrogen Detectors (Battery Room) / Gas Leakage detectors (Gas Bank) considered.
- Modules like Manual Call Station, Input Monitor Module, Output Control Relay Modules are considered as per the requirement of project based on the application.
- Aspiration Smoke Detection system considered in IBMS Server Room and the same to be integrated with Fire Detection System, Gas Suppression System & BMS.
- Fire Alarm Panel is to be located in Ground Floor Fire Command Room (FCC Room) as per the guidelines given in NBC.
- Graphical User Interface with workstation is located in FCC Room as per the guideline given by NBC for ease of operation.
- Fire Alarm System to be integrated with Public Address System, Access Control System, HVAC System, Lift / Escalator, BMS within the building level.
- Fire Alarm System shall be interfaced with Integrated Command & Control System for centralized monitoring and ease of operation.

Fire Signages & Fire Suppression system

- Clean Agent based Gas Fire Suppression System: - Clean Agent system will be designed as per NFPA 2001:2018 and will be provided to critical room i.e. IBMS & ICCC server room.
- Fire Signages shall be provided as per NBC-2016.

Public Address System:

- The proposed Public Address System is complied with NBC-2016 requirements & EN-54 standards.

- IP Based Public Address System is considered. The Main Equipment's like IP Multi-Zone Controller, IP Based Digital Amplifiers, IP Based Microphone Console shall be connected through LAN / IP Platform (Backbone).
- Field Speakers to be interfaced through 2 wire communication methodology. However, the all the speakers shall be complied with EN 54 Certification
- Mapping Software and its Operator workstation shall be located in FCC Room.
- Public Address System shall be interfaced with Fire Alarm System, BMS within the building level and interfaced with Integrated Command & Control System under centralized monitoring and ease of operation.

Closed Circuit Television (CCTV):

- CCTV is considered here for building Surveillance Purpose. IP CCTV System is considered with latest market trend technology as per the site requirement and building application.
- All Cameras are considered here are combination of 5MP & 8MP (4K) resolution with latest CCTV Algorithm to monitor the building in terms of security surveillance aspects.
- Cameras are considered in all the critical room like IBMS server room, ICCC room, FCC room and all hub rooms, passage, lift, staircase, utility rooms, electrical rooms, HVAC Rooms, Car Parking Areas, Building External Perimeter etc. and the cameras shall be connected through LAN Network. The power shall be driven from Network Highspeed Switches through Power over Ethernet (PoE).
- Layer 2 Network PoE Switches shall be placed in Floor wise HUB Room and the same shall be connected to L3-Core Switch with redundancy through OFC Backbone.
- The storage retention is considered here with 90days with Server based / NAS based storages Array box for Main Server Recording and the 30days data retention for Failover Server Recording.
- All the cameras shall have edge-based analytics and they shall be enabled at the time of commissioning as per the tender requirement. Server based Analytics shall be considered if camera does not have edge-based analytics.
- CCTV Control & Monitoring station is considered in FCC Room and the Storage Devices, Servers with redundancy are considered in IBMS Server Room.
- All the CCTV cameras and the systems to be interfaced directly with ICCC System for centralized monitoring.

Security Access Control System:

- Access Control System considered here to secure the places to avoid the un-authorized entry to the building.
- Smart-Card based Access Control System is considered for Utility Rooms, Electrical Rooms, UPS Room, TIDCO Office Spaces, Entrance Control Equipment's, HVAC Rooms etc. within the building.
- Bio-metric based Access Control System is considered for Critical Rooms like HUB Room, TSP / ISP Room, IBMS Server Room, ICCC Room within the building.

- Master IP Based Access Controller is considered in each floor and the field equipment's shall be connected to Reader module and the reader module shall be interfaced with Master Controller.
- The Access control System is proposed for throughout the building and the same shall be interfaced through LAN connection to connect the backbone.
- Electro Magnetic Lock is considered as per the Door closure and related accessories with Cables, Conduits, Cable tray etc considered.
- Access Control System Server with Redundancy is placed at IBMS Server Rooms and Operator Workstation is placed at FCC Room / ICCC room.
- Access Control System Software with multiple features like General Access Control / Attendance & Monitoring / Vehicular Access Control / Visitor Management System / Canteen Management System is considered.
- The proposed Access Control System shall be modular and scalable in case any other module to be added for future services enablement with limited to OEM availability.
- Perimeter entry & exit security considered by using Boom Barrier & Automatic Number Plate Recognition for Vehicular Movement and the Physical security shall be done through Baggage Scanning, Door Frame Metal Detector (DFMD) and Manual Movement shall be monitored through Swing Barriers at Ground floor Entrance Foyer.
- Swing Barriers is considered in Ground Floor Entrance Foyer and the same shall be controlled / interconnected with Access Control System. Minimum number of required Smart Card is considered for Access Control System operation at this tender.
- The Swing Barrier shall have inbuilt QR code reader for enabling the access to the visitors. The QR Code shall be generated from access control software and the same shall be sent through Push/E-mail/Printable format.
- The access Control System Software and its features shall be interfaced with ICCC system for centralized monitoring.

Integrated Building Management System:

- Integrated Building Management System (IBMS) is considered for this project as per the requirement which will enable the building rated LEED – Platinum requirement.
- The proposed BMS DDC Controllers shall have compatibility to connect directly with cloud server for ease of operation. In case any failure shall be happened in physical server, the BMS – DDC Controllers shall push / pull the data from the Cloud Server and the operator shall be monitored / control the Building Operation through Cloud BMS Software Graphical Station.
- The following Sub-systems are considered under IBMS to control & Monitoring.
- Control & Monitoring of HVAC Lower & Higher side Equipment's with Energy Conservation.
- Control & Monitoring of Ventilation & Pressurization Panels

- Tenant energy consumption and Billing System by using BTU Meters / Water Meter / Gas Meter / Energy Meters etc.
- Monitoring of Firefighting & PHE System
- Monitoring of Electrical Systems like HT / LT Panels, DG, Transformers, Energy Meters, UPS, Solar System, EV Charging Station etc.
- Monitoring of Low Voltage System like Fire Alarm System & Aspiration Smoke Detection System, Public Address System, CCTV & Access Control System, Gas Suppression System and Critical Room System like Water Leakage & Rodent Repellent System.
- All the above system shall be interfaced with DDC Controllers through Hard wired and Open Control Protocol like BACNet / IP, Modbus, M-Bus, LonWorks and KNX lighting Control Protocols etc.
- IBMS Server with Redundancy is considered in IBMS Server Room to install the IBMS Server Software and the Operator workstation with Client Software is considered in FCC Room for ease operation.
- Cloud Server shall be subscribed by TIDCO, and the Software installation shall be done by Successful Contractor. The cost of the software shall be included in the BMS Software itself.
- DDC Panels are considered in utility rooms as per the requirement and the same shall be interfaced with LAN Connectivity to connect within the building Backbone.
- All the required Field Sensors, accessories with cables, conduits and Cable trays are considered to complete as per project requirement.
- Finally, the BMS shall be interfaced with ICCC Software for centralized monitoring purpose.

Data Networking & Telecom System (ICT):

- Integrated Data Networking & Telecom System has been proposed to provide the high-speed internet, telecom services to entire building.
- The proposed ICT system shall be survived the common networking facility for Data Networking, Telecom works, CCTV, Access Control System, BMS Works, Car Parking Guidance System, IP PA System etc. However, the ICCC Backbone has been considered as dedicated network in Layer-2(L2) to facilitate the required communication without drop.
- The networking topologies has been considered Layer-3 (L3) Core Switch (Fiber Link Switch) with N:N redundancy, Layer-2 (L2) PoE+ Switches with Copper Distribution and the same shall be connected with L3 switch through OFC backbone. However, the external networking shall be connected with industrial grade 8Port PoE+ Rugged Switches and the same shall be interlinked with above backbone through OFC.
- Passive Components like OFC Backbone, Copper Distribution is considered as per the Project requirement and its application.
- CAT6A Copper distribution is considered for all the nodes of Data Networking, Telecom works, CCTV, Access Control System, BMS Works, Car Parking Guidance System, IP PA System and ICCC. Also 25 years stability certification

shall be provided by the OEM for all Passive cabling components from field to Switching side. The certificate shall be issued to the name of Fintech Tower, TIDCO, Chennai.

- IPABX System proposed for telecom functional. The proposed System shall have combinational Analog & IP Telephonic System as per the project requirement.
- ICCC Network path shall be common for Building internal services and Overall Fintech City External Utilities networking.
- Analog telephonic system shall be connected with Multi-Pair Telephone Cables from MDF to IPABX Machine and field to MDF shall be CAT6A cable.
- The scope of works limited to provide Router, Network Management System, Switching Part, Passive Components Part as per the detailed BoQ.
- Finally, the ICT shall be interfaced with ICCC Software for centralized monitoring purpose.

Integrated Command & Control Centre (ICCC) System:

- Smart & Secure Integrated Command & Control Centre System is considered for this project as per the requirement which complies with the standards and regulations.
- The Integrated Command & Control Centre System is considered to monitor the centralised operations for the following sub-systems.
  a. External Infrastructure
     - Power Supply Distribution System and Street Lighting System
     - Water Supply System - Potable water, recycle water and irrigation water
     - Smart Metering for Utilities (Water, Electricity, Gas)
     - Sewerage System
     - Flood Management System
     - Solid Waste Management System
     - External Video Surveillance and Gate security System
  b. Building - Instrumentation & Control System
     - Integrated Building management System
     - CCTV Surveillance System
     - Security Access Control System
     - Intelligent Fire Alarm System
     - Public Address System
     - The considered Integrated Command & Control Centre consisting of 12 Nos of 42” 4K Resolution UHD Display Panel to visualize the entire building & external operations. The Display Panel shall be installed 4 (L) x 3 (H) matrix. However, the display panel shall require Videowall Software and Videowall Controller for customizing the Video Output. Refer Tender BoQ and Tender Specifications for more details of the requirement.
     - The considered Integrated Command & Control Centre Software is open platform protocol interface with other sub-systems as listed above.
     - The dedicated Server with redundant and its software for server and operator workstations are considered this project.

1.1.2 Noise Level & Sound Control

- All installed plant is to be reasonably quiet in operation. Preference will be given to equipment operating at low noise level
- Vibration isolators shall be installed as necessary to eliminate transmission of vibration
- During initial testing operation of the installation, contractor is to correct for any undue noise & to make any adjustment & modifications necessary for this purpose
- Noise/sound level in various areas due to operation of equipment shall not exceed the recommended standards by local authority or IS codes whichever is lower.

1.1.3 Permits & Fees

- Contractor shall be supplied the materials at site location with inclusive of all permits, taxes, levies, Custom duty, freight charges, packing and forwarding and insurance, charges incurred in connection with this sub-contract. GST and Other taxes and laws shall be applicable as per the general contract's terms and conditions of this MEP works Tender. There are no special contracts conditions shall be applicable for Instrumentation and control system.

1.1.4 Specification key notes

- This specification is intended to set out in general the minimum requirements & standards of installation for various units of equipment & work it covers. Provision set out or claim made in the successful tender which are in excess of or improved upon basic requirements of specification shall unless otherwise determined by client become part of requirements of specification whether or not they are subsequently incorporated in addenda to the specification.
- Client shall be the sole judge of what constitute an improvement upon or exceeds the requirements of specification.
- Specification shall be read in conjunction with tender drawings (as per drawing schedule) and are intended to be mutually explanatory and complimentary to one another. All works & specifications called for shall be fully executed & complied within totality.
- Entire system shall be engineered by contractor based on guidelines furnished in the specification, various codes / standards with good engineering practice.
- Specification also includes supply, erection & commissioning of spares as specified along with special tools & tackles.
- This document also makes it obligatory to contractor for arranging & obtaining necessary clearance / approval from all local / statutory authorities.
- It is not intent to completely specify all details of design & construction herein. Nevertheless equipment & installation shall confirm to high standard of engineering, design and workmanship in all aspects and shall be capable of performing continuous satisfactory operation & acceptable to purchaser as well as to various statutory authorities. In case of any violation of above contract, purchaser

reserves right to change / reject / modify the equipment / system during detail engineering.

- Supplies & services to be covered under this tender specification & conditions thereof are detailed in subsequent sections of specification. In case of conflict among various sections, subsections, documents, drawings same shall be referred to purchaser whose decision shall be final & binding to bidder.
- Successful bidders shall be submitted the OEM technical datasheet of all the items as mentioned in the Bill of Materials and highlight the considered parameters as per the tender specifications.
- The document shall be rejected without any reason if the parameters of technical datasheets are not highlighted. However, the technical requirement shall be complied with compliance document. Deviation shall not be accepted and same shall be rejected.
- The above submissions to be applicable for all IBMS & ELV Works (inclusive of ICCC).

1.1.5 Materials & Workmanship

- Unless expressed to the contrary all materials & equipment supplied by contractor shall comply with applicable Indian standards (I.S) or various codes or specifications with good practice as approved by Indian standards.
- Where a standard is referred to, that standard shall be latest published edition thereof, unless otherwise stated.
- All materials & equipments supplied shall be new & of best type for each particular purpose & of first quality with regard to design, manufacture & performance.
- Equipment & materials shall be suitably designed & constructed for safe, proper & continuous operation under all conditions described or implied in this specification without undue heat, strain, vibration, corrosion or other operating difficulties.
- Unless otherwise specified, equipment & materials within the scope of this specification shall be of a standard proven design. Design incorporating components which may be considered prototype in nature will not be accepted.
- Parts subject to wear, corrosion or other deterioration or requiring any adjustment, inspection or repair shall be accessible & capable of reasonably convenient for removal, replacement & repair. All such parts shall be of suitable material for keeping maintenance to a minimum.
- Equipment shall be designed to permit replacement of parts & ease of access during inspection, maintenance & repair.
- Vibration, noise, mechanical & thermal stresses & susceptibility to corrosion & erosion shall not be greater than with similar plant of first-class design & workmanship operating under similar conditions.
- All works shall be carried out in accordance with best engineering practice by experienced tradesmen of appropriate grades to the approval of Indian Standards.

- Where disagreement occur between drawings & specification or within either document itself, the item or arrangement of better quality, greater quantities, or higher cost shall be deemed to be included in this -contract.
- Successful contractor shall be submitted the Work method statement of ELV & IBMS works and it shall be approved by consultant prior to start the work at site.
- The same shall be applicable for all IBMS & ELV Works (inclusive of ICCC)

1.1.6 Submission of Shop Drawings

- Successful Contractor shall be referred the tender conditions for shop drawing submission. In addition to that, List of Supporting document along with drawing to be submitted as part of shop drawing submission. The same shall be applicable for all IBMS & ELV Works (inclusive of ICCC). The supporting document has been as followed each sub system drawing shall be provided separately with each equipment connection / loop connection / node connection / Horizontal Cable Tray layout / Vertical Riser Cable Tray Layout etc. Successful contractor may reach out consultant to get the clarification prior to proceed the shop drawing preparation.
  - Fire Alarm System:
    - ✓ Each Floor Shop Drawing with co-ordination of RCP.
    - ✓ Single line diagram / Schematic Layout of the project
    - ✓ Typical installation details of all the equipments as per the BoQ
    - ✓ Loop Calculation sheet with inclusive of available spares points
    - ✓ Legend to be marked in the Layout with each floor Quantity
    - ✓ Connection diagram of individual equipments with third party interface
  - Gas Suppression System
    - ✓ Isometric View of Gas Suppression System shall be submitted.
    - ✓ Single line diagram / Schematic Layout of the project
    - ✓ Typical installation details of all the equipments as per the BoQ
    - ✓ Fire detection layout shall be submitted along with Gas Suppression System Layout.
  - Public Address System
    - ✓ Each Floor Shop Drawing with co-ordination of RCP.
    - ✓ Single line diagram / Schematic Layout of the project
    - ✓ Typical installation details of all the equipments as per the BoQ
    - ✓ Zone Calculation sheet with inclusive of available spares points
    - ✓ Amplifier calculation details with spare wattage availability in each type of Amplifier
    - ✓ Legend to be marked in the Layout with each floor Quantity
    - ✓ Connection diagram of individual equipments with third party interface
  - Security Access Control System
    - ✓ Each Floor Shop drawing with cable connection from each device to Reader Module and Access Floor Controller
    - ✓ Single line diagram / Schematic Layout of the project
    - ✓ Typical installation / mounting details of all the equipments as per the BoQ

- ✓ GA Drawing for Swing Barrier / DFMD / X-Ray Baggage Scanner / Boom Barrier with required civil structural elements
- ✓ Power socket requirement needs to be submitted as a part of shop drawing

➢ IP CCTV Surveillance System
- ✓ Each Floor Shop Drawing with co-ordination of RCP. All the Communication cable measurement to be mentioned in the drawing itself.
- ✓ Each Cameras coverage details shall be indicated in the shop drawing itself with respect to the product selection. However, coverage details shall be complied with DORI (Detection, Observation, Recognition, Identification) as per the OEM specifications.
- ✓ Single line diagram / Schematic Layout of the project with storage device / server element / display element needs to be furnished.
- ✓ All type of Camera mounting diagram as per the BoQ
- ✓ Each Floor Camera Node details shall be submitted.
- ✓ Legend to be marked in the Layout with each floor Quantity

➢ Parking Guidance & Management System
- ✓ Each Floor Shop Drawing with co-ordination of RCP.
- ✓ Single line diagram / Schematic Layout of the project shall be furnished.
- ✓ All type of equipments mounting diagram as per the BoQ
- ✓ Each Floor Node details shall be submitted.
- ✓ Legend to be marked in the Layout with each floor Quantity

➢ Integrated Building Management System
- ✓ Each Floor Shop Drawing with DDC Tag Identification.
- ✓ Single line diagram / Schematic Layout of the project shall be furnished
- ✓ All Sensors / DDC / Enclosures mounting diagram as per the BoQ
- ✓ GA drawing of DDC Controllers, IO Modules and Enclosures Panel / Wiring diagram of each DDC Controller / Selection of IO Points with Spare details to be furnished.
- ✓ Control Schematic Layout with each IO tag details, and Cable schedule shall be submitted.
- ✓ Each Floor Node details shall be submitted.
- ✓ Legend to be marked in the Layout with each floor Quantity

➢ Data Networking & Telecom Services - ICT
- ✓ Each Floor Shop Drawing with each Node Identification.
- ✓ Single line diagram / Schematic Layout of the project shall be furnished
- ✓ All type of Rack distribution diagram / drawing shall be provided
- ✓ Each Floor Node details shall be submitted.
- ✓ Legend to be marked in the Layout with each floor Quantity
- ✓ Connection diagram of Network Topology / Telecom Topology from the Service Provider to field point shall be provided in detail in the shop drawing.

➢ Integrated Command & Control Centre - ICCC
- ✓ ICCC Room Layout shall be provided with placement of all equipment

- ✓ Videowall GA Drawing with Isometric view of videowall shall be provided with required power socket on shop drawing.
- ✓ Single line diagram / Schematic Layout of the project requirement with respect to Internal & External services of TIDEL Park, Madurai Project shall be detailed in the SLD / Schematic Layout.

➢ General Requirements

- ✓ Detailed Layout of IBMS Server Room, ICCC Server Room Layout and FCC / IBMS Room Layout with required Operator Station, power socket details, CCTV Display mounting Details, furniture's etc shall be submitted.
- ✓ External CCTV Cameras Mounting Poles GA Drawing and its required foundation details with proper structural elements, Outdoor type IP65 Enclosure mounting arrangement details shall be submitted.

1.1.7 Statuary Approvals

- All systems shall have proper listing and/or approval from internationally recognized UL - Underwriters Laboratories Inc, IS & NFPA standards.
- Fire alarm panel shall meet modular listing requirements of Underwriters Laboratories, Inc. Each subassembly, including all printed circuits. It shall also include appropriate UL modular label.
- This includes all printed circuit board assemblies, power supplies & enclosure parts. Systems that do not include modular labels may require to be returned to the factory for system upgrades & are not acceptable.

1.1.8 Supports From Building

- Suitable metal expansion devices shall be used where plugs are necessary for securing equipment, pipes, conduits & other fittings. Wooden plugs will not be allowed. Holes shall be drilled by electrical/ pneumatic rotary drills wherever possible.

1.1.9 Metrification

- All gauges & indicators shall be provided with scales marked in SI units as well as in relevant Imperial units.

1.1.10 Samples

Samples to be submitted by the contractor shall be for the following but not limited to:

- Fire Alarm System:
  Detectors / Modules / Cables / Conduits / Manual Pull Station / Hooter
- Public Address System:
  Speakers / Cables / Conduits
- Access Control System:
  Smart Card Reader / Smart Cards / Electro-Magnetic Lock / Emergency Door Release / Door Buzzer / Cables / Conduits
- IP CCTV Surveillance System:

All type of Cameras

- Car Parking Guidance System:
  Ultrasonic Detectors / Cables / Conduits
- Data Networking & Telecom System:
  CAT6A IO / RJ 11 IO / GI Box / Face Plate / CAT6A Cable / Patch Cord / OFC Cables / Conduits / Cable Tray
- Integrated Building Management System:
  All type of Cables / Conduits

In addition, contractor shall also submit any other samples as may be required by the project manager.

1.1.11 Identification & Labelling

- Complete identification & labelling shall be provided for various sections of the work in accordance with Building Control Division & other relevant authority's requirements & to the approval of consultants & project managers
- Additional requirements as requested by fire safety bureau to suit local conditions shall also be complied.

1.1.12 Work By Other Contractors

Following works will be provided by the other contractors:

- All required power supply shall be provided by Electrical Contractors to IBMS Contractor.
- HVAC integration Voltage Free Contact needs to be provided by HVAC System Contractor.
- Flow Switch & Zonal Control Valve connection needs to be done by Firefighting / Sprinkler System Contractor.
- Access Control System & BMS integration needs to be done by IBMS Contractor themselves.

1.1.13 Provision Of Works by Other Trades

- It shall be the contractor's responsibility to advice, check & confirm that the works listed above are provided to his requirements during the course of building construction. Failure on that part, contractor to ensure that any or all of these services are provided will result in contractor having to carry out the respective works at his own expense.
- Contractor shall liaise closely with all other trades for such provisions & communicate all his requirements well in advance & confirm to the construction program.

1.1.14 Testing & Commissioning

- Contractor shall allow in his tender, price for the cost of all acceptance tests required as hereinafter specified or as required by the authorities having jurisdiction over the installation.

- All water & electricity (temporary or permanent supply) used during the testing & commissioning of systems in this contract shall be borne by the civil contractor including supply, installation & dismantling of necessary piping & associated works.
- All pipe works which are to be encased or concealed shall be tested & approved before they are finally enclosed.
- Contractor shall give the Employer / Architect / Consultant Five (5) days' notice of his readiness to carry out acceptance test & shall submit for his approval a complete & detailed schedule of his tests to be carried out.
- Before commencement of acceptance tests, contractor shall have brought the installation to a state of practical completion & shall have completed all his preliminary testing & adjusted the equipment to its proper running order.
- During testing period no modifications, adjustment or other work on the installation shall be carried out without permission of the Employer / Architect / Consultant. Should there be any contravention of this requirement, the results of all tests completed may be rejected & a retest ordered.
- No acceptance test shall be carried out except in presence of Employer / Architect / Consultant, or the representative appointed for the purpose.
- If the installation fails to perform in accordance with the requirements of specification and/or authorities, Employer / Architect / Consultant may reject whole or any part of it.
- Testing period shall form part of the contract period & no extension of the time will be granted by reasons of any extension of testing period to permit rectification, modification, adjustment or retesting of installation except where testing has been delayed or retesting has been necessitated by circumstances beyond the control of the contractor.
- Contractor shall also be required to conduct all tests as & when requested by the authorities during the free maintenance and guarantee period.

1.1.15 Tools & Equipments

- A complete set of tools & equipment for maintenance shall be submitted to the approval of Employer / Architect.
- Tools & equipment shall be contained in a standing lockable metal cabinet. Two sets of keys shall be provided. Design of cabinet shall be submitted to the approval of Employer / Architect.

1.1.16 Operation & Maintenance

- Contractor shall train the employer's operating personnel in operation & maintenance of the premises.

1.2 Intelligent Fire Detection and Alarm System

1.2.1 System General Requirement

- The facility shall have an emergency voice alarm communication system. Digitally stored message sequences shall notify the building occupants that a fire or life safety condition has been reported.
- Message generator(s) shall be capable of automatically distributing up to eight (8) simultaneous, unique messages to appropriate audio zones within the facility based on the type and location of the initiating event.
- The Fire Command Center (FCC) shall also support Emergency manual voice announcement capability for both system wide or selected audio zones and shall include provisions for the system operator to override automatic messages system wide or in selected zones.
- The system shall support additional, alternate Fire Command Centers, which shall be capable of simultaneous monitoring of all system events. Alternate Fire Command Centers shall also support an approved method of transferring the control functions to an alternate Fire Command Center when necessary. All Fire Command Centers shall be individually capable of assuming Audio Command functions such as Emergency Paging, audio zone control functions, and Firefighter's Telephone communication functions.
- Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the Fire Command Center (FCC) and designated personnel in other buildings at the site via a multiplex communication network.

1.2.2 Scope of Works

- A new intelligent reporting, microprocessor-controlled fire and gas detection system shall be installed in accordance with the project specifications and drawings.
- Basic Performance:
- Alarm, trouble, and supervisory signals from all intelligent reporting devices shall be encoded on NFPA Class A Signaling Line Circuits (SLC).
- Device Circuits (IDC) shall be wired NFPA Class A as part of an addressable device connected by the SLC Circuit.
- Notification Appliance Circuits (NAC) shall be wired NFPA 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 Signaling 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.
- Speaker circuits may be controlled by NAC outputs built into the amplifiers, which shall function as addressable points on the Digital Audio Loop.
- NAC speaker circuits shall be arranged such that there is a minimum of one speaker circuit per floor of the building or smoke zone whichever is greater.

- NAC speaker circuits and control equipment shall be arranged such that loss of anyone (1) speaker circuit will not cause the loss of any other speaker circuit in the system.
- Two-way emergency telephone (Fire Fighter Telephone) communication shall be supported between the Audio Command Center and up to thirty (30) remote Fire Fighter's Telephone locations simultaneously on a conference in multiple FFT Risers.
- Means shall be provided to connect FFT voice communications to the speaker circuits to allow voice paging over the speaker circuit from a telephone handset.
- The digital audio message generator shall be of reliable, non-moving parts, and support the digital storage of up to 32 minutes of tones and emergency messages, shall support programming options to string audio segments together to create up to 1000 messages, or to loop messages and parts of messages to repeat for pre-determined cycles or indefinitely.
- The proposed product shall not restrict the buyer to one single organization, nor shall it require any proprietary dongle or other programming tools for after sales & maintenance activity.

1.2.3 Applicable Standards & Product Approvals

The specifications and standards listed below form a part of this specification. The system shall fully comply with the latest issue of these standards, if applicable.

- National Fire Protection Association (NFPA) - USA:
- Underwriters Laboratories Inc. (UL) - USA:

UL 268, 7th Edition	Smoke Detectors for Fire Protective Signaling Systems
UL 864, 10th Edition	Control Units for Fire Protective Signaling Systems
UL 2572	Mass Notification Systems
UL 217	Smoke Detectors, Single and Multiple Station
UL 228	Door Closers - Holders for Fire Protective Signaling Systems
UL 268A	Smoke Detectors for Duct Applications
UL 521	Heat Detectors for Fire Protective Signaling Systems
UL 464	Audible Signaling Appliances
UL 38	Manually Actuated Signaling Boxes
UL 1481	Power Supplies for Fire Protective Signaling Systems
UL 346	Waterflow Indicators for Fire Protective Signaling Systems
UL 1076	Control Units for Burglar Alarm Proprietary Protective Signaling Systems
UL 1971	Visual Notification Appliances
UL 2017	Standard for General-Purpose Signaling Devices and Systems
UL60950	Safety of Information Technology Equipment

- Factory Mutual – USA

- Local and State Building Codes.
- All requirements of the Authority Having Jurisdiction (AHJ). The system shall be listed by the national agencies as suitable for extinguishing release applications. The system shall support release of low-pressure Co2.
- The system shall be certified for seismic applications in accordance with the International Building Code (IBC). The basis for qualification of seismic approval shall be via shake table testing.
- The System shall be FM 6320 (Factory Mutual) approved as a Gas Detection system when employed with the 4-20 monitor module and industry standard 4-20 mA gas detectors.

1.2.4 Main Fire Alarm Control Panel (FACP)

- 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 smoke and thermal (heat) detectors, addressable modules, printer, annunciators, and other system-controlled devices.
- In conjunction with intelligent Loop Control Modules and Loop Expander Modules, the main FACP shall perform the following functions:
- Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.
- Supervise all initiating signaling and notification circuits throughout the facility by way of connection to addressable monitor and control modules.
- Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed.

System Capacity and General Operation

- The FACP shall communicate on a peer-to-peer, inherently regenerative communication format and protocol. The network shall support communication speed up to 100 Mbps and support up to 200 panels / nodes per network.
- The control panel shall be capable of expansion via up to 10 SLC loops. Each loop shall support 125 Detectors + 125 Modules / 159 Detectors + 159 Modules / Any Combination of 256 Detectors and modules in which including of 20% spare. 20% spares need to be considered in each loop as per the configuration of Manufactures specification. SLC Loops to be considered Max 1 or 2 per Floor as per the OEM product lines. Single loop cannot be considered for multiple floors. The Fire Alarm Control Panel shall include a full featured operator interface control and annunciation panel that shall include a backlit 600-character liquid crystal display, individual, colour coded system status LEDs, and QWERTY keypad / Larger LCD Touch Screen Keypad QWERTY style alphanumeric for the field programming and control of the fire alarm system. Said LCD shall also support graphic bit maps capable of displaying the company name and logo of either come owner or installing company.

- All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel.
- The FACP shall be able to provide the following software and hardware features:
- Pre-signal and Positive Alarm Sequence: The system shall provide means to cause alarm signals to only sound in specific areas with a delay of the alarm from 60 to up to 180 seconds after start of alarm processing. In addition, a Positive Alarm Sequence selection shall be available that allows a 15-second time period for acknowledging an alarm signal from a fire detection/initiating device. If the alarm is not acknowledged within 15 seconds, all local and remote outputs shall automatically activate immediately.
- Smoke Detector Pre-alarm Indication at Control Panel: To obtain early warning of incipient or potential fire conditions, the system shall support a programmable option to determine system response to real-time detector sensing values above the programmed setting. Two levels of Pre-alarm indication shall be available at the control panel: alert and action.
- Alert: It shall be possible to set individual smoke detectors for pre-programmed pre-alarm thresholds. If the individual threshold is reached, the pre-alarm condition shall be activated.
- Action: If programmed for Action and the detector reaches a level exceeding the pre-programmed level, the control panel shall indicate an action condition. Sounder bases installed with either heat or smoke detectors shall automatically activate on action Pre-Alarm level, with general evacuation on Alarm level.
- The system shall support a detector response time to meet world annunciation requirements of less than 3 seconds.
- Device Blink Control: Means shall be provided to turn off detector/module LED strobes for special areas.
- NFPA 72 Smoke Detector Sensitivity Test: The system shall provide an automatic smoke detector test function that meets the sensitivity testing requirements of NFPA 72.
- Programmable Trouble Reminder: The system shall provide means to automatically initiate a reminder that troubles exist in the system. The reminder will appear on the system display and (if enabled) will sound a piezo alarm.
- On-line or Off-line programming: The system shall provide means to allow panel programming either through an off-line software utility program away from the panel or while connected and on-line. The system shall also support upload and download of programmed database and panel executive system program to a Personal Computer/laptop. A single change to one CPU database shall not require a database download to other CPUs.
- History Events: The panel shall maintain a history file of at least last 4000 events, each with a time and date stamp. History events shall include all alarms, troubles, operator actions, and programming entries. The control panels shall also maintain

a 1000 event Alarm History buffer, which consists of the 1000 most recent alarm events from the 4000-event history file.

- Smoke Control Modes: The system shall provide means to perform Fire Smoke Control Station mode. This mode controls all dampers, smoke extraction fan, fresh air supply fans, etc during Fire condition. Smoke Control to meet NFPA-92A and 90B and HVAC mode to meet NFPA 90A.
- The system shall provide means for all SLC devices on any SLC loop to be auto programmed into the system by specific address. The system shall recognize specific device type ID's and associate that ID with the corresponding address of the device.
- Passwords and Users: The system shall support two password levels, master and user. Up to 9 user passwords shall be available, each of which may be assigned access to the programming change menus, the alter status menus, or both. Only the master password shall allow access to password change screens.
- Block Acknowledge: The system shall support a block Acknowledge for Trouble Conditions
- Sensitivity Adjust: The system shall provide Automatic Detector Sensitivity Adjust based on Occupancy schedules including a Holiday list of up to 15 days.
- Environmental Drift Control: The system shall provide means for setting Environmental Drift Compensation by device. When a detector accumulates dust in the chamber and reaches an unacceptable level but yet still below the allowed limit, the control panel shall indicate a maintenance alert warning. When the detector accumulates dust in the chamber above the allowed limit, the control panel shall indicate a maintenance urgent warning.
- Custom Action Messages: The system shall provide means to enter up to 100 custom action messages of up to 160 characters each. It shall be possible to assign any of the 100 messages to any point.
- Local Mode: If communication is lost to the central processor the system shall provide added survivability through the intelligent loop control modules. Inputs from devices connected to the SLC and loop control modules shall activate outputs on the same loop when the inputs and outputs have been set with point programming to participate in local mode or when the type codes are of the same type: that is, an input with a fire alarm type code shall activate an output with a fire alarm type code.
- Read status preview - enabled and disabled points: Prior to re-enabling points, the system shall inform the user that a disabled device is in the alarm state. This shall provide notice that the device must be reset before the device is enabled thereby avoiding activation of the notification circuits.
- Custom Graphics: When fitted with an LCD display, the panel shall permit uploading of a custom bit-mapped graphic to the display screen.
- Group Decision Making by Smoke Detectors: The system shall provide means to link one detector with minimum two more detectors in group decision making. The group of minimum three detectors shall work in tandem to take fast and genuine

alarm decision mitigating the risk of false alarm. There shall be no requirement of cross zoning or mandatory sequential address setting in the detectors to achieve this function. This shall be a built-in intelligence in the system to take fast & reliable decision on genuine alarm triggering. The alarm event shall be a result of group of detector chamber readings considered as a consolidated alarm signal.

- ACTIVE EVENT: The system shall provide a Type ID called FIRE CONTROL for purposes of air-handling shutdown, which shall be intended to override normal operating automatic functions. Activation of a FIRE CONTROL point shall cause the control panel to (1) initiate the monitor module Control-by-Event, (2) send a message to the panel display, history buffer, installed printer and annunciators, (3) shall not light an indicator at the control panel, (4) Shall display ACTIVE on the LCD as well a display a FIRE CONTROL Type Code and other information specific to the device.
- NON-FIRE Alarm Module Reporting: A point with a type of ID of NON-FIRE shall be available for use for energy management or other non-fire situations. NON-FIRE point operation shall not affect control panel operation, nor shall it display a message at the panel LDC. Activation of a NON-FIRE point shall activate control by event logic but shall not cause any indication on the control panel.
- Mass Notification Override: The system shall be UL 2572 listed for Mass Notification and shall be capable, based on the Risk Analysis, of being programmed so that Mass Notification/Emergency Communications events take precedence over fire alarm events.
- Security Monitor Points: The system shall provide means to monitor any point as a type of security.
- One-Man Walk Test: The system shall provide both a basic and advanced walk test for testing the entire fire alarm system. The basic walk test shall allow a single operator to run audible tests on the panel.
- All logic equation automation shall be suspended during the test and while annunciators can be enabled for the test, all shall default to the disabled state.
- During an advanced walk test, field-supplied output point programming will react to input stimuli such as Control by Event and logic equations. When points are activated in advanced test mode, each initiating event shall latch the input.
- The advanced test shall be audible and shall be used for Pull station verification, magnet activated tests on input devices, input and output device and wiring operation/verification.
- Control By Event Functions: CBE software functions shall provide means to program a variety of output responses based on various initiating events. The control panel shall operate CBE through lists of zones.
- A zone shall become listed when it is added to a point's zone map through point programming. Each input point such as detector, monitor module or panel circuit module shall support listing of up to 10 zones into its programmed zone map.

- Permitted zone types shall be general zone, releasing zone and special zone. Each output point (control module, panel circuit module) can support a list of up to 10 zones including general zone, logic zone, releasing zone and trouble zone.
- It shall be possible for output points to be assigned to list general alarm. Non-Alarm or Supervisory points shall not activate the general alarm zone.
- 1000 General Zones: The system shall support up to 1000 general purpose software zones for linking inputs to outputs. When an input device activates, any general zone programmed into that device's zone map will be active and any output device that has an active general zone in its map will be active. It shall also be possible to use general zone as arguments in logic equations.
- 1000 Logic Equations: The system shall support up to 1000 logic equations for AND, OR, NOT, ONLY1, ANYX, XZONE or RANGE operators that allow conditional I/O linking. When any logic equation becomes true, all output points mapped to the logic zone shall activate.
- 100 trouble equations per device: The system shall provide support for up to 100 trouble equations for each device, which shall permit programming parameters to be altered, based on specific fault conditions. If the trouble equation becomes true, all output points mapped to the trouble zone shall activate.
- Control-By-Time: A time-based logic function shall be available to delay an action for a specific period of time based upon a logic input with tracking feature. A latched version shall also be available. Another version of this shall permit activation on specific days of the week or year with ability to set and restore based on a 24-hour time schedule on any day of the week or year.
- Multiple agents releasing zones: The system shall support up to 10 releasing zones to protect against 10 independent hazards. Releasing zones shall provide up to three cross-zone and four abort options to satisfy any local jurisdiction requirements.
- Alarm Verification, by device, with timer and tally: The system shall provide a user-defined global software timer function that can be set for a specific detector. The timer function shall delay an alarm signal for a user-specified time period and the control panel shall ignore the alarm verification timer if another alarm is detected during the verification period.
- Secure/Access Operation:
  - The system shall have the capability of configuring input modules to monitor status of door contact or other security type sensors.
  - These input modules shall be able to be commanded from the normally ‘Secure’ state to an ‘Access’ state. While in the secure state, the module will transmit alarm conditions to the controller, which shall be annunciated on the LCD and LED displays.
  - The modules shall be placed into the Access state either through the LCD display or through predefined operator keys. While in the Access state, all alarms from the module will be shunted.

- Placing the module into the access state shall cause a discrete LED associated with input point to flash, but no other trouble or disable condition will be annunciated.
- Change from Secure to Access and reverse shall be transmitted to the central monitoring station on a per zone basis. Systems that cause or indicate a trouble or disable condition are unacceptable.

- The FACP shall be capable of communicating with a Distributed Control System

Central Processing Unit

- The Central Processing Unit shall contain and execute all control-by-event (including Boolean functions including but not limited to programs for specific action to be taken if an alarm condition is detected by the system. Such control-by-event programs shall be held in non-volatile programmable memory and shall not be lost with system primary and secondary power failure.
- The Central Processing Unit shall also provide a real-time clock for time annotation, to the second, of all system events. The time-of-day and date shall not be lost if system primary and secondary power supplies fail.
- The CPU shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems that require the use of external programmers or change of EPROMs are not acceptable.
- The CPU shall provide an RS-232 interface between the fire alarm control panel and the UL Listed Electronic Data Processing (EDP) peripherals.
- The CPU shall provide two RS-485 ports for the serial connection to annunciation and control subsystem components.
- The RS-232 serial output circuit shall be optically isolated to assure protection from earth ground.
- In the event of CPU failure, all SLC loop modules shall fallback to degrade mode. Systems not offering degrade mode shall offer Redundant CPU. Such degrade mode shall treat the corresponding SLC loop control modules and associated detection devices as conventional two-wire operation. Any activation of a detector in this mode shall automatically activate associated Notification Appliance Circuits.

Fire Alarm Panel Display

- The system display shall have 640 Character QWERTY keypad / LCD Touch Screen Keypad. It shall also provide eleven Light-Emitting-Diodes (LEDs) that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM, SECURITY, SUPERVISORY, SYSTEM TROUBLE, OTHER EVENT, SIGNALS SILENCED, POINT DISABLED, CONTROLS ACTIVE, and CPU FAILURE.
- These characters shall be only for fire alarm / trouble information and not for Logo or other purpose. It shall be UL Listed. Repeater panel displays in FACP is not allowed unless until approved by UL
- The system display shall provide QWERTY keypad / LCD Touch Screen Keypad for ease of operation.

- The keypad shall have control capability to command all system functions, entry of any alphabetic or numeric information, and field programming without the use of any external equipment or laptop. Two different password levels with up to ten (one Master and nine User) passwords shall be accessible through the display interface assembly to prevent unauthorized system control or programming.

Loop (Signaling Line Circuit) Control Module:

- The control panel shall be capable of expansion via up to 10 SLC loops. Each loop shall support 125 Detectors + 125 Modules / 159 Detectors + 159 Modules / Any Combination of 256 Detectors and modules in which including of 20% spare. 20% spares need to be considered in each loop as per the configuration of Manufactures specification. The Fire Alarm Panel must have a capacity of 3000 detectors & Modules in each Panel with inclusive 20% spares.
- The Loop Control Module shall contain its own microprocessor and shall be capable of operating in a local/degrade mode (any addressable device input shall be capable of activating any or all addressable device outputs) in the unlikely event of a failure in the main CPU.
- Each loop shall maintain 20% spare capacity for future expansion.
- The SLC interface board shall receive analog or digital information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular device. Each SLC Loop shall be isolated and equipped to annunciate an Earth Fault condition. The SLC interface board software shall include software to automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information may also be used for automatic detector testing and the automatic determination of detector maintenance requirements.

Network Communication

- The FACP shall communicate over a peer-to-peer communication network, inherently over a regenerative communication format and protocol. The network shall support communication speed up to 100 Mbps and support up to 200 Control Panels/ Network Nodes, over a single medium (copper conductor), redundant ring, communication channel for fire alarm, and telephone talk-back system. The system shall support up to 200 such networks in a single system.
- The network card shall have inbuilt Fiber port for terminating Fiber Optic Cable without any third-party converters.

Digital Voice Command Center / Firefighter Telephone Center

- The Digital Voice Command Center located with the FACP, shall contain all equipment required for all audio control, emergency telephone system control, signaling and supervisory functions. This shall include speaker zone indication and control, telephone circuit indication and control, digital voice units, microphone and main telephone handset.
- Function: The Voice Command Center equipment shall perform the following functions:

- Operate as a supervised multi-channel emergency voice communication system.
- Operate as a two-way emergency telephone system control center.
- Audibly and visually annunciate the active or trouble condition of every speaker circuit and emergency telephone circuit.
- Audibly and visually annunciate any trouble condition for digital tone and voice units required for normal operation of the system.
- Provide all-call Emergency Paging activities through activation of a single control switch.
- As required, provide vectored paging control to specific audio zones via dedicated control switches.
- Provide a factory recorded "library" of voice messages and tones in standard WAV. File format, which may be edited and saved on a PC running a current Windows operating system.
- Provide a software utility capable of off-line programming for the DVC operation and the audio message files. This utility shall support the creation of new programs as well as editing and saving existing program files. Uploading or downloading the DVC shall not inhibit the emergency operation of other nodes on the fire alarm network.
- Support an optional mode of operation with four analog audio outputs capable of being used with UL 864 fire-listed analog audio amplifiers and SLC controlled switching.
- The Digital Voice Command shall be modular in construction and shall be capable of being field programmable without requiring the return of any components to the manufacturer and without requiring use of any external computers or other programming equipment.
- The Digital Voice Command and associated equipment shall be protected against unusually high voltage surges or line transients.
- Fire, Voice & Telephone data shall flow through single network cable.
- The Voice Evacuation System shall be capable of establishing communication between the master voice controller and amplifier over fiber optic cable network without using any third-party media converter.
- Failure of Fire Panel CPU shall not affect the operation of DVC. In case DVC / Amplifiers are controlled by Fire Panel CPU, a separate panel with dedicated CPU shall be considered for each DVC & Amplifier.
- The Fire Fighters Telephone System shall be capable of having minimum 30 Telephones in conference in multiple FFT Risers

Power Supply Unit

- The Main Power Supply shall operate on 120/240 VAC, 50/60 Hz, and shall provide all necessary power for the FACP.
- The Main Power Supply shall provide the required power to the CPU using a switching 24 VDC regulator and shall incorporate a battery charger for 24 hours of standby power using dual rate charging techniques for fast battery recharge.

- The Main Power Supply shall provide a battery charger for 24 hours of standby using dual rate charging techniques for fast battery recharge. The supply shall be capable of charging batteries ranging in capacity from 7-200 amp-hours within a 48-hour period.
- The Main Power Supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.
- The Main Power Supply shall be power limited per UL864 requirements.
- The Main Power Supply shall communicate power supply, line voltage, battery status and charger status to the local LCD display. Any abnormal condition shall be annunciated and logged to the system alarm history log.
- The interface to the power supply from the Fire Alarm Control Panel (FACP) shall be via the Signaling Line Circuit (SLC) or other multiplexed means Power supplies that do not use an intelligent interface are not suitable substitutes. The required wiring from the FACP to the addressable power supply shall be a single unshielded twisted pair wire.
- The addressable power supply shall supervise for battery charging failure, AC power loss, power brownout, battery failure, NAC loss, and optional ground fault detection. In the event of a trouble condition, the addressable power supply shall report the incident and the applicable address to the FACP via the SLC.
- The addressable power supply shall have an AC Power Loss Delay option. If this option is utilized and the addressable power supply experiences an AC power loss, reporting of the incident to the FACP will be delayed. A delay time of zero, two, eight or sixteen hours shall be programmable.
- The addressable power supply shall have an option for Canadian Trouble Reporting and this option shall be programmable.
- The addressable power supply mounts in either the FACP back box or its own dedicated surface mounted back box with cover.
- Each of the power supply's four output circuits shall be programmed- for Notification Appliance Circuit or General Purpose 24 VDC power. Any output circuit shall be able to provide up to 2.5 amps of 24 VDC power.
- The addressable power supply's output circuits shall be individually supervised when they are selected to be either a Notification Appliance Circuit when wired Class "A" or by the use of and end-of-line resistor. When the power supply's output circuit is selected as General 24 VDC power, the circuit shall be individually supervised when an end-of-line relay is used.
- When selected for Notification Appliance Circuits, the output circuits shall be individually programmable for Steady, March Time, Dual Stage or Temporal.
- When selected as a Notification Appliance Circuit, the output circuits of the addressable power supply shall have the option to be coded by the use of a universal zone coder.
- The addressable power supply shall interface and synchronize with other power supplies of the same type. The required wiring to interface multiple addressable power supplies shall be a single unshielded, twisted pair wire.

- An individual or multiple interfaced addressable power supplies shall have the option to use an external charger for battery charging. Interfaced power supplies shall have the option to share backup battery power.

Controls with associated LED Indicators

- Emergency Two-Way Telephone Control Switches/Indicators
- The emergency telephone circuit control panel shall include visual indication of active and trouble status for each telephone circuit in the system.
- The telephone circuit control panel shall include switches to manually activate or deactivate each telephone circuit in the system.

Field Programming

- The system shall be programmable, configurable, and expandable in the field without the need for special tools. There shall be no firmware changes required to field modify the system time, point information, equations, or annunciator programming/ information. It shall be possible to program through the standard FACP keyboard all system functions.
- All field defined programs shall be stored in non-volatile memory. Two levels of password protection shall be provided in addition to a key-lock cabinet. One level shall be used for status level changes such as point/zone disable or manual on/off commands (Building Manager).
- A second (higher-level) shall be used for actual change of the life safety program (installer). These passwords shall be five (5) digits at a minimum. Upon entry of an invalid password for the third time within a one-minute time period an encrypted number shall be displayed. This number can be used as a reference for determining a forgotten password.

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 UL window and have a minimum of 9 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 0 to 60 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.

System Point Operations

- Any addressable device in the system shall have the capability to be enabled or disabled through the system keypad or Graphics User Interface.
- System output points shall be capable of being turned on or off from the system keypad or the video terminal.

- Point Read: The system shall be able to display the following point status diagnostic functions without the need for peripheral equipment. Each point shall be annunciated for the parameters listed:
  a. Device Status.
  b. Device Type.
  c. Custom Device Label.
  d. Software Zone Label.
  e. Device Zone Assignments.
  f. Analog Detector Sensitivity.
  g. All Program Parameters.
- System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 5000 system events. Each of these events will be stored, with time and date stamp, until an operator requests that the contents be either displayed or printed. The contents of the history buffer may be manually reviewed; one event at a time, and the actual number of activations may also be displayed and or printed. History events shall include all alarms, troubles, operator actions, and programming entries.
- The history buffer shall use non-volatile memory. Systems which use volatile memory for history storage are not acceptable.
- Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent system 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 below or above normal limits, then the system will enter the trouble mode, and the particular Intelligent Detector will be annunciated on the system display and printed on the optional system 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.
- The system shall include the ability (programmable) to indicate a "pre-alarm" condition. This will be used to alert maintenance personal when a detector is at 80% of its alarm threshold in a 60 second period.

System Maintenance Analysis and Reporting

- The system shall automatically track NFPA 72 installation and testing requirements for all addressable devices to ensure that every device is functionally tested upon installation and then periodically as required by the Code.
- If after twelve months any device has not been functionally tested a led shall illuminate on the CPU or Network annunciator indicating the device that needs testing.
- The system shall automatically track device testing to ensure that a visual inspection is performed at least semi-annually.
- If after six months a device has not been indicated as "visually inspected" a led shall illuminate on the CPU or Network annunciator indicating the device that needs testing.

- A hand-held IR tool may be used to interact with each SLC device to indicate that a visual inspection has been performed. The IR device will explicitly identify the device by loop and address to ensure the correct visual inspection has been performed.
- A comprehensive report shall be available from the laptop programmer which shows a predictive report of all devices that have upcoming testing requirements. These reports shall be configurable as either 30, 60 or 90 days predictive, status, and "all database"
- Systems that do not automatically track the individual testing requirements of the field devices will not be accepted.

1.2.5 System Components Head End

Active Network Repeater Panel

- An Active Network Repeater Panel shall be provided to display all system intelligent points. The Active Network Repeater Panel shall be capable of displaying all information for 200,000 points on the network. Network display devices, which are only capable of displaying a subset of network points, shall not be suitable substitutes.
- The Active Network Repeater Panel shall include a 10” (1024 x 600) Color touchscreen display / QWERTY Keypad. Additionally, the network display shall include environmental adjustment controls to maximize LCD legibility and the ability to scroll events by type. i.e. Fire Alarm, Supervisory Alarm, Trouble, etc.
- The network control annunciator shall have the ability to display multiple events in order of priority and time of occurrence. Counters shall be provided to indicate the total number of events by type.
- The Active Network Repeater Panel shall mount in any of the network node fire alarm control panels. Optionally, the network display may mount in a backbox designed for this use and shall connect to the network over either a wire or fiber interface.
- The network control annunciator shall have an event history buffer capable of storing a minimum of 1000 events in non-volatile memory. Additionally, the Active Network Repeater Panel shall have a fire alarm history buffer capable of storing a minimum of 200 events in non-volatile memory. Systems that do not protect fire alarm events from being overwritten by other events are not suitable substitutes.
- The Active Network Repeater Panel shall include Three USB connection, USB C, USB B Micro, and USB A, industry standard RS-232 ports for UL864 listed printers and CRT's. These peripheral devices shall print or display network activity.
- The network control annunciator shall include control switches for system wide control of Acknowledge, Signal Silence, System Reset, Drill, and local Lamp Test. A mechanical means by which the controls switches are "locked out", such as a key, shall be available.

- The Active Network Repeater Panel shall include long life LEDs to display Power, Fire Alarm, Pre-Alarm, Security Alarm, System Trouble, Supervisory, Signals Silenced, Disabled Points, Other (non-fire) Events, and CPU Failure.
- The network control annunciator shall include a Master password and up to nine User passwords. Each password shall be up to eight alpha-numeric characters in length. The Master password shall be authorized to access the programming and alter status menus. Each User password may have different levels of authorization assigned by the Master password.
- The Active Network Repeater Panel shall allow editing of labels for all points within the network; control on/off of outputs; enable/disable of all network points; alter detector sensitivity; clear detector verification counters for any analog addressable detector within the network; clear any history log within the network; change the Time/Date settings; initiate a Walk Test.
- The network control annunciator shall support an optional Windows based program utility. This utility shall allow the user to create an Active Network Repeater Panel database, upload/download an NCA database, and download an upgrade to the Active Network Repeater Panel executive. To ensure program validity, this utility shall check stored databases for errors. A compare function shall be included to identify differences between databases.
- For time keeping purposes the Active Network Repeater Panel shall include a time-of-day clock.

1.2.6 Network Control Station (NCS) / Graphics User Interface (GUI)

- The NCS / GUI shall utilize a Microsoft(tm) operating system. Each Network Control Station shall be capable of graphically annunciating and controlling all network activity and at least 2,50,000 network points. Network display devices that are only capable of displaying a subset of network points shall not be suitable substitutes.
- Operator workstation shall be recommended by Fire Alarm System OEM with minimum latest technology Operator Station shall be selected. However, the monitor size shall be 22” 4K Resolution.
- The NCS shall be capable of storing over 100,000 network events in a history file. Events shall be stored on hard disk and shall be capable of back-up storage to a tape drive. The history buffer allows the operator to view events in a chronological order. A filter shall be available for displaying chronological events by operator, date, time, fire alarms, troubles (including security, supervisory and system/device), disabled points/zones, system programming, operator response and operator log in/log out. The ability to print NCS history files shall also be available.
- The NCS shall use a Windows(tm) dialog box technology to address, interrogate, control, and/or modify intelligent points on each fire alarm node. This shall include, and not be limited to: Activating outputs, enabling or disabling points, adding or removing intelligent points, viewing intelligent detector sensitivity levels and

modifying point information (custom messages, detector type, verification, day/night selection etc.)

- The NCS shall include the ability to display system information in a graphical (floor plan) form. Each view, created using standard Windows bitmap files, shall include icons created for intelligent devices. These icons shall blink and change to the appropriate programmed icon when an event occurs. When the device has been acknowledged, the icon shall become steady. Once the point has returned to normal, the normal icon is displayed. In addition to the graphical representation of the device, the user shall be able to link pictures, documents and sound files to the device. The NCS shall also provide the ability to auto-vector to the floor plan (screen) of the device that is active. By selecting a device in the graphic presentation, the operator of the NCS shall have the ability to log onto the corresponding node and interrogate the associated intelligent point.
- The NCS shall have the ability to provide the following information through a Windows(tm) pull down menu: An Event Counter that contains the number of new and total events on the network. The information that is displayed shall consist of Fire Alarms, Pre-Alarms, Security Alarms, Supervisory Alarms, and Troubles. A Detailed Event window that contains all Off-Normal events, both unacknowledged and acknowledged that are present in the system. It shall contain two views, Fire events and non-fire events that shall be user selectable. A Current Event window that shall contain all network and local events as well as system messages with a maximum of 1,000 events displayed. A Disabled Device window that shall contain all disabled devices in the system.
- The NCS shall have the option, from a Windows pull down menu, to connect to a third-party paging service that allows the NCS to automatically send text-based messages regarding system status to a typical text pager.
- The NCS shall include help screens, available to aid the user without leaving the selected application screen.
- The NCS shall be UL-Listed for fire protection (UL864) and burglary (UL1076).
- The NCS shall interface with other panels as a node in the pear-to-pear network.
- The operator shall be able to monitor the FFT system from GUI software and shall be able to monitor and control Integrated Voice Evacuation System.
- The NCS shall have a flexible way of assigning operator passwords. There shall be an unlimited number of possible operators, each with specific levels of control. Each operator shall have his/her own password. Operator password and control selection shall be available to a high level "administrator" who shall have complete control over levels of control. If no action has taken place on the NCS after 10 minutes, the current operator shall be logged out and require a new log-in.
- The NCS shall include an industry-standard RS-232 port for a UL864 listed printer.
- The NCS shall be a tabletop hardware configuration.
- Interactive Firefighters' Touch Screen Display
- The network will interface and report the individually monitored system's alarm status via a user-friendly Graphical User Interface (GUI) based software.

- The software shall operate under Microsoft® Windows® 7 or Higher Operating System in Embedded platform as manufactured by Microsoft Corporation.
- The GUI based software must be capable of graphically representing the facility being monitored with floor plans and icons depicting the actual locations of the fire alarm device locations. It shall be capable of mapping at least 2,50,000 network points
- The software shall use a Full HD GUI display capable of showing a large primary floor plan display, a site plan representative of an aerial view of the facility, the first active fire alarm on the system.
- The software shall permit automatic navigation to the screen containing an icon that represents the first fire alarm device in alarm in the event of an off-normal condition.
- The fire alarm device icon shall be visible only when it is in an alarm (or active) condition.
- The software shall display the activated smoke detectors in a time sequence to track smoke progression.
- The software shall allow the importation of externally developed floor plans in Windows Metafile (WMF), JPEG (JPG), Graphics Interchange Format (GIF) and Bitmap (BMP) format.
- The software shall provide a intuitive and easy way to navigate to different screens representing floors and areas within a facility.
- The system shall provide for continuous monitoring of all fire alarm conditions regardless of the current activity displayed on the screen.
- The software shall display “YOU ARE HERE” along with icons representing standard building objects (stairs, elevators, etc) to be shown on the floor plan.
- The software shall allow icons that represent hazardous materials stored in a facility.
- The software shall provide a screen that displays pre-programmed building contact information.
- The software shall provide a screen the displays building occupancy and other general building information.
- The software shall allow a site plan to be imported that shows an aerial view of the facility.
- The software shall display all active fire, supervisory, and security events within an event list.
- Bidders also have the option to propose UL Listed Software with UL Listed Industrial Grade Hardware to achieve this functional requirement.

1.2.7 BMS Integration Gateway Module

- BACNet / ModBus Interface Gateway: The system shall be capable of being interfaced with BACNet / ModBus compliant clients. A BACNet / ModBus interfacing communication shall be available from the fire alarm control panel

manufacturer. BACNet / ModBus shall support group of panels with respective data points/ object points. BACNet / ModBus solution shall have UL listing.

- Webserver: The system shall support a webserver allowing remote connection via the Internet or Intranet. Authorized users will have the ability to view panel/network history, event status and device properties. The webserver shall also support sending event information via email or text to up to 50 registered users, the web server shall be available from the fire alarm control panel manufacturer.
- Web Portal Interface: The system shall be capable of being interfaced with a web portal to integrate with Inspection and Service Manager utilities. The web portal and inspection and service manager utilities shall be available from the fire alarm control panel manufacturer.

1.2.8 System Components Field End

Addressable Devices – General

- Addressable devices shall provide an address-setting means using rotary decimal switches/Dip switches/Auto addressing
- Addressable devices shall use simple to install and maintain decade, decimal address switches.
- Addressable devices, which use a binary-coded address setting method, such as a DIP-switch, are not an allowable substitute. Addressable devices that require the address be programmed using a special tool or programming utility are not an allowable substitute.
- Detectors shall be intelligent (analog) and addressable and shall connect with two wires to the fire alarm control panel Signaling Line Circuits.
- Addressable smoke and thermal detectors shall provide dual alarm and power/polling bi-colour LEDs. Both LEDs shall flash green under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady red illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.
- 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.
- Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72.
- The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base options 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 7 applications.

- The system shall also support an intelligent programmable sounder base, the programmable sounder base shall be capable of providing multiple tones based on programming and at a minimum be capable of providing a Temp-4 tone for CO (Carbon Monoxide) activation and a Temp-3 tone for fire activations and be capable of being synchronized with other programmable sounder bases and common area notification appliances; 85 DBA minimum.
- Detectors shall also store an internal identifying type of code that the control panel shall use to identify the type of device (PHOTO, THERMAL).
- Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.
- Addressable devices shall store an internal identifying code that the control panel shall use to identify the type of device.
- A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.
- Addressable modules shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep customized box. The Box shall be Mild Steel powder coated and finished in Red Colour.
- All the detectors like above false ceiling / True Ceiling / False Floor shall be mounted on 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep customized box. The Box shall be Mild Steel powder coated and finished in Red Colour.

Addressable Manual Pull Station (Push & Pull-down Type)

- Addressable manual call point shall 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 using a key.
- All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
- Manual fire alarm boxes shall be constructed of Lexan / ABS Plastic with clearly visible operating instructions provided on the cover. The word FIRE / Fire Sign shall appear on the front of the stations.
- The rate shall inclusive of all the accessories like backbox, Glands, Screws, Ferrules, Lugs etc. No additional cost shall be provided separately.

Intelligent Multi Criteria Detector (Multi-criteria Detector)

- The intelligent multi-criteria detector shall be an addressable device that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The detector design shall allow a wide sensitivity window, 0.5 to 4.0% per foot obscuration. This detector shall utilize advanced electronics

that react to slow smouldering fires and thermal properties all within a single sensing device.

- Designed to meet UL268, 7th Edition
- 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 can automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).
- The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal to react hastily in the event of a fire situation.
- It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.
- The rate shall inclusive of all the accessories like backbox for above false ceiling detector, below false floor detectors, Glands, Screws, Ferrules, Lugs etc. No additional cost shall be provided separately.

Intelligent Thermal Detectors (Heat Detector)

- The intelligent thermal detectors shall be 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.
- A high heat thermal detector rated at 190 degrees Fahrenheit (87.8 degrees Celsius) shall also be available. The thermal detectors shall connect via two wires to the fire alarm control panel signaling line circuit.
  - Modern profile with White colour for improved aesthetics.
  - Advanced thermal technology for fast response.
  - Fixed temperature model factory preset to 135°F
  - Rate of Rise model preset to 15°F/min
  - High temperature model factory preset to 190°F
  - Low standby current. 200 micro-Amps @ 24 VDC
  - Two-wire SLC connection.
  - Rotary, decimal addressing
  - Dual bi-colour LED design providing 360° viewing angle. LEDs blink green in normal condition and illuminate steady red on alarm
  - Remote test feature from the panel.
  - Walk test with address display
  - Built-in functional test switch activated by external magnet.
  - Built-in tamper-resistant feature.
  - Sealed against back pressure.
  - Optional relay, isolator, and sounder bases.
- The rate shall inclusive of all the accessories like backbox for above false ceiling detector, below false floor detectors, Glands, Screws, Ferrules, Lugs etc. No additional cost shall be provided separately.

Intelligent Duct Smoke Detector

- The smoke detector housing shall accommodate an intelligent photoelectric detector that provides continuous analog monitoring and alarm verification from the panel. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.
- The Intelligent Duct Smoke Detector shall support the installation of addressable Photo-electric detector capable or being tested remotely.
- The rate shall inclusive of all the accessories like backbox for above false ceiling detector, below false floor detectors, Glands, Screws, Ferrules, Lugs etc. No additional cost shall be provided separately.

Addressable Input Monitor Module

- Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panels SLCs.
- The IDC zone shall be suitable for Class A or Class B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
- The rate shall inclusive of all the accessories like backbox, Glands, Screws, Ferrules, Lugs etc. No additional cost shall be provided separately.

Addressable Output Relay Module

- Addressable Relay Modules shall be available for HVAC control and other network building functions
- The module shall provide two form C relays rated at up to 3 Amps resistive and up to 2.0 Amps inductive.
- The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary devices energize at the same time on the same pair of wires.
- For multiple relays control a module shall be available that provides 6 programmable Form-C relays.
- The rate shall inclusive of all the accessories like backbox, Glands, Screws, Ferrules, Lugs etc. No additional cost shall be provided separately.

Short Circuit / Fault Isolator Module

- Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B 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. At least one isolator module shall be provided for each floor or protected zone of the building.
- 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.
- If Isolator Bases are proposed, Vendor needs to consider Isolator base for all detectors
- Serially Connected Annunciator
- The annunciator shall communicate to the fire alarm control panel via an EIA 485 (multi-drop) two-wire communications loop. The system shall support two 6,000 ft. RS-485 wire runs. Up to 32 annunciators, each configured up to 96 points, may be connected to the connection, for a system capacity of 3,000 points of annunciation.
- An RS-485 repeater shall be available to extend the RS-485 wire distance in 3,000 ft. increments. The repeater shall be UL864 approved.
- Each annunciator shall provide up to 96 alarm and 97 trouble indications using a long-life programmable colour LED's. Up to 96 control switches shall also be available for the control of Fire Alarm Control Panel functions. The annunciator will also have an "ON-LINE" LED, local piezo sounder, local acknowledge and lamp test switch, and custom zone/function identification labels.
- The annunciator may be field configured to operate as a "Fan Control Annunciator". When configured as "Fan Control," the annunciator may be used to manually control fan or damper operation and can be set to override automatic commands to all fans/dampers programmed to the annunciator.
- Annunciator switches may be programmed for System control such as, Global Acknowledge, Global Signal Silence, Global System Reset, and on/off control of any control point in the system.
- An optional module shall be available to utilize annunciator points to drive RS-485driven relays. This shall extend the system point capacity by 3,000 remote contacts.
- The LED annunciator shall offer an interface to a graphic style annunciator and provide each of the features listed above.
- The rate shall inclusive of all the accessories like backbox, Glands, Screws, Ferrules, Lugs etc. No additional cost shall be provided separately.

Addressable Hooters with Built-in Strobe Light

- UL/FM/EN/VDS Listed and approved as per applicable codes
- The unit shall be wall/ceiling mounted, approved colour, suitable for operation on 12V/24V.
- The Strobe shall have multiple selectable candela settings configured and selected from the FACP.
- The Hooter cum Strobe unit shall deliver output up to 94 dB at 3m from its installed location & 15dB above ambient noise level for audible annunciation and 110 cd flashing at 1 Hz for visual indication.

- The sounder/strobe unit shall display the output level at the main control panel. Coordination or synchronization of the Strobes are required for both Audio signal & Visual Signal to comply with ADA (Americans with Disabilities Act) and distinctive signaling across the infrastructure. The required Sync modules to be considered by OEM as part of the overall system
- The sounder/strobe unit shall display the output level at the main control panel.
- Hooter and Strobe elements of the combined unit shall have independent activation & deactivation criteria. Hooter shall stop at alarm "Acknowledge" and the Strobe shall stop at panel "Reset" after normalization of Alarm condition
- Hooter with Strobe unit shall have provision to be tested by a hand-held field diagnostic tool. The Strobe shall have multiple selectable candela settings configured in the configuration Software / tool.
- The proposed Hooter cum strobe shall be addressable type. The contractor needs to consider additional modules if the product doesn't have inbuilt addressable option. No additional cost shall be provided by client for providing the additional modules.
- The rate shall inclusive of all the accessories like backbox, Glands, Screws, Ferrules, Lugs etc. No additional cost shall be provided separately.

Addressable Portable Emergency Telephone Handset Jack

- Portable emergency telephone handset jacks shall be flush mounted on stainless steel plates as indicated on plans. Handset jacks shall be approved for emergency telephone system application.
- Insertion of a remote handset plug into a jack shall send a signal to the fire command center which shall audibly and visually indicate the on-line condition and shall sound a ring indication in the handset.
- The two-way emergency telephone system shall support thirty-five (35) handsets online without degradation of the signal.
- Remote Telephone Handset shall be capable of making paging announcement across all the zones in the system.
- The contractor shall consider Phone Control module in which directly communicating to the Fire Alarm – Digital Voice Communication panel.
- There will not any additional cost shall be paid for any additional modules (input modules/relay module/control module) shall be required to interface with Fire Alarm – Digital Voice Communication Panel.
- The rate shall inclusive of all the accessories like backbox, Glands, Screws, Ferrules, Lugs etc. No additional cost shall be provided separately.

Addressable Fixed Emergency Telephone Handset

- The telephone cabinet shall be painted red and clearly labelled emergency telephone. The cabinets shall be located where shown on drawings.
- The handset cradle shall have a switch connection such that lifting the handset off of the cradle shall send a signal to the fire command center which shall audibly and visually indicate its on-line (off-hook) condition.

- The two-way emergency telephone system shall support thirty-five (35) handsets online (off hook) without degradation of the signal.
- Remote Telephone Handset shall be capable of making paging announcement across all the zones in the system.
- The contractor shall consider Phone Control module in which directly communicating to the Fire Alarm – Digital Voice Communication panel.
- There will not any additional cost shall be paid for any additional modules (input modules/relay module/control module) shall be required to interface with Fire Alarm – Digital Voice Communication Panel.
- The rate shall inclusive of all the accessories like backbox, Glands, Screws, Ferrules, Lugs etc. No additional cost shall be provided separately.

Batteries Backup for Fire Alarm Panels

- The battery shall have sufficient capacity to power the fire alarm system for not less than 48 hours in standby plus 2hours of alarm upon a normal AC power failure. The requirement shall be furnished as per the NFPA 72 latest edition.
- The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills, and leakage shall not be required.
- If necessary to meet standby requirements, external battery and charger systems may be used.

1.2.9 Aspiration Detection

System Description

- Aspiration detection system shall be proposed for “IBMS Server Room & ICCC Server Room”.
- System consists of highly sensitive laser-based smoke detector using aspirated air sampling & is connected to sampling pipes. It shall be provided with a single/multiple sample pipe inlet, internal flow monitoring, smoke detection & a facility for exhaust pipe connection. Reset, disable, test & fault determination functions will be available via field service access door. System configuration will be provided through Auto Learn Smoke & flow functions, also available via field service access door.
- It shall support pre-engineered sampling pipe network designs with verified calculations in addition to custom sampling pipe network designs using a computer-based design modelling tool. Sampling pipe material shall be UL 1887 approved for use in air sampling smoke detection systems.
- When required, an optional display unit shall be provided to monitor each detector, & a programmer shall be supplied to configure the system.
- Common hooter cum flasher will be installed in the floor to alert the security personnel in the event when any of the aspiration detectors comes into alarm mode.
- The Aspiration Smoke Detector shall be proposed from the same OEM of Fire Alarm System to facilitate with Seamless integration with Fire Alarm System. The additional Modules to be provided without any cost if the Fire Alarm System OEM

product does not have Aspiration Smoke Detector. However, the providing additional modules shall be used to interface with Fire Alarm Panel by taking all the levels of inputs from the Aspiration Detector. Potential Free Contract input / output interfacing with Fire Alarm Panel shall not be approved.

Aspiration Detection Approvals

- Aspiration system must be of a type submitted to, tested, approved and/or listed by a Nationally Recognized Testing Laboratory (NRTL) as follows:
  - UL (Underwriters Laboratories Inc), USA
  - ULC (Underwriters Laboratories Canada), Canada
  - FM (Factory Mutual), and FM approved for Hazardous Locations,
  - LPCB (Loss Prevention Certification Board), UK
  - Detector shall be installed to comply with following codes or standards:
  - Fire Industry Association (FIA), code of practice for design, installation, commissioning &maintenance of Aspirating Smoke Detector (ASD) Systems
- Need to install the aspiration panel at eye level, power supply unit enclosure with the battery back up to be installed just beside or closure to it. Power supply unit needed visible, not accepted in below false floor or above ceiling location.

Aspiration Detection Design Requirements

- Shall consist of a highly sensitive LASER-based smoke detector, aspirator, and filter
- It shall be modular, with each detector optionally monitored by a display featuring LEDs & sounder. System shall be configured by a programmer that is either integral to the system, portable or PC based.
- System shall allow programming of:
- Four smoke threshold alarm levels.
- Time delays.
- Faults including airflow, detector, power, filter and network as well as an indication of the urgency of the fault.
- Seven or more configurable relay outputs for remote indication of alarm and fault conditions.
- It shall consist of an air sampling pipe network to transport air to the detection system, supported by calculations from a computer-based design modelling tool.
- System shall be suitable of having a high-level interface with the building fire alarm system.

Aspiration Detection Performance Requirements

- Shall be tested & approved to cover up to 250 - 500m² (5,000 sq. ft) based on unit capacity.
- Shall be approved to provide very early warning smoke detection and provide four output levels corresponding to Alert, Action, Fire 1 & Fire 2. These levels shall be programmable and able to be set at sensitivities ranging from 0.005-20% obs/m (0.0015–6% obs/ft). For compliance to UL approval range is 0.0015-4% obs/ft.
- Shall report any fault on the unit by using configurable fault relay outputs & via suitable graphic software.

- Shall be self-monitoring type for filter contamination
- Shall incorporate a flow sensor in each pipe and provide staged airflow faults.

Aspiration Detection Detector Assembly

- Detector assembly in a mounting box shall consist of a highly sensitive laser-based smoke detector, an aspirator & a dual-stage filter cartridge.
- It shall have control switches for reset, disable, test & restricted access switches for alarm setup & flow setup.
- Detector shall be LASER-based type and shall have an obscuration sensitivity range of 0.005-20% obs/m (0.0015–6% obs/ft).
- Detector shall have individual illuminated indicators for:
- Four alarm levels (Alert, Action, Fire1& Fire 2).
- Fault (in detector, airflow, filter, system, zones network & power), Power & Disabled.
- Alarm Setup & Flow Setup.
- Detector shall have a front-panel, 10 segment, illuminated, coloured smoke dial for the purpose of indicating current smoke level and detector status.
- It shall have individual relay outputs for Fault, Action and Fire 1.
- Shall have a built-in provision of BACNet-IP / Modbus - RS-485 / RS-232 compatible serial control port for the purpose of configuration, control, status monitoring, event log extraction & upgrade.
- Detector shall have an interface card.
- Detector shall have four in-line sample pipe inlets and must contain a flow sensor for each pipe inlet. Both minor &urgent flow faults can be reported.
- Filter shall be a two-stage disposable filter cartridge. First stage shall be capable of filtering particles more than 20 microns from the air sample. The second stage shall be ultrafine, removing more than 99% of contaminant particles of 0.3microns or larger, to provide a clean air barrier around the detector's optics to prevent contamination and increase service life.
- Aspirator shall be a purpose-designed rotary vane air pump. It shall be capable of allowing for single / multiple sampling pipe runs with a transport time per applicable local codes. (Shall be less than 90 seconds)
- Assembly must contain relays for alarm & fault conditions. Relays shall be software programmable to the required functions. Relays must be rated at 2 AMP at 30 VDC. Remote relays shall be offered as an option and either configured to replicate those on the detector or programmed differently.
- Assembly shall be able to be surface mounted to a wall or recessed in the wall cavity (the unit may be inverted in either option).
- It shall have built-in event and smoke logging. It shall have separate event log storage for smoke levels, alarm conditions, operator actions and faults. Date & time of each event shall be recorded. Each detector (zone) shall be capable of storing up to 18,000 events.

Aspiration Detection Sampling Pipe

- Sampling pipe shall be smooth bore. Normally, pipe with an outside diameter (OD) of 25mm and internal diameter (ID) of 21mm should be used.
- Pipe material should be suitable for the environment in which it is installed preferably approved make CPVC pipes.
- All joints in the sampling pipe must be airtight and made by using solvent cement, except at entry to the detector.
- Pipe shall be identified as Air Sampling/Aspirating Smoke Detector Pipe (or similar wording) along its entire length at regular intervals not exceeding the manufacturer's recommendation or that of local codes and standards.
- All pipes should be supported at not less than 800mmdistance interval or that of the local codes or standards. Support stands sample need to take approval from Project in-charge, PMC. It should suit to site requirement & meet aesthetic requirement too.
- Far end of each trunk or branch pipe shall be fitted with an endcap & made air-tight by using solvent cement. Use of end vent will be dependent on calculations.

Aspiration Detection Sampling Holes

- Sampling holes shall not be separated by more than the maximum distance allowed for conventional point detectors as specified in the local codes and standards. Intervals shall be justified by calculations. For NFPA the maximum allowable distance is 30ft.
- Each sampling point port shall be identified in accordance with Codes or Standards.
- Consideration shall be given to the manufacturer's recommendations and standards in relation to the number of sampling points and the distance of the sampling points from the ceiling or roof structure and forced ventilation systems.

Aspiration Detection Programmers

- Programming shall be performed using a Windows® application running on a PC connected through a High-Level Interfacing unit.
- Each Programmer shall support the following features at a minimum:
- Programming of any device
- Viewing of the status of any device in the system
- Adjustment of the alarm thresholds of a nominated detector
- Setting of Day/Night, weekend, and holiday sensitivity threshold settings
- Initiation of Auto Learn™, to automatically configure the detector's alarm threshold settings to suit the current environment.
- Multi-level password control
- Programmable latching or non-latching relay operation
- Programmable energized or de-energized relays
- Programmable high and low flow settings for airflow supervision
- Programmable aspirator speed control
- Programmable maintenance intervals
- Facilities for referencing with time dilution compensation
- Testing of relays assigned to a specific zone to aid commissioning

Aspiration Detection Device Networking Requirements

- Devices in the smoke detection system shall be capable of communicating with each other via twisted pair RS485 cable. Network shall be able to support up to 200 devices (detectors, displays and programmers), of which 100 detectors can be supported.
- Network shall be capable of being configured in a fault tolerant loop for both short circuit and open circuit. Any communication faults shall be reported unambiguously & shall be clearly attributable to an individual device or wire link in the fault messages.
- PC based configuration tools shall be available to configure and manage the network of detectors. However, Software generated sheet shall be get approved by consultant prior to procure the materials.

Aspiration Detection Initial (Factory Default) Alarm Delay Thresholds

- Initial (factory default) settings for the alarm delay threshold shall be:
  - Alarm Level 1 (Alert) 10 seconds
  - Alarm Level 2 (Action) 10 seconds
  - Alarm Level 3 (Fire 1) 10 seconds
  - Alarm Level 4 (Fire 2) 10 seconds
  - Fault Alarm 05 seconds

Aspiration Detection Fault Alarms

- Detector fault relay shall be connected to appropriate alarm zone on the fire alarm control panel (FACP) in such a way that a detector fault would register a fault condition on the FACP. Minor fault & isolate relays shall also be connected to the appropriate control system.

Aspiration Detection Monitoring Software & Functionality

- Software shall support local and remote password-based access control.
- It shall have a user-friendly graphics user interface.
- Shall provide support for multiple languages including English,
- Shall have capacity to monitor multiple connections
- Shall enable one or more workstations to monitor & configure multiple detection systems in multiple rooms, floors/buildings.
- It shall provide an event list that provides a single integrated view of all events (faults/troubles and alarms) across multiple sites.
- Shall prioritize all events presented in the event list according to logical precedence rules.
- It shall allow management of all events from the event list including acknowledgement of events and resetting of devices.
- Shall allow colour to be assigned to different event types
- Software shall allow printing of event lists.
- Using standard RS485/232 ports or Ethernet on existing & future monitoring & control systems, PCs using the software shall connect to & interpret status change data transmitted from ports & provide graphic annunciation, control, history logging & reporting as specified herein.

- Network systems that cannot interface to network systems or systems requiring the use of a “dry contact” or “voltage monitoring” interfaces to connect to network systems shall not be accepted.
- Software shall be able to connect to multiple remote sites via IP-based LAN or WAN using virtual serial port emulation.
- It shall be compatible with 4 alarm levels:
- Alert (Alarm Level 1) – may be used to activate a visual & audible alarm in the fire risk area.
- Action (Alarm Level 2) – may be used to alert the security by visual display in the fire alarm panel located at the main lobby.
- Fire 1 (Alarm Level 3) – may be used to activate an alarm condition in fire alarm control panel to call the fire brigade & activate all warning systems.
- Fire 2 (Alarm Level 4) – may be used to activate a suppression system and/or other suitable countermeasures (e.g., evacuation action or shutdown of systems).
- Software shall allow importation of .wav files for event notification.
- Shall support sophisticated floor plan development and management functionality.
- Shall enable floor plan drawings to be used in software to graphically notify users where a smoke event is occurring in their monitored system.
- Software shall allow development of multiple levels of interconnected floor plans.
- Software shall allow importation of AutoCAD, jpg, bmp and other common image files.
- It shall include software to allow designers to create and manipulate CAD images for incorporation in meaningful context-sensitive multi-level floor plans.
- It shall allow for multiple device smoke trending on a single graph.
- Software shall support printing on a printer such as a line printer that supports Unicode.
- The software shall support sophisticated event log management functionality:
- Event logs from all networked detectors shall be able to be retrieved and viewed.
- Event logs shall be able to be archived and stored.
- All system, network and device events shall be stored in an ODBC-compliant database.
- A remote notification facility shall enable the use of email or SMS to provide immediate and up-to-date information the system’s operational status irrespective of location shall be achieved through auto dialer attached to.
- Software shall enable presentation of unique customized corporate response procedures upon occurrence of specific events in defined parts of the facility.

Aspiration Detection Power Supply & Batteries

- System shall be powered from a regulated supply of nominally 24V DC. Battery charger & battery shall comply with relevant codes, standards & regulations. Typically, 48 hours standby battery backup is required followed by 30 minutes in an alarm condition.
- Power supply unit enclosure need to mount near to aspiration panel, it should be visible, not accepted it below false floor or above ceiling.

Aspiration Detection Installation

- Detection system: Contractor shall install system in accordance with manufacturer's system design manual.
- Capillary Sampling Network
- Where false ceilings are installed, sampling pipe shall be installed above the ceiling & capillary sampling points shall be installed on the ceiling & connected by means of a capillary tube.
- Typical internal diameter of the capillary tube shall be 5mm or 3/8", maximum length of capillary tube shall be 8m (26 ft) unless manufacturer in consultation with the engineer have specified otherwise.
- Capillary tube shall terminate at a ceiling sampling point specifically designed and approved by the manufacturer. Performance characteristics of sampling points shall be taken into account during the system design.
- Air sampling pipe network calculations: Shall be provided by air sampling pipe network modelling program. Pipe network calculations shall be supplied with the proposed pipe layout design to indicate the performance criteria majorly transport time.

Aspiration Detection Submittals

- Product data & site drawings shall be submitted &it shall include pipe layout, operational calculations& performance criteria.
- A copy of manufacturer's installation, operation & maintenance manuals shall be supplied upon completion of installation.
- System commissioning data shall be supplied (in a format recommended by the manufacturer and per the instructions provided by the manufacturer) within 30 days of completion of the installation.

Aspiration Detection Commissioning Tests

- Contractor shall allow for the manufacturer's representative to attend commissioning of the entire installation in the presence of the owner and/or its representative.
- All necessary instrumentation, equipment, materials, and labour shall be provided by the Contractor.
- Contractor shall record all tests and system configuration and a copy of these results shall be retained on site in the System Logbook.

Aspiration Detection System Checks

- Visually check all pipes to ensure that all joints, fittings, bends, sampling points, etc., comply with the Specification.
- Check the system to ensure the following features are operational and programmed in accordance with the specification.
- Alarm threshold levels (for both day & night settings), Pipes in use, Detector address, Display address, Clock and date, Time delays, Air flow fault thresholds, Display buttons operable (Mode, Silence, Reset, Isolate), Referencing Units set to metric etc
- Check to ensure that all ancillary warning devices operate as specified.

- Check interconnection with fire alarm control panel, BMS to ensure correct operation.

Aspiration Detection Tests

- Perform the transformer cable burn test as recommended by OEM's, within 120 sec alarms should reach to aspiration panel.
- Verify that transport time from farthest sampling port does not exceed the requirements.
- Activate appropriate fire alarm zones & advise all concerned that the system is fully operational. Fill out the logbook & commissioning report accordingly.

Aspiration Detection Integration

- All aspiration detectors shall be integrated with fire alarm panel using interface module (Monitor module) so that fire alarm panel shall monitor & also display the location of aspiration panel.
- Aspiration panel shall be integrated with BMS through Modbus / BACNet.

1.2.10 Novec 1230 – Clean-Agent Fire Suppression System

General

- NOVEC 1230 is one the clean agents to replace Halon - 1301 in total flooding applications. Most notable property of this agent is an Ozone depleting potential (ODP) of zero.

Specification

- Contractor shall supply, install, test & put in operation Novec1230 based fire suppression system. Fire suppression system shall include and not be limited to gas release control panel, PESO approved seamless cylinders, discharge valve (with solenoid or pneumatic actuator) as the case may be, discharge pipe, non-return valve and all other accessories required to provide a complete operation system meeting applicable requirements of NFPA 2001 or ISO standards & installed in compliance with all applicable requirements of the local codes &standards.
- System design should be based on specifications contained herein, NFPA 2001 & in accordance with requirements specified in the design manual of agent. Bidder shall confirm compliance to the above along with their bid.

Design & Engineering

- NOVEC-1230 systems shall be designed taking minimum design concentration of 7.00% (0.6835kgm/m³) as applicable to class ‘A’ & ‘C’ risks.
- System design must consider limitations caused by void height. It should also consider temperature in the void. Vendor should clearly indicate the qty. of gas in "Kg" to be used for the system. All voids within each hazard shall be discharged simultaneously. Each hazard shall have an independent system, unless otherwise specifically stated, when a centralized system with directional valves can be used.
- System shall have a working pressure of 25bar.
- A fill density between 0.56 Kg / lt. to 0.85 Kg/lt. should be considered for agent to be discharged within the specified time of 10 seconds maximum.

- System engineering company should carry out the piping isometric design & validate the same with flow calculation generated by using agent's design software. Appropriate fill density shall be arrived at based on the same.
- Design & calculation shall be checked & certified by Manufacturer. Calculation is the only guarantee that system will work, provided system is installed exactly as per design. Contractor has to take into consideration routing available while designing the pipe network.

Novec Authentication

- A certification (from manufacturer of agent or their direct distributor) on authenticity with gas chromatography & quality of agent filled in the system procured should be submitted by the system engineering company.

Refilling & Maintenance

- In case of any leakage or accidental discharge of agent, it should be possible to refill cylinders in India itself. Contractor shall indicate source of refilling & time that will be taken for refilling & replacement.

Discharge Time

- Gas must be fully discharged within 10 seconds for effective quenching of fire as per the relevant standards; contractor has to ensure that design meets this requirement. Once the discharge takes place there should be warning signs restricting personal from entering the protected area until gas has been cleared from the area.

Materials & Equipments

- All materials & equipments shall be from approved manufacturers & shall be suitable for the performance of their respective functions. Cylinders should be complete with all accessories. Contractor shall indicate the dimensions of cylinders required for each area while quoting.

Cylinders

- Cylinder shall be high pressure, seamless steel gas cylinder, flat type, concave bottom as per IS 7285 complete with neck ring. Welded & cylinders without CCOE approval shall not be accepted.
- Each cylinder shall be seamless steel type manufactured from billets and tested in accordance with IS 7285.
- As per regulations of the Chief Controller of Explosives (CCOE) Nagpur, any system which has a working pressure above 19 bar (280 psi) will require the use of seamless cylinders that have been duly approved by the CCE, Nagpur.
- Maximum fill density of Novec gas in a cylinder shall not be less than 0.56 kg/lt. & not exceed 0.85 Kg/lt. of internal volume.
- Appropriate fill density shall be chosen based on the cylinder location & piping retrofit.
- Flow calculations should prove that fill density is appropriate & total discharge will take place within 10 seconds.
- Cylinders shall be super-pressurized with dry nitrogen to 25bar at 20°C. It shall be capable of withstanding any temperature between -30° C & 70°C.

- Cylinders shall be mounted according to manufacturer recommendations.
- Cylinders shall withstand hydrostatic test pressure up to 250 bar &maximum working pressure at 15°C shall be 150 bar.
- Cylinder/valve assembly shall have suitable metallic protection for valve enabling transportation of the filled cylinders safely.

Cylinder Valves

- Discharge valve shall be approved or listed. All the gaskets, O-ring, sealant & other valve component shall be constructed of materials compatible with the clean agent.
- System should be engineered using hardware approved for use with the systems. This would include main discharge valve, solenoid, check valve / non-return valve &pneumatic actuators.

Cylinder Valve Actuators

- In a single cylinder system cylinder shall have a solenoid operated actuator & a manual actuator incorporating a strike knob mounted on top of solenoid operated actuator.
- Multi cylinder systems shall have the same fitted on to master cylinder & pressure operated actuators fitted on each slave cylinder.
- All actuators shall be original OEM make only.

Hoses

- Each cylinder valve shall be provided with a plug-in type flexible rubber discharge hose of minimum 40mm size and shall with stand a test pressure as 52bar. Each hose shall be permanently marked with the test pressure and OEM's part number.
- Multi cylinder systems shall have an interconnect hose for each cylinder. Interconnect hose shall have a length not less than 700 mm and shall be labeled with the test pressure and OEM's part number.
- All hoses shall be original OEM make & locally manufactured hoses shall not be used.

Manifold With Check Valve

- Manifold shall be fabricated from ASTM A106 Schedule 80 seamless pipe & shall have integral check valves provided for each cylinder.

Other Accessories

- Electric control head, pressure operated control head; master cylinder adapter kit, flexible discharge hose, discharge nozzles & other required accessories shall be approved or listed for use with system. All gaskets, O-ring, sealant & other components shall be constructed of materials compatible with the clean agent.
- System should be engineered using hardware & accessories approved by Engineering System distributors of agent as mentioned in list of approved makes. Vendor shall submit detailed data sheets & drawings of each accessory with the required part no's and also common system data sheet containing these parts with part Nos.

Pipes & Fittings

- All pipes shall be of ASTM A-106, Gr: B, schedule - 40 seamless Carbon steel & fittings shall be as per ASTM A-105 standard. Distribution piping & fittings shall be

installed in accordance with manufacturer's requirements, NFPA 2001 & approved piping standards, guidelines.

- All distribution piping shall be installed by qualified individuals using accepted practices & quality procedures. All piping shall be adequately supported & anchored at all directional changes & nozzle locations.
- All piping shall be reamed, blown clear & swabbed with suitable solvents to remove burrs, mill varnish and cutting oils before assembly.
- All pipe threads shall be sealed with Teflon tape pipe sealant applied to male thread only.

Discharge Nozzle

- Nozzle shall control flow of gas to ensure high velocity, proper mixing in the surrounding air and uniform distribution of the agent throughout the enclosure.
- Number of nozzles & their positions must be chosen so that design concentration is maintained everywhere in the enclosure.
- Nozzle shall be located where they can be adequately supported on walls, ceiling or structural members.
- Software generated calculation supporting the nozzle design shall be submitted by the successful bidder before signing of contract.

Integration of Fire Detection, Gas Release Panel & Operation Process

- Gas release panel shall be a conventional panel with 04 zones specifically used for each protected zone/area.
- Addressable detectors which are in cross zone are linked to the main fire alarm panel for alert & triggering of gas release panel to release the agent in the event of fire.
- Gas release panel shall have the provision of integrating with BMS through RS-485 Modbus protocol.
- Some of the enhance features of detection cum gas release panel shall be:
- Disable / Enable control per input zone and output zone
- Display countdown timer before extinguishing release
- Adjustable pre-discharge, discharge & delay timers
- 4 programmable style B (Class B) IDCs (Initiating Device Circuit)
- Four programmable style Y (Class B) output circuits
- 80-character LCD display
- Manual release button for manual activation & abort circuit to cancel initiated release command
- Piezo sounder for alarm, trouble & supervisory
- Panel shall have built-in alarm, trouble, security & supervisory signals.
- Auto mode operation: Sequence of operation for gas release system shall be as follows.
- When both cross zoned detectors in the critical room connected to main fire alarm panel goes into alarm, it triggers the agent release panel, immediately sounder cum strobe shall get activated.
- Fire detection panel shall ensure that the access control shall get deactivated.

- First stage activation in the gas release circuit shall happen only when any one of the detectors in protected area goes into alarm.
- When first stage gets activated, specific zone number& detector location shall be displayed & panel buzzer shall start operating. Stage 1 bells shall be identified by fact that they pulsate at the rate defined by timer 1.
- Panel shall also illuminate "ALARM" lamp on the control panel face.
- Sounder cum strobe shall remain on until alarm is silenced in the panel. Panel shall return to normal only after fire alarm condition is cleared & a reset is performed in the panel.
- Second stage activation in gas release panel shall happen when the second detector (cross zoned detector) in the protected area goes into alarm in second stage or vice versa.
- AC units shall be deactivated. Panel shall also illuminate the "PRE-DISCHARGE" lamp on the control panel face
- When second stage is activated, second zone number & detectors location shall also be displayed on the panel & sounder shall be activated which is identified by a continuous tone. Stage 2 bells indicate that area is to be evacuated.
- Timer shall start to trigger the signal for gas release. Delay set time shall NOT exceed 60/120 seconds. It shall be possible to program the delay timing at site.
- During the delay time period, gas release can be aborted by activating the “Manual abort switch” mechanically. Countdown timer shall countdown till 10 second & stops. Once if the abort switch is released, timer shall start count down from 10 seconds.
- Releasing & pressing again the manual abort switch shall reset the countdown time to 10 seconds. A buzzer shall be activated when the abort switch is operated.
- After expiry of the timer, output from actuator output terminal of panel shall activate & operate solenoid valve in master cylinder. It is important to note that actuator output on panel shall be enabled only if automatic gas release mode is selected
- A gas sign board with lamp (located outside the protected area) shall also illuminate indicating that gas discharge has taken place
- Gas shall discharge into protected area within 10 seconds as stipulated in the NFPA 2001 guidelines (2004 edition).
- As long as both stages remain in alarm, output to solenoid shall be active. If at least one of two stage returns to normal as explained above, delay timer shall stop. Gas release shall not happen if delay is set to zero.

Manual mode operation

- Manual release shall happen in three ways. One through agent release panel, manual release station & manual release directly from cylinder.
- Manual release shall happen in such a way that, upon activation of manual release switch relay shall be sent to the electric actuator immediately to release gas/agent.
- Electric manual release (activated through the panel) shall be a dual action switch device which provides a means of manually discharging the suppression system from panel.

- Manual release station shall also be a dual action device requiring two distinct operations to initiate a system actuation.
- Manual actuation shall be capable of bypass time delay or shall have time delay depending upon client requirements. It shall be possible to program both at site and abort functions and shall cause all release and shutdown devices to operate in the same manner as if the system had operated automatically.
- Manual release station shall be located outside the room
- Manual release lever on master cylinder shall be activated by operating the lever; gas shall get released immediately. Abort function cannot be performed after activating the manual release lever.

Connection details

- Addressable detectors shall be installed in the protected room & connected to main fire alarm panel through cross zoning. Upon activation of these cross zoned detectors main FA panel shall send a signal to gas release panel for activating the suppression system after a preset time delay (time delay can be set in the gas release panel b/w 60/120 seconds & shall be programmable at site as per client requirement).
- Manual abort & release stations shall be connected to gas release panel. In addition, gas release panel shall have manual mode switch as explained above
- Local sounder shall be connected gas release panel
- Solenoid actuator shall be connected to gas release panel in the gas release terminal.
- Fire alarm panel shall ensure tripping of AC units before agent is released into the room.
- Monitor module shall be connected from main fire alarm panel to the gas release panel for alarm communication, fault status and gas release status of the gas release panel.
- Manual release units / stations: Shall be provided in a monitored/access-controlled space (i.e., inside BMS room) as indicated in drawings. Manual release unit casings shall be coloured YELLOW & shall be inscribed with the lettering "AGENT (NAME) MANUAL RELEASE POINT". Mounting heights for manual release units shall be agreed on site.

Abort units / stations.

- Abort switches, where provided, shall be located within a monitored/access-controlled space (i.e., inside & outside the room). Abort switch shall be of a type that requires constant manual pressure to cause abort, in all cases normal & manual emergency control shall override the abort function. Abort switch shall be clearly recognizable for the purpose intended.
- Abort units shall be momentary devices requiring constant pressure to maintain contact closure & shall be coloured RED & shall be inscribed with the lettering "AGENT (NAME) ABORT POINT". Mounting heights for abort units shall be agreed on site.

Room Integrity Test Procedure

- Work method statement for Room integrity test
- Before work start check the test clearance availability, check the cleanness of room.
- Check the door size, frame for tightness of door panels
- Check the dampers operation – close & open properly
- Check the room civil structure, gaps, and any holes in the wall/partition
- Check the power availability
- Check the holes/cut-outs all incoming cables, trays, pipes sealed properly
- Install the door panels at door frame
- Check all the panels are locked each other
- Connect the test fan to the calibrated meter
- Disconnect the GAS suppression system – provided for room
- Connect the power supply unit to the fan & meter and connect the input power supply 230VAC to power supply unit
- Switch ON the power and check the testing fan working
- Calibration software shall have the following data like client name, contact details, room volume, GAS quantity, GAS volume, area height from sea level, minimum protected height.
- Install the test fan on door panel, set the pressure in calibration meter and set the rings in door fans
- Switch ON the fan and take the reading and then switch OFF the fan
- Remove the fan and reinstall it in reverse direction
- Switch ON the fan and take the reading and then switch OFF the fan
- Fill all the readings in software, check the results.

Testing

- Contractor to share testing methods prior to carry out any test
- Puff test to be carried out for suppression piping by blowing air through the piping to make sure that all discharge nozzles are free from blockages.
- Leakage test to be carried out on suppression piping network pneumatically with nitrogen as a medium in a closed circuit for a period of 20 minutes at test pressure of 40 PSI (2.756 bar). Pressure drop shall not exceed 20% of test pressure at the end of 20 minutes.
- Room integrity/door fan test for all protected areas/zones at pressure of 25Pa for a retention time of 10 minutes. Test to be carrie0d out with the mixed air or circulation of air, testing to be carried out till successful result, before test contractor to synch with project execution team & if any openings observed, same to be closed. All test reports need to be submitted to project team & same shall be attached in handing over documents.
- Certificates related to cylinders, gas filling, Novec system accessories need to be submitted in handing over documents.

Documentation:

- System engineering company should prepare & submit along with bid documents, piping isometric drawing & support the same with flow calculation generated by

using the agent's design software. The calculations shall validate the fill density assumed by the bidder.

- Bidder shall submit copies of the datasheets of the hardware used in the system. The bidder shall also submit copy of PESO approval letter for the cylinder proposed to be used. These documents shall be attached to the bid.
- Bidder shall also submit calculations to evidence the qty of agent considered for the system.
- Vendor must submit, along with the supply invoice, a certificate of authenticity, for the agent from system engineering company duly checked & verified by distributor

1.2.11 Water Leakage Detection System

General

- This section covers water leak detection cables, detection modules, control panel & sounders.
- System is proposed to cover periphery flooring areas of IBMS Server Room, ICCC Server Room & ICCC Server Room nearby ICCC Server Room to intimate water/liquid presence in critical, highly sensitive areas
- Water leak detection System shall be integrated with BMS & designed to protect the air-conditioned premises & to alert the personnel about the leak.
- Events are clearly reported on LCD/LED display with full English language description of the nature of the fault in the panel.
- Control Panel for water leak can locate inside the same room that is being protected.

Control Panel

- Controller shall have built-in software to sense, receive & recognize the signals sent by sensor cables.
- Panel shall have 4 x 20 LCD displaying status of all water leakage sensors, door status.
- System shall be UL listed & manufacture shall be registered @ ISO 9001.
- In the event of any abnormal condition or malfunction, it activates an alarm that must be acknowledged physically & reset.
- In-built connectors shall be provided within the panel for interfacing hooters & RS 485 Modbus communication & potential free contacts for FAS integration.
- Panel shall be connected with UPS for 230 V AC 50Hz & shall be equipped with a 3-pin power supply cord with event logging facility.
- Accuracy of water sensing shall be at an interval of 0.5 to 1mt.
- Panel shall also have the feature of software of monitoring & generating reports along with LED display status for all zones.

Water Sensing Cable

- Water sensing cable shall be resistant to corrosion. It shall detect the presence of water-based liquids but shall not detect hydrocarbons.
- It shall be reliable to sense any conductive fluid & shall not create any false alarm on application of pressure on the cable.

- Cables shall be flexible & easy to maintain

Accessories

Jumper Cable Connection

- To connect between the sensor module and the sensing cable, jumper cable shall be used for the connections. Warning Labels shall be placed on the sense cable approximately every Three metres. All wire and cable shall be ISI approved.

Modular Leader Cable

- Modular Leader cable shall be a minimum 3 metres connection cable with one end prepared for connection to terminals in Control panel / module, and with socket-type plastic connector at other end to connect to the sensor cable / jumper cable.

Modular End Termination

- Terminates sensing circuit; has pin-type plastic connector. Required at end of sensing circuit and ends of all branches.

Modular Branch Connector

- Allows a “T” or branch in the sensing circuit. Has pin-type plastic connector to connect to cable from alarm module, two socket-type plastic connectors to connect branches. Wires the branches in series and adds a simulated length of 15 ft on each branch to make clear division between areas.

Tags

- High-visibility yellow tags to identify sensing cable and record mapped distance. Package contains a permanent marker. Tag attaches to sensing cable by sticking on itself. Use a tag on each length of cable and at mapping points.

Hold-down clip

- Hold-down clips to attach sensing cables to flat surfaces. Hold-down clips shall be used to fix the sensing cables for everyone (1) meter or where deem necessary.

Panel Security

- The System Monitoring Panel shall provide security to the user or administrator via password access.

Power

- The System shall be powered by 230 +/- 15% VAC, 50/60 Hz single phase. It shall be provided with the option to be powered by 12 to 24Vdc or Vac source (if required).

Execution

- All System components shall be installed in accordance with the manufacturer's installation instructions, drawings, and local code requirements.
- Sensing cable shall be installed after all piping, air conditioning, raised flooring, and other mechanical work has been completed. The sub floor sensing cable path shall remain clear of water, oil, solder, flux, dirt, or other materials that may spoil the sensing cable.
- Sensing cable shall be installed beneath the raised flooring, around the perimeter of all rooms, a maximum of three feet from the outside wall. Route the sensing cable a minimum distance of three feet beyond the perimeter of all A/C units.

- In addition, lay the cable in a serpentine pattern, on 4–8-foot minimum centers, to protect interior surface areas where water sources are found, such as A/C unit, CPU piping, floor drains, chillers, etc. (optional)
- Cable should be installed under the center of floor tiles to facilitate access to, and visual location of, leaks. Sensing cable shall be secured to the sub floor with plastic hold-down clips) on approximately six-foot intervals.
- Cable installer shall be responsible for installation of the sensing cable, functional testing, and mapping of the system.

Testing

- Upon completion of the system installation, a factory pre-connectorized, five foot long, water-sensing cable shall be temporarily installed at the far end of each leak detection circuit.
- Sensing cable shall be immersed in approximately one foot of water, at a depth of 1/8 inch, to confirm that an audible alarm is generated at the alarm module and that the appropriate distance to the leak is displayed. The installer shall perform and certify the tests in the presence of the owner's representative.
- A graphic display map, prepared from “as- built” drawings, shall be furnished upon completion. The map shall indicate the location of the sensing cables, landmarks such as equipment, A/C units, walls, floor drains, change of cable direction, and cable distance readings. The map shall be mounted next to the alarm and locating module.

1.2.12 Rodent Repellent System

General

- This section covers rodent repellent system with controller, transducers
- Manufacturer shall have an IDEM & CFTRI certification.
- Rodent repellent system considered for following areas & all voids (Ceiling Void, Room Void, Floor Void)
  - UPS Room & Battery Room
  - IBMS and ICCC Server Room
  - ISP & TSP Rooms
  - HUB Rooms (all floors)

Controller

- Controller shall support 20 Transducers & shall come with a pair of stands & brackets. The controller is installed in the respective rooms & the transducers in the problematic areas i.e., room voids, below false flooring & above false ceiling.
- Each controller shall cover 7200 Sq feet of area with 20 transducers covering 300sft coverage each (considering room void areas of 10ft high).
- Controller shall have LCD display with on-board controls for changing the following parameters like wave speed, wave density, frequency testing, transducer testing.
- It shall automatically operate at minimum 3 different frequency bands & the time of operation of each band can be set at controller.

- Controller shall provide 5 different values for the wave speed parameter which is an indicator for the number of frequency sweeps per minute. The 5 wave speed values shall be 90, 100, 110, 120 and 130/ frequency sweeps per minute.
- It shall have RS/ EIA 485 feature to transfer the controller data to the serial port of IBMS computer up to a kilometre apart.
- Controller shall be password protected.
- Controller shall be equipped with a 3-pin power supply cord of 1.5meters and each controller shall be provided with of 5A electrical plug points.
- Standard 2core, flexible (14/40) SWG multi-stranded CT wires of 275 meters shall be used for connectivity between the transducers and the master console.

Transducers

- Transducers shall be circular ceiling mounted low profile units that produce high decibel sound waves at very high frequency not less than 20 KHz.
- These transducers shall cover an area not less than 300 Sq. ft for Room void application, & 200 Sq. ft for ceiling Voids & floor void applications.
- These shall be powered thru main Controller to 20 satellites in parallel (i.e. no looping of satellites).
- Transducers shall have pre-tuned operating frequency band of > 20 KHz and <60 KHz.
- Power output per transducer shall be 800mW.

Stand

- Powder coated MS stand accessory for mounting of the master controller.

Cables

- Standard 2 Core, 0.5 sq.mm, Flexible (14/40) SWG multistranded cable, specially coated CT Wires, for connectivity between the transducers and the master console / as per OEM Standard along with MS conduits.

1.2.13 Fire Alarm System & PA System Cables

- The wiring shall be PVC insulated 2 core 1.5 Sq mm FRLS shielded copper Conductor stranded cables Outer sheath in red Colour and generally confirming to IS-694-2010 and meet the signal cabling requirements.
- The strand of cables shall not be cut to accommodate & connect to the terminals. The terminals shall have sufficient cross-sectional area to take all the strands.

1.2.14 Electrical Power Supply

- Power Supply Source: At-least two independent and reliable power supply shall be provided, one primary and one secondary, each of which shall be of adequate capacity for application.
- Primary Power Supply: A dedicated branch circuit from power supply source with independent MCB shall be provided near to control panel in form of sockets. The circuit shall be mechanically protected by means of conduit. The power supply shall provide sufficient power to panel. It shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.

- Secondary supply: It shall be in the form of storage batteries of sufficient capacity and ratings to operate fire alarm system. The Contractor shall submit necessary calculations for both alarm and supervisory power requirements. The power supply shall be capable of operating the system under quiescent condition (non-alarm condition) for minimum of 24 hours and then shall be capable of operating the system during fire condition for a period of 30 minutes at maximum connected load.
- The battery charger shall charge the system batteries up to 200 AH batteries within 48 hours. Battery charging shall be microprocessor controlled and programmed with a special software package to select charging rates and battery sizes. A thermistor for monitoring battery temperature to control charging rate shall be provided. Transfer from AC to battery power shall be instantaneous (within 10 seconds) when AC voltage drops to a point where it is not sufficient normal operation.

1.2.15 Installation

- Installation shall be in accordance with the NBC-2016, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.
- All conduit, junction boxes, conduit supports, and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.
- 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.
- Manual fire alarm boxes shall be suitable for surface mounting or semi-flush mounting as shown on the plans and shall be installed not less than 42 inches (1067 mm), nor more than 48 inches (122 mm) above the finished floor.

1.2.16 Cable trays and accessories

- Cable trays if used, shall be Hot dip Galvanized GI Perforated type as specified complete with matching fittings (like brackets, elbows, bends, tees, crosses, etc.) accessories (like side coupler plates, etc. and hardware (like bolts, nuts, washers, G.I. strap, hook etc.) as required.
- GI Cable trays shall have standard width of 100 mm, 225 mm & 300 mm standard lengths of 2.5 meter. Minimum thickness of mild steel sheets used for fabrication of cable trays and fittings shall be 2 mm. The thickness of side coupler plates shall be minimum 3 mm.
- Cable troughs shall be required for branching out few cables from main cable route. These shall be U-shaped, fabricated of mild steel sheets of minimum.

1.2.17 Interfaces as per Fire Alarm Cause & Effect (C&E) Matrix

- Fire Alarm System Interface with third party Systems at Main Fire alarm Control Panel (FACP) in Fire Control room in Podium1.
- Necessary wiring, relay, contacts etc. required for interfaces with 3rd party shall be provided by Contractor as per Fire Alarm Cause and Effect (C&E) Matrix.
- Fire Pump Status: Each fire pump shall have status indication for power failure, pump running status. An audible trouble signal shall sound until acknowledged and automatically restored. The running condition of pump shall be permitted to be alarm condition whereas all other status of pumps shall be permitted to be supervisory condition.
- The operation of water flow switch shall be permitted to cause an alarm condition at control panel.
- The operation of Valve supervisory switch and pressure switches shall be permitted to cause supervisory condition at control panel.
- Gas Suppression system activation: On activation of 1st Knock Spot type fire alarm detectors in particular zone/area, there will be LED activation of gas release module in Fire alarm panel.
- On activation of 2nd Knock Spot type fire alarm detectors in the zone/area, Gas release module time delay of 60 secs will start, after which gas to be discharged for the specific zone/room unless Abort is pressed.
- Gas discharge is performed by activation of Zone Gas release valves through Gas release modules.
- Stair Pressurization: Within a given zone, an automatic sprinkler system water flow switch, an open area smoke detector outside a pressurized stairwell shall activate the stair pressurization systems for that zone.
- Access control Door Release: Within a given zone, an automatic sprinkler system water flow switch, spot type detectors activation shall release/deactivate the associated access control door.
- Wiring from Fire alarm Control relay module to Door Access controller shall be done by the Fire alarm Contractor.
- Public address system announcement: Within a given zone, One or Two spot type detectors activation shall activate the announcement of public address system through Control relay modules, as per defined C & E Matrix and with or without delay, as configured.
- In case of fire, Voice Evacuation System to relay evacuation message on specific floor and alert message on two floor above & one floor below immediately as per C&E matrix.
- Emergency Power Status: LED with trouble indicate / ion and buzzer will be activated when the system goes to “emergency” source power.
- Elevator Recall for Fire fighter services at Ground floor: The Ground floor recall shall be activated on alarm by a detector of floor. On activation of detector of floor, all lifts will park at ground floor for further use by Fire fighters.

- FAS system shall interface with Building Management System for monitoring in BMS through BACnet / IP Protocol.

Note:

- FAS System needs to be configured as per Client initial requirements during the project stage. However, the vendor may have to modify the configurations & settings in future for improvements & based on customer requirements for various floors.
- Vendor should not charge additional for any such modifications & changes in Fire Logics / C & E Matrix etc.
- Vendor needs to ensure availability of the backup of all the FAS Panels / Logics / Configurations etc.
- In the BMS System desktops & provide backup copy on external media like CD / USB Drive.
- System shall be programmed as per the approved cause & effect logic.

1.2.18 Execution

Preparation

- Carefully check Drawings and specifications of other trades before installing any work. In all cases consider the work of all other trades, and coordinate this work with that of the structural, sheet metal, piping, plumbing, electrical, and site work Contractors so that the best arrangement of all equipment, piping, conduit, ducts, and other related items can be obtained.
- Coordinate work to the end that there is no conflict between location of detectors and electric fixtures, piping, ducts, and other items
- Call to the attention of the Client any points of conflict between fire protection work and that of the other trades, so that the conflict may be properly resolved. Work which interferes with the work of other trades shall be removed and re-installed at Contractor's expense when so directed by the Client.
- It is the Contractor’s responsibility to provide additional work as necessary to satisfy the requirements. It shall be understood that no extras to the Contract will be permitted to accomplish the above results
- The Contractor shall take any necessary measures to prevent damage to the facilities and equipment and shall take any necessary measures to keep the premises always dry. Damage resulting from the work and testing under this section, whether intentional or not, shall be repaired by the Contractor at no cost to the Client.

Installation

- All equipment shall be installed in an aesthetic and skilled manner in accordance with applicable codes and other applicable standards referenced by this document. Final appearance of all systems and equipment shall be neat and clean. All piping in areas with finished ceilings shall be concealed.
- Refer to the Drawings for mounting heights of wall-mounted visual signaling devices, unless otherwise required by local governing authorities.

- All wiring for the System shall be in accordance with applicable Standards.
- All splices shall be made using solderless connectors. All connectors shall be installed in conformance with the Manufacturer recommendations.
- Crimp-on type spade lugs shall be used for terminations of stranded conductors to binder screw or stud type terminals. Spade lugs shall have upset legs and insulation sleeves sized for the conductors.
- Permanently label or mark each conductor at both ends with permanent alphanumeric wire markers.
- The Contractor shall submit for review prior to installation of wire, a proposed colour code for system conductors to allow rapid identification of circuit types.
- Wiring shall be checked and tested by the Contractor in accordance with the instructions provided by the Manufacturer to assure that the system is free of earths, opens, and shorts.

Inspection and Testing

- The system shall be subject to inspection and acceptance by the Client in accordance with applicable standards.
- Authorities Having Jurisdiction for the purpose of determining the system is in accordance with life safety requirements federal, state, local and specification requirements only and not the adequacy of the design for asset protection.
- The Contractor shall be responsible for performing and certifying requisite inspection and tests in accordance with applicable codes and standards for all equipment furnished under this specification.
- Inspection and test procedures shall be submitted to the Engineer for approval prior to use.
- All field tests performed by the Contractor shall be conducted in the presence of the Client and other representatives. All persons concerned shall be notified two weeks in advance of the tests to arrange attendance at the tests.

1.3 IP Based Public Address System

1.3.1 System General Requirement

- The system shall be IP-network based as well as Hybrid system
- All system devices such as system controller, amplifiers and call stations shall communicate via IP, using an Audio over IP protocol, offering real-time authentication and audio encryption on IP as protection against malicious attacks.
- The audio part shall support IP Layer 3 & Layer 2 Network connections via routers between subnets with latency of less than 10ms and synchronized outputs.
- The control data part shall be guaranteed by Transmission Control Protocol (TCP) Layer 4.
- Dual Ethernet connection for installations with redundant network systems. The connection is constantly monitored and switches automatically when required
- It is equipped with a full range power supply (110-240Vac 50/60 Hz) as well as a secondary battery 24 VDC (only for the control part).

- Four amplifiers outputs that incorporates DSP and monitoring functions. DSP functions: Controls for volume, bass and treble or 10 band filter through the PA Manager
- Monitoring of the speaker line: To accomplish this the equipment injects different frequencies in the speaker line; it then collects and analyses these frequencies to determine the condition of the line (line open, short-circuit, low impedance, high impedance, or line in good condition)
- Monitoring of the condition of the amplifier by analysing the audio signal to detect if the power stage has entered protection mode or is turned off
- Reception of digital audio via an IP connection (4 simultaneous channels). Reception and sending of control data via an IP connection.
- Monitoring of the operation of the equipment using software and/or basic functions.
- Configuration of the IP address in Flash memory via software and web page
- Constant notification (IP) of the status of the equipment via a Heartbeat signal
- Pre-recorded messages residing in the equipment that can be remotely updated using the PA software via IP located in the internal Micro SD memory (16 GB).
- Communication with external systems: - VoIP: receiving of direct calls from any VoIP digital telephone that uses standard SIP protocols. Incorporates zone selection by sending DTMF tones. Provides the possibility of protecting the access with a password. Direct integration (XML, API/DLL and SNMP)
- Monitoring functions: - of the speaker lines (short-circuit, open line and ground leakage). - of the amplifiers. - of the primary and secondary power supplies. - of the input contacts. - of the pre-recorded messages.
- A system based on a single system controller shall support unlimited system devices and unlimited zones.
- System functionality shall be defined in software, allowing for regular updates for functional and/or security improvements.
- The system software shall run on the system controller with additional firmware on other system devices for device-related functions.
- Upload and installation of new firmware into the system devices shall be secure. After completion of the system configuration, no connection to a PC shall be required for operation of the system.
- The system software shall support the discovery and assignment of all system devices in a system and the individual configuration of each device.
- The system shall include diagnosis and logging software, supporting different modes of enquiry, including call events and fault events. It shall be possible to view fault events, collected by the system controller, on a call station screen, including the fault status of connected third party equipment.
- It shall be possible to acknowledge and reset faults and alarm states, and to log these actions.
- The System should have scalability and flexibility to be used for small to large applications.

- All system devices should have dual Ethernet ports, to recover automatically from a broken network link.
- The system should have provision to distribute amplifiers and be connected over IP as well controller side to work as hybrid system.
- Distributed amplifiers can be placed close to speaker circuits, thereby reducing the Loudspeaker cabling cost as well as command Centre to reduce the cabling cost.
- The system devices shall be certified for EN 54, marked for CE and be compliant with the RoHS directive.

1.3.2 IP Digital Voice Alarm Network Controller

- The system controller shall dynamically assign network audio channels for audio routing between system devices across multiple subnets.
- Fully monitored system which includes amplifiers, call stations & loudspeaker lines and should have the ability to log the fault history and should have 16 monitored relay inputs for integration with the fire alarm system.
- The network controller should have redundant IP connection ports, to ensure greater reliability
- The network controller should provide redundant power supply to ensure stability and redundancy of the system in case of power failure
- The system should be able to work as Peer-to-peer in the case of large projects connected over IP or as Master-Slave for small/medium standalone systems
- The controller should be SIP/IP enabled without the requirement of additional hardware to facilitate the integration of SIP phones
- The system should support easy seamless interface with 3rd party systems over TCP/IP via XML, API/DLL
- Android/IOS Application suitable to control the music, announcements, status updates and sending of pre-recorded messages with access protection to be provided without the need of intermediary servers
- Shall be capable to play at least 16 pre-recorded messages simultaneously.
- The network control unit shall have extensive audio processing possibilities for audio inputs and audio outputs. 10-band Parametric equalization, limiter, and gain can be adjusted with the configuration software.
- The network controller shall monitor the status of all equipment including the status of the microphone capsule of a call station and report any fault.
- The controller should have a built in LCD display which ensures the monitoring of the loudspeaker lines, detailed description of system errors, displaying the failure history and many management functions.
- The controller should have a fireman's microphone with dedicated warning/evacuation buttons to trigger pre-recorded messages.
- The controller should be able to control the volume on each individual zone
- It shall be compliant and certified to EN 54-16.
- OEM Product warranty shall be three years minimum.

Technical Specifications:

Ethernet communication	2 Nos of Ethernet connections (RJ45) A and B for installations with redundancy. IP Layer 3 & Layer 4 Network
Input contacts	Minimum 16 input contacts on the control module. Configurable NC/NO. Supervised
Output contacts	Minimum 7 output contacts on the control module. Configurable NC/NO. Dry contacts or referenced to ground
Audio inputs	Two analogue audio inputs that are configurable for music or announcements (voice activated or PTT) and USB
Internal audio channels	16 inbuilt and the same shall be expandable upto 256 Channels.
SD memory for pre-recorded messages	16 GB

1.3.3 EN 54 or UL Certified IP Networked Dual Channel Amplifier

- Audio Interface with IP connection which incorporates a module of 2 output zones with monitoring functions
- Dual Ethernet connection for installations with redundant network systems. The connection is constantly monitored and switches automatically when required
- The amplifier shall adapt the maximum output power of each amplifier channel to its connected loudspeaker load, with free assignable output power per channel for a total maximum of 500 watt per channel and connect 1000W per amplifier, supporting 70V or 100V operation.
- The IP Audio interface should provide redundant power supply to ensure stability and redundancy of the system in case of power failure
- Two amplifiers outputs that incorporates DSP and monitoring functions. DSP functions: Controls for volume, bass and treble or 10 band filter through the PA Manager
- Monitoring of the speaker line: To accomplish this the equipment injects different frequencies in the speaker line; it then collects and analyses these frequencies to determine the condition of the line (line open, short-circuit, low impedance, high impedance, or line in good condition).
- Monitoring of the condition of the amplifier by analysing the audio signal to detect if the power stage has entered protection mode or is turned off.
- Reception of digital audio via an IP connection (2 simultaneous channels). Reception and sending of control data via an IP connection.
- Monitoring of the operation of the equipment using software and/or basic TELNET functions.
- Configuration of the IP address in Flash memory via software and web page

Technical Specifications:

Ethernet communication	2 Ethernet connections (RJ45) A and B for installations with redundancy. IP Layer 3 & Layer 4 Network
Input contacts	Minimum 3 input contacts on the control module. Configurable NC/NO. Supervised
Output contacts	Minimum 3 output contacts on the control module. Configurable NC/NO. Dry contacts or referenced to ground
Audio inputs	USB
Power supply	230 V AC, 50 ~ 60 Hz / 24 V DC
Channels	2
Power per channel	2 x 500 W (100 V
Inputs	2 x aux 0 dB, 10 kohm, unbalanced
Frequency Response	80 ~ 16.000 Hz (+1 dB, -3 dB)
S/N Ratio	> 80 dB
Total Harmonic Distortion	< 0,5 % (1/3 rated power)
Maximum dissipation power	2 x 750 W at 24 V C

1.3.4 EN 54 or UL Certified IP Networked Single / Dual Channel Amplifier

- The Single / Dual channel amplifier shall be fully connected with IP/LAN to connect with Voice Alarm Controller. If the proposed OEM shall not have inbuilt IP / LAN Port in Amplifier, they shall be considered IP interface unit separately without any additional cost.
- The amplifier shall adapt the maximum output power of each amplifier channel to its connected loudspeaker load, with free assignable output power per channel for a total maximum of 500 watt per channel and connect 500W per amplifier, supporting 70V or 100V operation. Single Channel shall have 1 x 500W and Dual Channel shall have 2 x 300W per amplifier. The proposed Amplifier shall be loaded in one channel. The other channel shall be kept as free in case any failure in first channel the second channel shall be reprogrammed.
- The amplifier shall have an independent spare amplifier channel for automatic failover
- The amplifier shall provide min 2 channel of output message to the controller to power up 2 channels of audio.
- The amplifier shall have dual power supply inputs and provision to connect emergency backup power for uninterrupted operation
- The amplifier shall provide front-panel LED status indications for the network link, ground fault, power supplies, signal, peak, protection and provide additional software monitoring and fault reporting features.
- Cooling function by means of fan blowers
- The amplifier shall be rack mountable (2U) and feature software-configurable signal processing including level control, parametric equalization, limiting and delay for each channel.

- The amplifier shall be certified for EN 54-16, marked for CE and be compliant with the RoHS directive

Technical Specifications:

Power supply	230 V AC, 50 ~ 60 Hz / 24 V DC
Channels	1/2
Power per channel	1 x 500 W (100 V) or 2 x 300W (100 V)
Inputs	2/4 x aux 0 dB, 10 k ohm, unbalanced
Frequency Response	80 ~ 16.000 Hz (+1 dB, -3 dB)
S/N Ratio	> 80 dB
Total Harmonic Distortion	< 0,5 % (1/3 rated power)
Maximum dissipation power	2 x 750 W at 24 V C

1.3.5 Multifunction Power supply and Battery Charger

- The multifunction power supply shall have an integrated battery charger for a connected battery, and independent converters to use the battery as a backup power source for all connected loads in case of mains failures
- Failover to the backup battery shall be without interruption of output power
- It shall use a single 12 V VRLA backup battery to eliminate the need for battery balancing, Battery hot swappable, Thermal regulated end-of-charge voltage, zero interruption when switching from one to the other energy source Soft start characteristic.
- The Battery charger and power manager with total discharge protection
- The multifunction power supply shall provide front-panel LED indications for status of the power supply sections, mains and battery and fault presence, and provide additional software monitoring and fault reporting features
- The multifunction power supply should Protects the battery from temperature variations and system should have independent fuse-protected outputs, Built in lightning protection
- The multifunction power supply shall be rack mountable (2U). The multifunction power supply shall be certified for EN 54-4, marked for CE and be compliant with the RoHS directive.
- OEM Product warranty shall be three years minimum.

Technical Specifications:

Input Power Supply	Main: 230 Vac, +10% / -15%, 50-60 Hz Alternative: 24 Vdc (rechargeable battery)
Output Voltage	24V DC
Load output current	150A or more
Output terminals (Each 40A)	6 or more
Output terminals (Each 5A)	3 or more
Battery capacity	32-50 Amperes x Hours (Ah), also dependent on the additional consumer load current

Fuse values of the 24 V outputs	Blade fuses 40A are pre-assembled. Fuse values must be adapted to the cross section of the connecting leads and to the load current respectively. Fuse value = load current x 1.3

1.3.6 IP Touch screen Call Station

- Remote call station is to be used for Paging purpose and other applications with following functionalities:
- Built in LCD touch screen to enhance the functionality of the control unit by means of direct access to the functionality of the monitoring of the zones, detailed description of any communicates messages and ability to management PA functionality of PAVA SYSTEM
- No Keypad extension to be considered and all zones should be in single screen with multi option.
- It should be possible to include graphical layouts so that zones can be represented pictorially on the building graphical representation
- It should allow the connection of a musical source, sending the musical program via IP
- Should Allow broadcasting announcements through an IP network in streaming as well as unit control and configuration parameters
- Should have following features
- Digital audio and control data via an IP connection
- AC 100-240 full range power supply
- Graphic display with configurable position of buttons and background images to facilitate the user operation
- IP control of all the situations in the installation
- Zones and groups buttons for selection
- Live or pre-recorded messages activation
- PA system surveillance
- Modification of zones volume or equalization
- Zone status indication, Announcements with or without a pre-announcement tone (Gong)
- Recording and sending adhoc messages
- The desktop call station shall be marked for CE and be compliant with the RoHS directive
- OEM Product warranty shall be three years minimum.

Technical Specifications:

Communication system	IP Layer 3 & Layer 2 Network
Microphone Type	Unidirectional
Microphone Sensitivity	1.78mV/Pa/1Khz
Microphone Capsule	Dynamic Type
Microphone Frequency Response	50 Hz ~ 12 KHz

Display	Minimum 7 Inch LCD Touch screen

1.3.7 Loudspeakers

6W Ceiling Loudspeaker

- The lower ceiling areas shall be supplied with Recessed Ceiling loudspeakers with optional metal fire dome.
- The Loudspeaker shall be suitable for delivering audio in the full frequency band. The loudspeaker shall be humid resistant.
- The speaker is made up of powder-coated metal housing, equipped with ceramic block and thermal fuse certified for EN 54-24 Voice Alarm applications.
- The ceiling loudspeakers shall be rated for 6 watts output power, with an integrated 100V line matching Transformer with multiple taps.
- The speaker shall be equipped with neodymium magnet.
- The ceiling mount shall be Bayonet recessed with low installation depth.
- Spring-loaded snap locks with cranked leg spring, increased clamping strength and shorter tension interval ensure quick and simple mounting.
- The ceiling loudspeaker shall be equipped for the following performance criteria.

Parameters	Values
Rated power	6 W
Maximum Power	9 W
Power taps @ 100V	6W / 3W / 1.5W
Sound pressure level	98dB (Avg), 104dB (Peak) or Better
Sensitivity (1W / 1m)	85dB or better
Frequency range (-10dB)	68 Hz to 20 kHz (-10 dB)
Dispersion angle (1kHz/-6dB)	180°
Rated input voltage	100 V
Connection	Plastic terminal blocks
Dimensions	As per OEM standard with minimum space occupancy.
Hole cut-out size	Needs to be specified by OEM
Size of speaker	5 to 6” Max
Color	White (RAL 9016)
Material	ABS Housing & Metallic grille
Certification	Certified with EN 54-24 or UL 1480 or UL 2043

Note: The rate shall inclusive of all the necessary accessories like M.S Backbox (for True Ceiling Speakers), Gland, Screws, Ferruling, Lugs etc. However, the speakers shall comply with EN Standards. Hence, the fire dome cabinet shall be considered without any additional cost of each Speakers.

6W Wall Mounted Cabinet Loudspeaker

- The non-false ceiling services Room areas shall be supplied with Wall mounted loudspeakers with metal fire dome.

- The Loudspeaker shall be suitable for delivering audio in the full frequency band. The loudspeaker shall be humid resistant.
- The speaker is made up of powder-coated metal housing, equipped with ceramic block and thermal fuse certified for EN 54-24 Voice Alarm applications.
- The wall mounted loudspeakers shall be rated for 6 watts output power, with an integrated 100V line matching Transformer with multiple taps.
- The speaker shall be equipped with neodymium magnet.
- The ceiling loudspeaker shall be equipped for the following performance criteria.

Parameters	Values
Rated power	6 W
Maximum Power	9 W
Power taps @ 100V	6W / 3W / 1.5W
Sound Pressure Level	94dB / 90 dB
Sensitivity	88dB or better
Frequency range (-10dB)	15 Hz to 16KHz or better
Dispersion angle (1kHz/-6dB)	90° x 90°
Rated input voltage	100 V
Connection	Plastic terminal blocks
Dimensions (Φ x H)	As per OEM standard with minimum space occupancy.
Size of speaker	Compact Square / Rectangular Speakers to be proposed.
Color	White (RAL 9016)
Material	ABS Housing & Metallic grille
Certification	Certified with EN 54-24 or UL 1480 or UL 2043

Note: The rate shall inclusive of all the necessary accessories Gland, Screws, Ferruling, Lugs etc. However, the speakers shall comply with EN Standards.

15W Wall/Surface Mount Cabinet speaker

- Surface mounted loudspeakers shall be provided for surface mount in areas without false ceiling.
- Two-way compact speaker, power of 15 W RMS at 100 V line, also with connection available at 8 ohms. It can be installed on the wall or ceiling with the swivel bracket included, both indoors and outdoors (it has IP65 degree of protection).
- The speakers shall be available in black and white. The Client / Consultant will choose the colour of the speakers post tender awarded to successful bidder.
- Suitable for voice alarm systems, it complies with BS-5839, part 8 and is EN 54-24 certified.
- The speaker shall be equipped with line matching transformer suitable for 100 V line.
- The Loudspeaker shall be weather-proof and suitable for outdoor use.
- The cabinet loudspeaker shall be equipped for the following performance criteria.

Parameters	Values
Rated power	22 W
Power taps @ 100V	15 W/7.5W/3.75 W/1.8 W
Sound pressure level at 6W/1W (1kHz,1m)	94 dB / 82 dB
Frequency range (-10dB)	~115Hz – 16kHz (±5dB) or better
Opening angle	~110°conical or better
Color	Black/ White
Rating	IP65 Rating
Dimensions (W x H x D)	As per OEM standard with minimum space occupancy.
Material	ABS Aluminium, painted grille. Weatherproof and the Speaker should pass 100HR Salt Spray Test Per ASTM B117., UL-1480, CE
Certification	Certified EN 54-24:2008. Compliance with BS-5839-Part 8

Note: The rate shall inclusive of all the necessary accessories Gland, Screws, Ferruling, Lugs etc. However, the speakers shall comply with EN Standards.

1.3.8 End-of-Line Device

- The end-of-line device shall only require a connection with the end of the loudspeaker line to supervise its integrity.
- Supervision reliability shall not depend on the number of connected loudspeakers.
- Supervision shall be inaudible and not interrupt audio content.

1.3.9 Volume Controllers

- Volume Controllers have the following four types: 6W & 30W respectively. The features are as follows:
- Build-in 24V DC forced cut-off relay
- 5 volume levels control
- Applicable to 3-wire, 4-wire and 6-wire systems
- Standard 86X86 installation base-shell.

Parameters	Values
Rated power	30W Max
Supply voltage	100V
Frequency response	50Hz~20KHz
Attenuation	5X2dB + off
Current consumption	20mA, 24V DC

1.3.10 Integrated Audio Source

- The Integrated CD player supports the MP3 music files on removable disks, SD cards, DAB digital broadcastings and FM tuners.

- Two single CD\USB\SD and DAB\FM line outputs can play music applications in two areas.
- The volumes of the two-line outputs can be adjusted separately.
- CD\USB\SD has three play modes: single play, all play and repeated play.
- DAB\FM can preset 10 channels of programs.
- RS485 remote control interface

1.3.11 Cables & Wiring

- All the cables, conduits & cable tray shall be proposed as per the details provided under Fire Alarm System. However, the cable outer sheath shall be considered in Blue / Grey colour.
- However, the outer sheath colour shall be finalised at the procurement.

Note: The OEM shall have an option to re-engineer the Quantity of each equipment without damaging the technical requirement, design changes, BoQ description, individual item price, with respect to the make selection. However, the same shall be done post the order awarded to the contractor. This assignment shall be carried out with proper analysis/site inspection with backup documents. If any cost shall not be bring-down the contractor needs to go-ahead as per the original design approached herewith.

1.4 Security Access Control System

1.4.1 System General Requirement

- The ACS must fulfil all the Access Control Operational Requirements, it is the responsibility of the bidder to ensure the required technology, integrations and workflows are provided by ACS with no deviation.
- The ACS shall be an enterprise-class service-oriented solution platform providing a comprehensive solution to the physical security and identification application needs as follows:
  - Access Control
  - Time Attendance
  - Visitor Registration & Access Management
  - Centralized Alarm Management
  - Emergency & Evacuation Management
  - AI Powered Centralized Alarm and Monitoring station.
- The Access Control System Software shall have an inbuilt feature as mentioned below
  - Security Access Control Module
  - Vehicle Access Control Module
  - Visitor Management System Module
  - Attendance & Time Management Module (HRMS)
  - Video System Interface (CCTV) Module
  - Interface Module for Integrated building Management System (IBMS)
  - Mass Notification Module for Integrated Command & Control Centre

Note: All the above features shall be provided as a part of Access control System Software Cost. However, the IBMS integration shall be done through Software & Hardware level without adding any additional third-party devices.

- The ACS system must support a unified database upgrade approach, utilizing a single upgrade patch that seamlessly upgrades from any lower versions. Manual execution of multiple version patches for database upgrades will not be accepted. The upgrade process should be streamlined and automated for efficiency.
- The ACS shall be based on a true open architecture which means that the platform shall have the ability to integrate with several third-party open architecture intelligent devices and technologies such as:
  - Access Controllers & Card Readers
  - Biometric Readers & Enrolment Devices
  - QR Code Readers
  - Card Printers
  - Card Encoding Devices
  - Smart Cards, Mobile/Digital Credentials
  - BLE/NFC-based access readers.
- The ACS shall have the flexibility to switch to a different access control software without the need to replace the hardware or part of the hardware. The ACS software license shall be fully perpetual and free from any hardware locking like dongles.
- The ACS software license shall provide unlimited user logins, unlimited client licenses for system monitoring and configuration tools, and unlimited branches and shall be further scalable for up to thousands of controllers.
- It shall also be ensured that the software OEM shall not discontinue the proposed software for at least 5 years and the support shall be available for at least 8 years.
- The ACS shall be open to interface with other security & and safety systems like CCTV Video Surveillance System, Fire Alarm System, Intrusion Management System, and Building Management System (BMS). The ACS system shall be open to be customized and integrated with any other third-party system as per the user requirements.
- The ACS shall support bi-directional integration with Information Technology (IT) Systems like Enterprise Resource Planning (ERP) System, Human Resource Management (HRM) System, Student Information System (SIS) and Customer Relationship Management (CRM) System via APIs. This integration shall provide Employee profile synchronization/transfer from the IT system to ACS Software and Attendance log transfer from ACS Software to IT System. The APIs shall be readily available and shall be provided along with the ACS software.
- The ACS software shall be a multi-user design where a logged-on user in the software whether on the web interface or on the client interface shall not have any effect on the user experience or operational capabilities of any other user logged on to the software. Also, the changes made by one user shall be updated for other users on a real-time basis.

- The ACS software shall provide options to create multiple branches. It shall further allow to creation of the enterprise structure by creating the branch hierarchies.
- The ACS software shall allow the system administrator to create a complete organizational structure by defining multiple departments, designations, and Employee types. The users shall be created and shall be mapped with their corresponding department along with the related designation. There shall be no limit on the creation of departments, designations, and Employee types. This shall allow for the creation of a complete hierarchical chart by allowing each user to be mapped with their reporting manager and selecting the profile of the superior.
- The ACS software shall provide a tool for defining user privilege templates in the software. The software shall have default templates like Administrator, Group User, Normal User, etc. These templates can be used as the base templates to further create unlimited new privileges by enabling or disabling any function or feature of the software. All the users of the software shall have access to the software based on the privilege assigned to them.
- The ACS system shall provide a comprehensive login and password policy which shall be configurable by the end user in terms of the following parameters as minimum:
  - Password parameters like minimum and maximum length, use of alphabets as mandatory or not, use of upper case as mandatory or not, use of lower case as mandatory or not, use of numeric as mandatory or not, and use of special characters as mandatory or not.
  - Passwords Generation Policy: Auto-generate password on account creation, enforce password change on 1st login, Privileged user can reset others password, enable, or disable 'Forget Password' feature, generated reset password link expires in a day(s)
  - Notifications: Notify user on account creation, notify the user on admin reset password
  - Password Expiry Policy shall allow to select either none or to define the number of days after which the passwords automatically expire.
  - Login Parameters: Using Employee ID as username, using email ID as username, enable or disable login lockout, define several unsuccessful attempts before lockout & and lockout time in hours.
- The ACS software shall be language agnostic and provide a methodology to create labels in all local languages used worldwide. These labels can be uploaded back to the software and can be saved in the language section as the user's personalized choice of language and dialects. Once saved the users shall be able to switch between the saved languages.
- The ACS software shall provide an option of personalizing the portal by users by changing the Colour theme of the software. It shall also provide the option of setting custom Colours by defining Colour codes for the menu background colour, menu mouse hover Colour & menu text Colour. The software personalization option shall also enable users to upload their corporate logo to be used on each page of the software.

- The ACS software shall also provide dashboards for users to choose widgets to be shown on their dashboard. It shall allow creating a new dashboard by simply defining the name and making it active. Further, it shall be possible to select different default widgets to be shown on each dashboard template and it shall be possible to make these widgets available to multiple privilege levels defined for the software. The minimum available widgets shall be:
  - Alarm Count Weekly
  - Branch Attendance Summary
  - Card Summary
  - Dormant Cards
  - Employee & Visitor Head Count
  - Employee & Visitor In-Out Count
  - Security Behavioral Anomalies and Incidents
  - It shall also be possible to export these widgets to another portal by providing a link to a specific widget which can be embedded by any other portal like ERP system, HRMS, website, etc.
- The ACS software shall be cloud-ready, so if the system stakeholders decide to install it over the cloud, then it shall be possible without additional licensing. The licenses shall be valid for hosting it on-premises server or the cloud.

1.4.2 Functional Requirements

- The ACS software shall provide menu-driven functions for ease of use and best user experience. The following modules shall be part of ACS Software:
  - User Management
  - Credential Management
  - Access Control
  - Time Attendance Module
  - Visitor Management Module
  - Badge Printing Module
  - Hardware Configuration Module
  - Alarm Monitoring and Management Module

  User Management Module

  The User Management Module of ACS Software shall support the following:
  - ✓ Seamless active directory integration for single sign-on, automatic import of Employee details, and automatic deactivation of access rights on Employee profile deactivation in the active directory server
  - ✓ Adding users with standard fields like name, email, Employee id, contact details, blood group etc. and option shall be available to create at-least 40 additional custom fields.
  - ✓ Adding Employee photograph along with provision to add at-least three more pictures corresponding to an Employee such as scanned copies of national ID card, passport, police verification etc.

- ✓ Managing access rules in terms of setting up extended access time for physically challenged users, pass back exemption for specific users, PIN exemption for specific users and Multi Man Role.
- ✓ Assigning up to 8 access levels per user, an additional 2 elevator/lift access levels and unlimited shared access levels. The users shall get access to the different areas of the premises based on these access levels. It shall be possible to group users and assign them the access levels in bulk.
- ✓ Assigning current and future shift roster to an Employee. It shall be possible to assign Shift roster to Employees in bulk.
- ✓ Defining custom Employee groups. The feature shall facilitate the logical grouping of Employees based on management structure, thus shall empower the project coordinators, floor-managers, or project managers to manage access rules and view reports of a specific user- group. It shall be possible to delete these groups.
- ✓ Assigning privilege level of an Employee like Administrator for the entire system, administrator for a branch only, report viewer and a normal user having access to own personal information/ personal reports/ability to file outstation duty request, visitor request as minimum. It shall be possible to create group users to manage access of groups.
- ✓ Assigning a privilege to approve visitor request and outstation duty request. Assigning privilege of a security administrator who can configure and monitor the access control hardware and a security viewer privilege who can only monitor and respond to the event and alarms.
- ✓ It shall also be possible to select 'None' as a privilege which allows no access to the software.
- ✓ Advanced search form to search users on fixed and mixed search criteria such as: name, department, title, access group, credential status etc.
- ✓ Assigning access levels to an Employee of the same organization visiting a different branch.
- ✓ Assigning Mobile App and Mobile credentials to users. This shall also allow to edit the mobile privilege of a user, remove the mobile privilege of a user, and delete a mobile device from the user-authorized list of devices.
- ✓ Importing the Employee or contractor profile information from Excel/CSV file.
- ✓ The application must have the option to generate secure auto passwords instead of default passwords.
- ✓ The application shall have the ability to create a custom field with unique attributes. If marked as unique, the field's value must be distinct across the entire company. Additionally, the user can set a custom field as compulsory, ensuring that an employee profile cannot be added or edited without providing this value. Furthermore, dropdown-type custom fields allow users to define multiple options for the field, including a default value.
- ✓ The application allows defining a unique PIN to trigger specific command events on pin pad readers. Users should be able to create Input/Output rules linked to this transaction, enabling enhanced control and automation. For

example, entering a preset PIN could trigger a premises lockdown or activate a specific output, like turning off all lights, providing convenient and customizable access management.

Credential Management Module

The credential management module shall provide the following functionalities:

- ✓ Create and maintain credential directory. It shall be possible to upload all card details (format and/ or card ID) in the ACS Software and whenever required it can be issued to the Employee. The card IDs which are not issued to any users shall be made available by the software to be issued to Employee.
- ✓ Searching of cards based on various searching criteria drop downs such as Employee ID, Employee Name, Card Number, Format Name, Status (active/inactive). It shall also be possible to search the mobile ids/credentials issued to different users using the search tool.
- ✓ Issuing a credential where the credential can be issued to either a human or vehicle, access type shall be selectable from different modes, 'card only', 'card + pin', 'card or pin' and 'pin only'. It shall also be possible to issue card/credentials from the list of available credentials or manually adding a card id.
- ✓ Editing a credential where cards can be searched either by Employee Id or Card Number and allows the user to edit PIN, Card Issue Date, Card Type and Expiry Date. It shall also allow us to set the status of a card to active or inactive.
- ✓ Segregate credentials into different categories based on owner types such an Employee, vehicle, visitor etc.
- ✓ Assigning credentials to Employee in bulk and assigning multiple credentials to single user.
- ✓ Capable of managing multifactor authentication for biometric readers also like finger only, finger + card, card only, finger or card etc.
- ✓ Searching interface to edit the credentials or to get the complete visibility of the company owned credentials along with their status.
- ✓ Assigning priority or VIP category to a card id or to a user so that the credential is never denied access on the ACS System.

Badge Designing, Printing & Encoding

The ACS Software shall also be capable of designing Identity Badges for the users and it shall be possible to print & program these cards using open platform card printers & Encoders. This functionality shall support windows-based image printing command so that the designed badges can be printed from a variety of card printers. The following options shall be available in the application.

- ✓ Select or define the size of the ID card/Badge.
- ✓ Pick & Drop user information from the available list of profile information fields like name, department, designation etc.
- ✓ Uploading the Photo or Automatically fetching the photo of a user from the database.
- ✓ Uploading corporate logo as opaque or as a background image
- ✓ Alignment shall be possible for all fields.

- ✓ Save the ID card/ Badge template in the software for printing.
- ✓ Application shall support card key management by encoding multiapplication smartcards like Mifare and Desfire cards with a USB encoder. It must comply with the requirements for fast and highly secure data transmission, flexible memory organization and interoperability with existing infrastructure.
- ✓ All the above functions will be available for Employee as well as contract labours Via Integration to contract labour management system.
- ✓ The badging system shall support printing of custom fields apart from standard fields available in access control application.
- ✓ The system shall be capable of encoding cards to save biometric templates on its memory of the card. This is used to open biometric doors where biometric templates are not saved on the device.

Following options shall be available for ID Card/Badge Printing:

- ✓ Automatic fetching the user profile information according to the saved template of badges.
- ✓ Automatically managing static & variable data printing.
- ✓ Single or Dual side printing.
- ✓ UV codes to make ID Cards easier to identify and printing them in compatible printers.

Biometric Enrolment and Distribution

- ✓ The ACS Software shall be integrated with different biometric technologies which are fingerprint, face recognition, Iris, 3D Fingerprint (Wave). The Enrolment module shall support enrolment of all these technologies from a single software interface.
- ✓ The ACS Software shall be integrated with different biometric manufacturer's directly with the devices, it shall not use any middleware software or database from the manufacturer, for enrolment of the biometric templates of the users.
- ✓ The ACS Software shall be integrated in such a way that it shall not use any middleware software or database from the manufacturer, for communication and distribution of the biometric templates of the users to all the biometric devices.
- ✓ The ACS software shall enable enrolment directly from the Biometric device over TCP/IP or from the USB based enrolment setup. It shall have no effect on the distribution, which shall happen to all devices.
- ✓ All above functions shall be available for Employees as well as contract labours.

Hardware Configurations Module

- ✓ The hardware configuration module should list all controllers configured in the application with details such as Name, MAC address, IP Address, Make, Type.
- ✓ It shall be possible to search hardware from the network with the help of 'search device' tool and it shall contact search capability by taking inputs like MAC address or make of the hardware.

- ✓ The Hardware config must be able to add any new controller or biometric device by filling details of the hardware like Make, Type, Name, MAC Address, IP Address, ID.
- ✓ Hardware configuration shall allow users to group multiple controllers with features such as 'action group details' it should be possible to make multiple groups of controllers.
- ✓ This tool shall allow configuring and creating different floor names with details such as ID floor name etc, which will be further used on the Elevator access management.
- ✓ This module should have various options to troubleshoot connected hardware. It must be able to reset controller, reset SIO, reset time, sync time zone, sync access group, sync card format, sync card DB, sync IO mapping, reset access areas, enable event reporting, disable event reporting, reboot controller, and factory reset.
- ✓ Hardware configuration tool should allow users to rename controllers and configure Interface devices.
- ✓ This module should allow users to configure readers which are connected to the application and should be able to name the readers and configure parameters such as reader protocol, reader address, reader type In/Out, Access type, Access grant time for the door, minimum open time for lock, REX in, Door held time, OSDP secure channel, Advanced control, PL Bypass, OSDP Baud rate to have the door and reader definitions mapped on the application.
- ✓ The hardware config tool should be able to list all the inputs configured on the platform with relevant information such as Input name, Interface type, Input port, controller name, MAC Address, Controller type, Last updated on, Updated by (user).
- ✓ The hardware config tool should be able to list all the readers configured on the application platform with details such as name, position, type, interface type connected to, controller connected to, MAC address, controller type, protocol, updated on, updated by (user).
- ✓ The hardware config tool should be able to list all the configured on the application with details such as, Output name, output port, interface type, controller name, MAC address, controller type, last updated on, updated by (user).
- ✓ Users must be able to blacklist a controller/device. Upon reconnection of a blacklisted controller/device, the device shall undergo a factory reset for security reasons. This feature is crucial to ensure the application's security by preventing unauthorized or compromised devices from accessing the system. The factory reset will eliminate any potentially harmful configurations or data on the blacklisted controller/device, bolstering the overall security and integrity of the application and its connected components.

Logical Area control

The Application shall allow users to configure physical areas with entry and exit to map logic to the specific area and drive policy and features around this configuration.

- ✓ An area configuration must have information like ID, Name, Alias
- ✓ Area mapping configuration must cover information such as name of reader, type of reader, Area IN drop-down, Area out drop-down.
- ✓ This tool must allow user to configure 'who's where' tool with ability to include or exclude details such as User ID, username, current area, time entering the current area, department, designation, mobile number, office phone. This allows a person trying to people to have access to vital information.
- ✓ This tool shall allow user to user to group areas in groups for various purposes.

Access Control Module

- ✓ The ACS Module shall provide options to configure multiple access levels. The Access Level shall be a combination of various access parameters such as working day/holiday, time codes, reader groups, elevator groups, etc.
- ✓ The ACS Module shall support assigning access levels (up to 8 access levels per facility/branch/business unit) to a set of users to enable them to access specified areas & additional 2 access levels for elevators during a specified period.
- ✓ The ACS Module shall support multi-Man role enforcing more than one user to present their cards to get access through the designated access-controlled points.
- ✓ The ACS Module shall support Timed Anti-pass-back (APB) which means it shall be possible to define a time delay between 2 readings of a same access card. This shall enable to avoid unwanted events logged in the system and within the defined time, it shall avoid reading the same card if passed back by its user to another person.
- ✓ The ACS Module shall support Soft APB and Hard APB, where Soft APB shall generate an alarm in the Module if a user has any miss punch on any of the entry or exit reader of a door but shall not deny access, the Hard APB shall generate Module alarm if a user has any miss punch on any of the entry or exit readers & additionally the controller shall deny access for the same user on the door.
- ✓ The ACS Module shall support Local Anti-pass-back and Global Anti-Pass-Back to deter tailgating. This shall mandate a user to flash access card at each access point whether entry or exit. Bypassing any access point deactivates the access rights of the user. Local refers to the entry and exit of a single access door/point and Global means the entry & exit points of multiple doors.
- ✓ The ACS Module shall support allocation of extended access time to some specific users like physically challenged users who need extra time to move in and out. The extended access time shall be configurable in the Module and the access control rules shall be applicable accordingly to such users.

- ✓ The ACS Module shall have the option to define Time Code which means the total duration of time in a day when users/Employee can get access through the access barriers/doors. This shall be configurable between 00:00 hrs. to 23:59 hrs. It shall be possible to define multiple time codes.
- ✓ The ACS Module shall have option to define multiple holidays up to unlimited number of days. The interface shall provide option to make a specific holiday as repeating holiday which means the holiday will automatically get repeated on the same day of upcoming years also. Further, the Module shall provide the option to group multiple holidays so that all branches available in different geographical locations can have their regional holidays to be applicable on access rules.
- ✓ The ACS Module shall support defining of Time Zone that are the combination of Time Code and Holiday groups applicable to number of days in a week. The access rule shall work according to the defined Time Zone. It shall be possible to create Multiple Time zones in the system.
- ✓ The ACS Module shall allow grouping of access readers for user/Employee access. The list of all the installed readers shall be available in this section that can be grouped floor-wise, area-wise, or location-wise.
- ✓ The ACS Module shall further support combining Time Zone and Reader Groups to create Access Groups. It shall be possible to define it either for Employee or Vehicle and applicable to Visitor as well. All users/vehicles shall be issued these Access Groups and the respective time code, time zone, holidays and readers shall be available for that user to get access to the premises.
- ✓ The Access Groups shall also support the functionality of Shared access Groups which means an access group can be made applicable to multiple branch users. The users of different branches can be issued with this shared access group, and they can access multiple branches using the same access credential.
- ✓ The ACS Module shall support the Multi-man Access rule in such a way that for getting access from a particular door, it shall become a mandate for all the users in the Multi-man Access Rule to show their credentials.
- ✓ The ACS Module shall support the allocation of access rights to Visitors, also to track a visitor.
- ✓ The ACS Module shall provide real real-time occupancy count of the whole location or any of the areas.
- ✓ The ACS system shall have the capability to unlock, lock, or permanently lock specific doors or groups of doors within a controller. This functionality can be initiated by entering a predefined PIN, enabling quick response to scenarios such as evacuation or lockdown.
- ✓ The ACS system shall be able to schedule pin entry suppression on the pin reader. For instance, they can set card-only access between 9 AM to 6 PM and card + pin entry between 6 PM to 9 AM, allowing for flexible access control based on specified time intervals.

- ✓ The ACS system shall support 'double tap' feature where specific credentials.
- ✓ The ACS system shall have the ability to create a custom field with unique attributes. If marked as unique, the field's value must be distinct across the entire company. Additionally, the user can set a custom field as compulsory, ensuring that an employee profile cannot be added or edited without providing this value. Furthermore, dropdown type custom fields allow users to define multiple options for the field, including a default value.
- ✓ The system should support precision access refers to user-specific access rights designated by readers and time zones. With precision access, users have the flexibility to assign or remove reader-wise access for each individual Employee. This level of customization allows for fine-tuned control over access permissions based on specific requirements.
- ✓ The system must allow manual activation/deactivation of relays via software, even if the relays are not mapped with any input. This feature provides users with the ability to control relays directly through the software interface, enhancing flexibility and facilitating specific actions as needed.
- ✓ The application should support Global/Regional IO mapping, enabling users to establish peer-to-peer communication between controllers. With this feature, users can create IO mapping rules to execute global IO actions. For instance, in the event of a fire input, users can unlock all doors across multiple controllers, eliminating the need for dedicated fire inputs for each individual controller or server-based 'open-all-door' functionalities. This streamlines access control management and enhances operational efficiency.
- ✓ The application needs to support input masking in controllers. Input masking involves disabling specific inputs. When an input is masked, any configured rules associated with it will not be executed upon status change. However, users should have the option to configure inputs in a way that allows a masked input to either generate or prevent status change events.
- ✓ The application should be able to groups of doors from various controllers and use that group to lock/unlock doors in bulk from the application interface.
- ✓ The application must include a feature to create a procedure that resets the Anti Pass Back for all Employee upon the activation of a specified time zone. For instance, every day at 8 AM, the Anti Pass Back should be automatically reset for all Employee, ensuring a hassle-free entry in the morning. This functionality allows for smoother access control operations and ensures that Employee can freely access designated areas without restrictions during the specified time zone.
- ✓ The application should implement distinct grids for input and output sections to clearly display the status of inputs and outputs. This differentiation will provide users with a clear overview of the current state of both inputs and outputs. Additionally, upon clicking on a specific input, the application should allow users to view the corresponding mapped outputs. This feature enables users to quickly identify which outputs are associated with a particular input and take necessary actions on those outputs as needed. Such interactive

functionality enhances the user experience, making it easier for them to manage and control inputs and outputs effectively.

- ✓ The application must incorporate door masking, which should include the ability to enable door held masking and door forced masking. This feature is essential to allow users to disable door held/force events selectively for individual doors or groups of doors. The door masking functionality should be achieved through two methods: firstly, users must be able to create controller-based IO mapping rules to mask a door using inputs, time zones, double taps, pin commands, and other relevant parameters. Secondly, users must have the capability to mask specific doors or groups of doors directly by issuing commands from the security view. The implementation of door masking is crucial for providing users with enhanced control over door events, ensuring a more flexible and secure access management system.
- ✓ The application should have the capability to analyze user access attempts even after access has been granted. It must verify the legitimacy of the user for the granted access and identify if the access was unauthorized. In such cases, the system should display the access attempt as "unauthorized grant access" and provide a clear reason for the denial. This functionality is essential to enhance security measures and ensure that only legitimate users have appropriate access rights, helping to identify and address any access control issues promptly and effectively.

Evacuation Management

- ✓ The ACS Module shall support configuring some specific readers as muster point readers at the assembly points.
- ✓ In case of a fire/emergency alarm all the access points shall get automatically disabled and all the people present inside the premises shall be able to freely reach to the assembly points.
- ✓ The users will show their credentials on the muster point readers installed on the Assembly Points to mark them as present on Assembly points.
- ✓ The system shall show, on real time basis, the information about how many people is present at the assembly points and how many are not. Those who are not present at the assembly point during this exercise/real emergency their tentative location shall be shown based on the last card action on any of the access readers.
- ✓ It shall be possible to get a dashboard on the user interface having real time updating widgets regarding the emergency evacuation and area wise head count.

Guard tour Management

- ✓ A guard tour system helps companies and organizations efficiently organize, log, and execute patrols using existing access control inputs and readers.
- ✓ It ensures security officers accomplish tasks within predefined intervals, provides real-time monitoring and alerts for missed checkpoints, streamlining security measures without the need for additional devices.

Alarm management & Monitoring

Alarm Management

This Module must have the following minimum characteristics to assign manage and mitigate risks and faults: Alarm class, escalation, Instructions, remarks, policy & Assignment of such policy.

- ✓ Alarm class must have different classifications of alarms like Critical, warning, attention & Normal. The classifications must have interchangeable colour codes and text colour for easy identification.
- ✓ Alarm Escalation means the different escalation matrix an alarm must follow in case of an alarm situation. This module must be user configurable for different types of alarms with escalation levels up to 5 and with time duration for each escalation selectable to minutes/ hours/ days and person/ user to escalate to.
- ✓ Alarm Instructions: the application must have a clear and user definable up to 5 sets of instructions for each type of alarm so that a security personal who will receive a pop on the screen may the action based on instructions.
- ✓ Alarm remarks: each alarm must have a set of dropdown instructions which can be set so that after an action is taken by security, he may choose a remark for each for future reference and quick response.
- ✓ All alarm management modules must support setting a specific priority for each alarm type.
- ✓ Application must support for each type of alarm if acknowledgement is required or not based on site requirements and alarm type.
- ✓ Application must support for each type of alarm if remarks is required or not based on site requirements and alarm type.
- ✓ Security admins should have the flexibility to create a comprehensive alarm policy definition for every type of alarm by choosing an escalation matrix of their choice, and set of predefined instructions, and choose a type of classification, and for ease of response have a preset remarks to select from so that the over implementation and compliance for rules and policies are easier.
- ✓ The applications should support different types of notifications for alarms like popups, email, and Push notifications to mobile applications for specific predefined personals.
- ✓ The application must support an alarm policy to be assigned to only certain readers, inputs or controllers as per requirement.

Live Monitoring

The Application must support a comprehensive live monitoring module with following aspects. Controller/ Device status, Interface status, door status, input status, reader status, Live events, Reader event live view, Event history, who's were, Area count.

- ✓ Controller status window must show the live status and information of controller or devices which are configured on the application with information such as Name of device, branch, type of device, MAC Address, IP Address, Online or offline status, time of last communication.

- ✓ The Interface Status window must show the live status of interfaces connected to controllers with information such as Name of device, branch, type, panel address, Port, or type of communication, and online or offline status.
- ✓ Door status live monitoring window must show details of the name of the door, branch, type of door, Door status open/ closed, Lock status locked/ unlock, Door held alarm active or inactive, door forced violation, door forced alarm, tamper violation.
- ✓ It should be possible on the Door Monitoring window to select any door and to lock/ unlock or permanently lock or disable the lock remotely.
- ✓ On the Door monitoring application interface, it should be possible to mark any door as 'under maintenance' and select an action like activate/ deactivate Forced open alarm masking or activate/deactivate held open alarm masking.
- ✓ It shall be possible to 'Lockdown' all doors or 'Emergency Evacuate' of the branch from door monitoring window or reset to 'normal'.
- ✓ Input/ Output Monitoring window shall support monitoring live condition of all inputs and outputs and mask any input or activation/deactivation of all outputs.
- ✓ Reader status window shall show the live status of all branch readers by their name, controller connected to, branch, status active/ inactive, Tamper status.
- ✓ Events Window shall show all comprehensive live events and alarms as defined in the alarm policy with live pops of alarms and information such as what, where, branch, who, when, Acknowledgment status.
- ✓ Live view window shall allow pops and shall show alarm class by the text colour and colour code so that it's easier to identify.
- ✓ Alarms popups must have live view window from the CCTV camera connected and shall also support moving camera angle if it's a PTZ camera.
- ✓ Live view Popups should allow for incident view of the camera where it shall show the actual footage of the event from CCTV systems archives.
- ✓ Popups also give instructions to security staff manned at the station as configured in the alarm management system and shall allow up to 5 sets of instructions.
- ✓ Popups shall also allow the security staff manning the station to apply preset remarks or type remarks for each alarm event for future reporting.
- ✓ Reader Live view window shows the events of a single reader with details of users who have last swiped. The details shall include information such as Access granted or denied, ID, Name of personal, Card type, Photo, Card Issue date, Department, Designation, expiry date of the card. This helps security personal near the door to monitor the face of person entering with the photo in the application.
- ✓ Event history window allows users to view and download past alarms and events based on period event type, alarm class, branch, acknowledgment status.
- ✓ The Who's Where window allows users to check the current location of people inside the premises with the help of their last card action. This is made easier

by searching the application based on branch, searching based on Employee ID/ First name/ Location.

- ✓ Area Count shows the total live headcount of Visitors and Employee present at different locations of the premises.
- ✓ Access control Module shall support Intelligent auto event popups for various access control events based on policy definitions.
- ✓ Access control system shall be capable of notifying users or admins of various alarms via SMS or email.
- ✓ The system should enable users to monitor the real-time connection status of interfaces. Additionally, changes in the interface connection status should be tracked and viewed on the event monitoring page, ensuring continuous monitoring and better visibility of interface connectivity.
- ✓ The application must support monitoring cabinet tamper and power monitor inputs across all controllers and interfaces. These inputs should be in-built and come with fixed NO or NC mode. Users can define IO linking rules against this input, allowing them to utilize it for general purposes as well, providing flexibility and enhanced functionality.

Graphical User Interface for Monitoring

- ✓ It shall be possible to create a Graphical User Interface (GUI) by uploading floor maps in image formats into the Module.
- ✓ The Module shall provide default icons to drag and drop on the floor maps GUI and shall be mapped with the actual device behind that icon. for example, a lock icon, alarm icon etc.
- ✓ The icons once mapped with the actual devices shall change its appearance according to the change in the status of that device. for example, if an alarm hooter is activated then the alarm icon shall start flashing on a particular location on the GUI where actually the alarm is hooter is activated. In this way the entire GUI shall be highly interactive.
- ✓ It shall be possible to divide the floor maps into different logical areas which can be mapped with the real entry & exit device to find out the Occupancy in each logical area. These occupancy details shall further provide the possibility of knowing who all are present in those logical areas.
- ✓ It shall be possible on the GUI to drag and drop CCTV Camera Icons and map those icons directly with the actual camera. This shall enable real time video view on any selected camera within the access control Module GUI.

Visitor Management Module

- ✓ The Web based visitor management module shall be hosted on the CLIENT website.
- ✓ The Visitor Management Module shall be by default part of Access Control software and shall utilize the same database. Any system providing a Visitor Management software as a separate software with the separate database is not acceptable.

- ✓ The Integrated Visitor Management System shall support assigning the access levels and access credentials to visitors allowing them to get access into the premises. The supported credentials shall be an access card, PIN & QR Code.
- ✓ The Visitor management module shall support Visitor request and approval workflow to allow only properly registered, approved, and authorized visitors to get entry to the premises.
- ✓ The Visitor management module shall support Visitor registration to be initiated either by Employee or Visitor. This shall also support a walk-in visitor registration at the security gate or at reception.
- ✓ The Visitor management module shall support adding multiple visitors and participants in a single invite request.
- ✓ The Visitor management module must have the capability to send email notifications to visitors and meeting participants in a calendar invitation format. This feature will ensure effective communication and timely updates for scheduled meetings.
- ✓ The Visitor management module should include the functionality to configure and select meeting rooms for each meeting request or appointment. Users need to have the flexibility to customize and assign appropriate meeting rooms to ensure seamless scheduling and management of appointments.
- ✓ Visitors should be checked out from the facility after completing the appointment and record the same in the visitor management application via Check-out and Check-in manually or automatically.
- ✓ The Visitor management module must support a touchscreen interface in kiosk mode or setup, specifically designed for self-service use. Additionally, the interface should seamlessly adapt to a regular computer with a mouse, enabling receptionist-assisted interactions. This dual functionality will enhance user convenience and ensure a smooth visitor management process.
- ✓ Visitor management system shall support integration of National ID readers and authenticate the person. This can be used to fill ID holders name, company, email ID, Etc, automatically.

Defining Visitor Policy

- ✓ The visitor management module shall provide a criterion to define visitor policy having at least as per the following parameters:
- ✓ Mandatory fields shall be set in the policy enforcing the requestor to fill the selected mandatory fields to be filled for submitting a visitor request.
- ✓ Appointment is mandatory for every visitor or not mandatory. If this is defined as mandatory, then each visitor shall be required to get pre-registered before getting an entry credential.
- ✓ Issue access card to visitor is mandatory or not mandatory. If this is defined as mandatory, then it shall be required to issue an access card for each visitor.
- ✓ Generate a separate asset pass for a visitor asset that he/she is carrying inside the premises.

- ✓ Visitor Appointment Lapse Time, the admin shall be able to define the default lapse time in number of hours. Any visitor coming after the lapse time is over then the visitor pass cannot be generated on the same request.
- ✓ Default departure time shall be set as a time in a day which becomes the departure time of those visitor appointments which are not having a departure time selected.
- ✓ Pass printing hours shall be configurable so that when a visitor arrives prior to the pass printing hours then the visitor pass shall not be printed. For e.g. – If the expected arrival time is scheduled at 1 PM and the 'Pass print starting hours' value is set as 2, then the visitor pass cannot be printed prior to 11 AM.
- ✓ Authentication Type, this shall set the mode of authentication allowed to the visitor to gain access. It shall provide a list – Appointment ID, Access Pin, Smart QR or Classic QR
  - ➢ Appointment ID refers to a unique combination of identification numbers given to the visitor to show at the arrival.
  - ➢ Access PIN refers to a PIN number provided to the visitor by which he/she can gain entry simply by entering the same at the entrance.
  - ➢ Smart QR code is sent on the visitor's mobile which he/ she can flash on the QR code reader device at the entrance to gain entry.
  - ➢ Classic QR code refers to Static QR codes that can be used by visitor to gain entry by either flashing it against the QR reader or showing it at reception, as the case implies.
- ✓ The Visitor Management module shall provide a notification policy section where it can be configured to send the notifications via SMS, e-mail or Pop-up which can be sent on different conditions like host receiving notification when request is initiated by visitor, visitor receiving notification when visitor appointment is generated or cancelled.
- ✓ The Visitor Management Module shall allow to define Kiosk policy which offers a self-registration option to the visitors at the entry gate. The walk-in visitor shall fill the mandatory fields to fill while using the kiosk method to get himself/herself registered.
- ✓ It shall be possible to define a self-registration policy and any visitor applying for online visitor request shall submit the online according to this policy. This shall include the mandatory fields, defining the form title, add a description to be displayed on the form, define confirmation messages to be shown to visitor once the visitor form is submitted, uploading a Non-Disclosure Agreement which shall be checked 'agreed' by the visitor to complete visitor registration and uploading a Safety Instruction Document which shall be checked 'complied' by the visitor to complete the visitor registration.
- ✓ It shall be possible to define the Visitor Approval Groups referring to the group of those employees who can approve the requests Ex: CLIENT security team.
- ✓ The approval shall be based on 2 conditions in case of multiple level of approving authorities are there. There shall be up to 5 levels of approving authorities in a group.

- ✓ The conditions shall be either 'Approved by all, reject by anyone' which means all the levels of approving authorities shall receive the approval request simultaneously and it must be approved by all the approve the request, rejection by any one of the approving authorities shall reject the visitor request.
- ✓ Or the condition shall be 'Hierarchy level' approval which means that the Visitor Request shall be approved stepwise by different approving authorities in a group. In this case, the next level shall receive the visitor request only if the previous level approving authority has approved the request.
- ✓ A suitable authority to have approval privilege for approving Visitors, but not limited to CISF as there might be multiple teams for the same.

Employee User Interface

The Employee shall get a web login to the ACS Software which shall provide access to the visitor module, but the Employee shall be able to do the following tasks:

- Add New Visitor
- New Visitor request
- Adding meeting participants
- Request Approval/Rejection
- Self-reporting daily/weekly/Monthly/custom

Lobby Interface/Client Module

The Lobby Interface of the Visitor management software shall be client-based software without the need for a separate database. It shall utilize the same database of Access Control Software. This Interface shall support following:

- Check 'Today's appointment and expected visitors.
- System user checks or Inform visitor regarding their appointment status (Pending approval, Rejected, Expected, Inside, Inside Overstay, Visited)
- Issue a visitor pass to visitor with mandatory or optional fields.
- User shall be able to create their own pass by drag and drop feature related to pass designing. The user shall be able to select size, colour for front and rear and or size of labels, photo, company name logo etc., to be printed on the pass.
- User shall create separate pass for asset & vehicle and shall define asset that is deposited at gate as well as carried inside by visitor and mentioned in asset pass.
- User shall scan various visitor documents such as visiting card, ID proof etc.
- User shall print visitor pass, issue visitor pass, issue access credential/card to visitor.
- User shall be able to assign up to 4 access levels to a visitor and assign elevator access level, escort employee option, Pass-back exemption, extended access time to physically challenged visitors.
- The client application shall have a Smart Face Detection algorithm which crops the face only and gives up to 6 options of photographs of a visitor and any one can be selected by the user to be uploaded as visitor photograph.

Visitor Management Kiosk Module

- Self-Visitor registration
- Generate Visitor e-pass QR Code via email.

Visitor Management Client/Reception Module

- Add Walk-in visitors.
- Generate a Visitor request.
- Check Appointments.
- Issue Visitor pass with e-Pass QR Code via email
- Check Overstay Reports.

Reporting Module

The ACS Software shall provide a centralized reporting module that can provide multiple categories of reports based on the different functional requirements like:

- Attendance Reports.
- Access Reports.
- Visitor Reports.
- Vehicle Reports.
- Employee Audit Log reports.
- Card Audit Log Reports.
- Biometric Enrolment report.

Reporting Module Standard Features

- The section shall provide the option to filter the reports based on days like today, weekly, monthly & and custom date (from date – to date selectable).
- Further filtration shall be supported based on Employee criteria like Employee, branch, and department, selectable.
- It shall provide ordering of reports based on various parameters like Employee name, Employee id, shift name, etc., in ascending or descending order and then by parameters like date of duty, first login, last logout, etc., again in ascending or descending order.
- The reports shall be available at least in CSV and pdf format.
- Besides the standard reports the system shall allow customized report templates to be created utilizing the above filtering and ordering along with enabling and disabling any field and sequencing of rows and columns. These customized reports shall be saved as templates to be generated at any time by the user.
- The system shall support report scheduling which shall enable to user to create a criterion and save it for the system to create, generate, download, and send the report to the provided email ID in the criteria.

Access Reports

- Individual Access Report: In this section, the user shall generate an access (In/Out) report of the Employees.
- Reader Access Report: In this section, the user shall generate an access report based on a specific reader.

- Reader Group Access Report: In this section, the user shall generate an access report based on a reader group.
- Card Not Shown Report: In this section, the user shall generate a report which gives details of Employee who have not shown their card for a specified number of days.
- Who's Where Report: In this section, user shall generate a report to find out the current area of the Employee's presence.
- Muster Point Report: This generates a report of all the Employees gathered at a muster point (Know Muster Point here)
- Individual Reader Assignment Report: In this section, the report will provide details about which reader is assigned to each Employee.
- Reader Assignment Report: In this section, the user shall generate a report showing the Employee who are provided access to a particular reader.
- Guard Tour Report: In this section, the user shall generate a guard tour report by scanning all the checkpoints used during the guard tours.
- Employee Verification Report: In this section, the user shall generate the reports of Employee verified by the tab application (verified by authorized supervisor).
- Logical Access Report: In this section, the user shall generate a report which consists of login and logout details of users/ Employee who accessed Access Control Software Web Interface and Client Interfaces.
- Biometric Enrolment Report: Generate a report of Employee(s) enrolled through various biometric/ biometric enrolment devices.
- Employee Muster Point Report: Generate a muster point report of Employee(s), i.e., who all get gathered in an area during a specified period.
- Visitor Muster Point Report: Generate a muster point report of the visitor(s) i.e., whom all gather in an area during a specified period.

Employee Audit Log Reports

- Employee Card Assignment Report, in this section, the card assignment history of Employee(s) shall be audited.
- Employee Access Rule Assignment History, in this section, the access rule assigned to the Employee(s) for a particular time period shall be audited.
- Employee Current Card Report, in this section, a detailed report shall be generated elaborating details of the current cards issued to the Employee with date and time.
- Employee Current Access Rule Report, in this section, the user shall generate a report that provides details of the current access rule assigned to the Employee(s).

Card Audit Log

- Card Life Cycle Report, in this section, the user shall generate a report to get the details of the life cycle of a card (such as activation date, assigned Employee, etc.)

- Access Rule Assignment History, in this section, the user shall generate a report listing the access rules associated with cards used in the access management process
- Card Current Status Report, in this section, the user shall find the current status of the linked cards such as issued, available, active, inactive, suspended, and lost.
- Card Current Summary, in this section, the user shall get summarized information of card details.

Visitor Reports

- Visitor Summary: The summary report shall provide the visitor data in a summarized form.
- Visitor Details: This report shall provide the detailed information of the visitors.
- Daily Access Report: This report shall provide the access information of the visitors.
- Individual Access Report: The user shall generate an access report of each visitor with this standard report.
- Reader Access Report: As the name suggests, this report shall provide the access report of a particular reader or all readers.
- Card Summary: This report shall provide the summary of a particular visitor card.
- Blacklist Visitor Details: The report shall provide the details of the restricted visitors.
- Visitor Overstay: This report shall provide information on the visitors who have stayed on the premises more than the expected departure time.

Artificial Intelligence (AI) based Access Control System Software

The system shall provide a set of interactive and analytical dashboards that aggregate logs, trends, policies, and best practices with the help of advanced Machine Learning (ML) algorithms to provide actionable predictive insights for pre-emptive risk management. The set of dashboards shall comprise a minimum of the following functionalities:

- The dashboard shall provide a graphical and statistical representation of alarms based on various criteria: alarm severity, response, escalation, event sources, and location. The data range for the graphs shall be selectable based on different filtration criteria.
- The dashboard shall show alarms in context to the geographical location of a facility on scalable graphical maps.
- The dashboard shall offer operators a single-click underlying data access by simply clicking on various graph elements. The dashboard shall provide the logs for that graph element and offer further filtration and sorting options for data analysis.
- The dashboard shall highlight insights on anomalous events and defaulting users on various criteria based on analysis of personnel's and system's

historical behavioral patterns using machine learning algorithms. It shall further consolidate the anomalies to help identify risky profiles and faulty devices.

- The dashboard shall provide security audits & scores using advanced Machine Learning engines to measure and rate the robustness of physical access management infrastructure on multiple parameters such as alarms, response, infrastructure, and administration.
- The dashboard shall pinpoint vulnerabilities and threats to each facility to facilitate corrective actions to improve the organization's scores and overall security.
- The dashboard shall provide a graphical representation of various credential distribution patterns and credential types across the facilities.
- The dashboard shall accurately represent the total users within a facility, active headcount, user status, and type-wise & department-wise user count.
- The dashboard shall provide a glimpse of the organization's workforce/personnel/resident profile.
- The dashboard shall provide the total number of hardware components installed and configured within the facility.
- The dashboard shall provide visitor insights consolidating and presenting the visitor trends in an easily understandable format.
- The dashboard shall give alerts on the visitors' behavior in the facility, bringing the authorities' attention to the most frequent visitors, most active hosts (managers inviting the visitors), over-stayers, and the cards not returned post-visit.

Note: The Access Control Server Software shall have an inbuilt feature of integration with Integration Command & Control Centre (ICCC) Application Software without any additional Hardware. Bidders / OEM shall be proposed the software shall have the above requirement for Seamless integration with ICCC application. Successful bidder / Contractor shall be submitted the technical datasheets of above technical requirement in the form of Compliance document. No deviation shall be accepted. The Access Control System Software shall have an inbuilt feature as mentioned below

- Security Access Control Module
- Vehicle Access Control Module
- Visitor Management System Module
- Attendance & Time Management Module (HRMS)
- Video System Interface (CCTV) Module
- Interface Module for Integrated building Management System (IBMS)
- Mass Notification Module for Integrated Command & Control Centre

All the above features shall be provided as a part of Access control System Software Cost. However, the IBMS integration shall be done through Software & Hardware level without adding any additional third-party devices.

1.4.3 Specifications of Intelligent IP Controller

General Requirements:

- The family of intelligent controllers and peripheral interface devices must provide an open architecture family of products that enables a choice of host software system vendor without replacement of hardware.
- The networked door controller shall not be a proprietary product of the manufacturer of the host access control software application and must have the ability to migrate to an alternative manufacturer's host access control software application by remote reconfiguration or firmware upgrade and without intervention from the original controller manufacturer.
- The IP Controller should support at least 2 doors and 2 readers on Weigand protocol and 2 doors and 4 readers and OSDP protocol. The controller should provide the flexibility to connect additional readers with the support of reader expansion module as per the design requirement. With such expansion module, with single IP network point, controller customization option should be available to have design flexibility. The IP controller should support upto 64 doors with reader expansion module, if required.
- The IP controller should have 8 supervised inputs and 4 relay outputs natively. The controller should provide the flexibility to connect additional input or output module with the support of input/output expansion module as per the design requirement. With such expansion module, with single IP network point, controller customization option should be available to have design flexibility. The IP controller should support upto 500 inputs and 500 outputs with input/output expansion module, if required.
- The Intelligent IP controller should have at least 50,000 offline transaction storage capacity and should support at least 2,00,000 card holders.
- The controller should support a dual IP connectivity using an adaptor, if required.
- The intelligent controller should provide a robust network security such as mutual authentication with using TLS 1.2 while running in an FIPS 140-2 approved operating environment.
- The controller should support OSDP V2 to ensured secured communication between reader and controller. Controller should be able to get the health status of the reader through 2-way communication supported by OSDP.
- The intelligent controller should provide an enhance security with AES 256 encryption with Expansion modules.
- Card Formats: The intelligent controller should support 16 card per active reader & 8 card formats offline. Controller should support 255 access level per card holder. The intelligent controller should support 19-digit (64 bit) card format.
- The controller should support global (Hard) anti-passback. Anti-passback should be ensured from the controller level even if the access controller server is offline.

- Card Reader functions: The intelligent IP controller should have Elevator support, Turnstile and Biometric device Support (centralized biometric template management), paired and alternate reader feature, multi-occupancy Rules etc.
- Intrusion Alarm function: The Intelligent IP controller should have intrusion alarm functions like Entry/Exit delays, Area monitoring, Standard Alarm Masking etc.
- The intelligent IP controller should support wireless lock integration.
- The intelligent IP controller must comply with certification agencies such as including, but not limited to the following: UL-294, NIST certified encryption, FCC, RoHS, CE compliant.

Technical Specifications

- The interface is for use in low voltage, Class 2 Circuits only.
- The installation of this device must comply with all local fire and electrical codes.
- Primary Power: 12 to 24 Vdc ± 10 %, 500 mA maximum (reader and USB ports not included)
- Reader Ports 600 mA maximum (add 600 mA to primary power current)
- Micro USB Port 5 Vdc, 500 mA maximum (add 270 mA to primary power current)
- Memory and Clock Backup Battery: 3 Volt Lithium, type BR2330 or CR2330
- microSD Card: Format: microSD or microSDHC; 2GB to 8GB
- Host Communication: Ethernet: 10-BaseT/100Base-TX and Micro USB port (2.0) with optional adapter: pluggable model USB2-OTGE100
- Serial I/O Device One each: 2-wire RS-485, 2,400 to 115,200 bps, asynchronous, half-duplex, 1 start bit, 8 data bits, and 1 stop bit
- Inputs: Eight unsupervised/supervised, standard EOL: 1k/1k ohm, 1%, ¼ watt Two unsupervised dedicated for cabinet tamper and UPS fault monitoring
- Outputs: Four relays, Form-C with dry contacts Normally open contact (NO) contact: 5 A @ 30 Vdc resistive Normally closed contact (NC) contact: 3 A @ 30 Vdc resistive
- Reader Interface
  - Power: 12 Vdc ± 10 % regulated, 300 mA maximum each reader (jumper selectable) (input voltage (VIN) must be greater than 20 Vdc) or 12 to 24 Vdc ± 10 % (input voltage (VIN) passed through), 300 mA maximum each reader
  - Data Inputs: TTL compatible, F/2F or 2-wire RS-485
  - RS-485 Mode: 9,600 to 115,200 bps, asynchronous, half-duplex, 1 start bit, 8 data bits, and 1 stop bit. Maximum cable length: 2000 ft. (609.6 m)
  - LED Output: TTL levels, high>3 V, low<0.5 V, 5 mA source/sink maximum
  - Buzzer Output: Open collector, 12 Vdc open circuit maximum, 40 mA sink maximum
- Cable requirements
  - Power and Relays: 1 twisted pair, 18 to 16 AWG
  - Ethernet: CAT-5, minimum
  - RS-485

- (I/O Device Port): 1 twisted pair, shielded, 120-ohm impedance, 24 AWG, 4,000 ft. (1,219 m) max.
- (Reader Port): 1 twisted pair, shielded, 120-ohm impedance, 24 AWG, 2,000 ft. (610 m) max.
- Alarm Input: 1 twisted pair, 30 ohms maximum

- Environmental
  - Temperature:
    - -55 to +85 °C, storage
    - 0 to +70 °C, operating
    - Humidity: 5 to 95 % RHNC
  - Mechanical
    - Dimension: 8 in. (203.2 mm) W x 6 in. (152.4 mm) L x 1 in. (25 mm) H
    - Weight: 9 oz. (255 g) nominal, board only
- Product Compliance
  - UL294 Recognized
  - FCC Part 15 Class A
  - CE Compliant
  - RoHS (2011/65/EU & 2015/863)
  - EU REACH (1907/2006)
  - California Proposition 65
  - NIST Certified Encryption

Technical Features

- Connectivity: 10/100 Ethernet. Optional alternate 10/100 Ethernet (using USB/Ethernet converter)
- Security:
  - Host/Controller connection protected by TLS 1.2/1.1 or AES-256/128
  - Controller/IO Expansion connection protected by AES
  - Generate and load custom peer certificates for TLS
  - Port based network access control using 802.1X
  - Crypto memory chip
  - FIPS 140-2 user of OpenSSL
  - HTTPS protection for installer web pages
  - Secure cookies
  - SNMPv3/v2c
  - DIP switch toggle sets 5-minute time to disable webpage access
  - Disable default login credentials
  - Authorized IP address filtering
  - IP Client Proxy
  - Bulk erase controller and periphery devices during replacement
  - Strong password enforcement
- Door Control:
  - Two-reader ports: Clock and Data, Wiegand, or RS-485
  - Eight programmable inputs, four relays, diagnostic LEDs

- Access Control:
  - 240,000 Cardholder capacity
  - 50,000 Transaction buffer
  - If/Then Macro capability
  - Adjustable cardholder capacity
  - Supports up to 520 inputs and 516 outputs
- Card Formats:
  - 16 card formats per active reader, 8 per offline reader
  - Entire card number reported on invalid read
  - 19-digit (64-bit) User ID and 15-digit PIN numbers maximum
  - PIV, CAC, TWIC card compatible
  - 255 Access Levels per cardholder
  - Activation/Deactivation Date or Date & Times
- Card Reader Functions
  - Multiple card format support by reader
  - Paired reader support
  - Alternate reader support
  - Elevator support
  - Turnstile support
  - Biometric device support
  - Open Supervised Device Protocol (OSDP) and OSDP SC compliant
  - Occupancy count
  - Support of multi-occupancy rules
  - Anti-passback support
    - Area-based, reader-based, or time based
    - Nested area, hard, soft, or timed forgiveness
  - Supports host-based approval rules
  - Keypad support with programmable user commands, card input
  - Shunt relay support
  - Strike follower relay support
  - Threat level and Operating Modes
  - Host controlled OSDP reader passthrough
  - Elevator floor override
- Database Functions
  - Encrypted database
  - Configurable card database
  - Supports up to nineteen (19) digit card numbers
  - Supports pin codes up to fifteen (15) digits
  - Card issue code of up to 32 bits, ADA and VIP flags; PIV (75 bits); Smart Card (200 bits)
  - Ability to track people and objects
- Intrusion Alarm Functions
  - Supports entry delays and exit delays

- Area monitoring
- Standard alarm masking
- Provides control and alarm processing from the keypad

- Supported Integrations
  - Regional I/O shares I/O status
  - Wireless locks
  - Map Power Supply Alarms and Events using PSIA
  - Reader firmware and configuration download
  - Supports 1 total RS-485 I/O protocols
- System Functions
  - Relay count activations
  - Interoperability with older host software using Legacy Mode feature
  - Synchronize time using NTP

Note: Successful bidder / Contractor shall be submitted the technical datasheets of above technical requirement in the form of Compliance document. No deviation shall be accepted.

1.4.4 Technical Specifications of Reader Module

General Requirements:

- The Reader Expansion module should be used for adding additional readers to master IP controller.
- The Reader Expansion module should support at least 2 doors and 2 readers on Weigand protocol and 2 doors and 4 readers and OSDP protocol.
- The Reader Expansion module should have 8 supervised inputs and 4 relay outputs natively.
- The Reader Expansion module should be connected to master controller through RS-485 communication.
- The Reader Expansion module shall be able to utilize a cryptographic module that can encrypt/decrypt communication with the intelligent controller, supporting AES encryption using a minimum 256-bit key length.
- The Reader Expansion module must comply with certification agencies such as including, but not limited to the following: FCC, UL-294, IEC 62368-1, RoHS, and CE Complaint

Technical Specifications

- The Reader Module is for use in low voltage, Class 2 circuits only
- The installation of this device must comply with all local fire and electrical codes.
- Primary Power: 12-24 Volts DC +/- 10%, 550mA maximum (reader current not included)
- Intelligent Controller Communication: 2-wire RS-485 supporting 9600, 19200, 38400 or 115200 bps
- Inputs: Eight unsupervised/supervised, standard EOL: 1k/1k ohm, 1%, ¼ watt, Two unsupervised dedicated for cabinet tamper and UPS fault

- Outputs: Six relays, Form-C with dry contacts Normally open (NO) contact: 5 A @ 30 Vdc resistive, normally closed (NC) contact: 3 A @ 30 Vdc resistive
- Reader Interface: Two reader ports
  - Power:
    - 12 Vdc ± 10 % regulated, 300 mA maximum each reader (input voltage (VIN) must be greater than 20 Vdc) or
    - 12 to 24 Vdc ± 10 % (input voltage passed through), 300 mA maximum each reader
  - Data Inputs: TTL compatible, F/2F or 2-wire RS-485
  - RS-485 Mode: 9,600 to 115,200 bps, asynchronous, half-duplex, 1 start bit, 8 data bits, and 1 stop bit. Maximum cable length: 2000 ft. (609.6 m)
  - LED Output: TTL levels, high>3 V, low<0.5 V, 5 mA source/sink maximum
  - Buzzer Output: Open collector, 12 Vdc open circuit maximum, 40 mA sink maximum
- Cable requirements
  - Power: 1 twisted pair, 18 AWG
  - RS-485 I/O devices: 1 twisted pair with drain wire and shield, 24 AWG, 120ohm impedance, 4,000 ft. (1,219 m) max.
  - Alarm Inputs: 1 twisted pair, 30 ohms maximum
  - Outputs: As required for the load
  - Readers:
    - Wiegand (TTL): 6-conductor, 18 AWG, 500 ft. (150 m) maximum
    - F/2F: 4-conductor, 18 AWG, 500 ft. (150 m) maximum
    - OSDP (RS-485): 1 twisted pair with drain wire and shield, 24 AWG, 120-ohm impedance, 2,000 ft. (610 m) maximum
- Environmental
  - Temperature:
    - -55 to +85 °C, storage
    - -0 to +70 °C, operating
  - Humidity: 5 to 95 % RHNC
- Mechanical
  - Dimension: 6 in. (15 2mm) W x 8 in. (203 mm) L x 1 in. (25 mm) H
  - Weight: 11 oz. (312 g) nominal
- Product Compliance
  - UL294 Recognized
  - FCC Part 15 Class A
  - CE Compliant
  - RoHS (2011/65/EU & 2015/863)
  - EU REACH (1907/2006)
  - California Proposition 65

Technical Features

- Card Formats:
  - Eight active card formats per intelligent controller

- 19-digit (64-bit) User ID and 15-digit PIN numbers maximum
- PIV-II, CAC, TWIC card compatible

- Card Reader Functions
  - Multiple card format support by reader
  - Paired reader support
  - Alternate reader support
  - Turnstile support
  - Biometric device support
  - Keypad support with programmable user commands, card input
  - Shunt relay support
  - Strike follower relay support
- Database Functions
  - Supports up to nineteen (19) digital card numbers
- Intrusion Alarm Functions
  - Supports entry delays and exit delays
  - Provides control and alarm processing from the keypad
- Offline mode operation
  - Door mode
    - Unlocked, locked, facility code only
- Relay Mode
    - Programmable for offline conditions

Note: Successful bidder / Contractor shall be submitted the technical datasheets of above technical requirement in the form of Compliance document. No deviation shall be accepted. However, the Reader Module shall have inbuilt OSDP Protocol 4 Reader Connectivity. If the Reader Module does not have a OSDP Protocol scheme of operation, the scheme of proposals which can be submitting by successful bidder shall not be accepted.

1.4.5 Technical Specifications of Multi Technology Contactless Smart Card Readers

- The Multi-Technology contactless smart Card reader should be of Mullion Mount.
- The multi-technology contactless smart card reader must comply with the ISO 15693 and ISO 14443A 13.56MHz-related standards to ensure product compatibility and predictability of performance.
- The multi-technology contactless smart card reader must support communication frequency of 13.56MHz and 2.4 GHz (BLE)
- To ensure data authenticity and privacy the multi-Technology contactless smart card reader shall follow the standards-based, device-independent Security Identity Object (SIO) portable credential methodology. The SIO shall be able to reside on any number of identity devices, including Seos, iCLASS SE, iCLASS SR, MIFARE Classic, and MIFARE DESFire EV1/EV2/EV3 credentials.
- To enable mobile access the multi-Technology contactless smart card reader must support Bluetooth Low Energy (BLE) and NFC card emulation mode.

- The multi-technology contactless smart card reader shall utilize Secure Element Technology to protect keys and ensure secure cryptographic functions. The secure element on the reader should be minimally rated with the international standard Common Criteria security evaluation, achieving an Evaluation Assurance Level of EAL 5+.
- Mandate to provide universal compatibility with most access control systems the multi-Technology contactless smart card reader shall support the SIA AC-01 Wiegand standard as well as secure, bidirectional communication in compliance with v2 of the SIA OSDP (Open Supervised Device Protocol) standard
- The Multi-Technology contactless smart card reader shall allow the reader firmware to be upgraded in the field without the need to remove the reader from the wall through the use of programming utilities or applications.
- The Multi-Technology contactless smart card reader shall have the ability to provide consistent optimal read range by implementing an automatic surface detection function that adjusts for mounting environment and manufacturing tolerances to enhance consistency of read performance
- The multi-technology contactless smart card reader shall reduce power consumption by as much as 50% through the use of Intelligent Power Management (IPM) technology
- The multi-technology contactless smart card reader must have an environmental rating of IP65 to withstand water and dust ingress commonly associated with outdoor mounting
- The reader must comply with local certification agencies such as including, but not limited to the following: UL 294/cUL, FCC certification CE including RoHS II, BIS etc.

Note: Successful bidder / Contractor shall be submitted the technical datasheets of above technical requirement in the form of Compliance document. No deviation shall be accepted.

1.4.6 Technical Specifications of Biometric reader

- The dual factor fingerprint biometric access control reader must support live capture of fingerprints for matching identification or verification for physical access control.
- In order to ensure interoperability, the biometric fingerprint reader must support ANSI-378 template standard (Template on Card).
- The fingerprint biometric access control reader must support a communication frequency of 13.56MHz and 2.4 GHz (BLE)
- The fingerprint biometric access control reader shall follow the standards-based, device-independent Security Identity Object (SIO) portable credential methodology. The SIO shall be able to reside on any number of identity devices, including Seos, iCLASS SE, iCLASS SR, MIFARE Classic, and MIFARE DESFire EV1/EV2 /EV3 credentials

- To ensure product compatibility and predictability of performance the reader must support the following standards: ISO 15693 and ISO 14443
- In order to provide universal compatibility with most access control systems, as features become available, the reader must support output card data in compliance with the SIA AC-01 Wiegand standard or v2 of the SIA Open Supervised Device Protocol (OSDP) over RS485 for access control data communication- in order to cover the widest possible use cases, the biometric must have the following interfaces:
  - One Wiegand Port In/Out Selectable
  - One RS-485 Port (OSDP)
  - One TTL Input/Output Selectable
  - One selectable Supervised Input/ TTL Output
- The dual factor fingerprint biometric access control reader shall be equipped with an EAL4+ certified Secure Element to protect keys and execute cryptographic functions.
- The dual factor fingerprint biometric access control reader must feature a multispectral sensor to capture fingerprint images from both the surface and the sub-surface, therefore delivering optimal biometric performance regardless of environmental and skin conditions
- The dual factor fingerprint biometric access control reader must support liveness detection capabilities, preventing spoof attempts leveraging fake fingers or latent fingerprints
- The dual factor fingerprint biometric access control reader must support multiple authentication modes:
  - Template on card for dual factor authentication with fingerprint and iCLASS Seos cards
  - Card Only for single factor authentication with supported HF physical cards or mobile credentials
  - Fingerprint Only for 1:1 single factor authentication – for up to 5,000 users n the device database.
  - Card + Fingerprint for 1:N dual factor authentication – for up to 2,00,000 templates in the device with physical access cards or mobile credentials
  - Combination mode: Card only or Finger only for single factor authentication with physical access cards or mobile credentials
- In order to ensure a consistent security level throughout the access control system the reader must support a standard based Secure Identity Object data model, both for standard and virtual badges. Within the Secure Identity Object data is secured with a wrapper that provides key diversification, authentication signatures, and encryption.
- The dual factor fingerprint biometric access control reader must connect to the web based Biometric Manager on a TCP/IP network and allow the following functions:
  - Remote Management of the reader
  - User Enrolment

- System Configuration
- Live Events Transaction for connected readers
- Software and Firmware Update/Upgrade
- Import User Credential from OEM Database

- The dual factor fingerprint biometric access control reader must be IP67 Indoor/Outdoor and IK09 Impact rated for outdoor installation.
- The reader must comply with certification agencies such as including, but not limited to the following: BIS, UL 294/cUL, FCC certification, CE, RoHS etc.

Note: Successful bidder / Contractor shall be submitted the technical datasheets of above technical requirement in the form of Compliance document. No deviation shall be accepted.

1.4.7 Technical Specifications of QR Code reader

Card type	EM Card / IC Card
Barcode type	QR, One-dimensional Code
Communication	Weigand / RS232 / RS485
Decoding Mode	Image decoding
Reading Direction (Barcode)	45º inclined plane with the lens
Reading feature	Auto-induction, Beep hint
Working Voltage	5~15V
Working Current	800mA
Reading distance (card)	3~6 cm
Reading Speed	<200 m/s
Reading distance (Barcode)	0~20 cm
Material	Tempered glass (code window)
Working humidity	10%~90%
Working temperature	-20º C ~ 70º C
Dimensions	Compatible to fit inside the Swing Barrier
Indicating light	Blue - Working Green - Feedback
Weight	As per the Swing Barrier Recommendation
QR code format	Code 128, Code 39, EAN-8, EAN-128, EAN-13, QR code, ISBN-13, Data matrix

1.4.8 Technical Specifications of Contactless smart cards

- The contactless smart cards (13.56Mhz support) must be compliant with the following standards:
  - ISO/IEC 7810 Physical characteristics, format ID-1: 5.40 cm x 8.57 cm x 0.084 cm
  - ISO/IEC 14443-A parts 1-4 Contactless integrated circuit cards with random UID

  - ISO/IEC 7816-4,3.1 ISO/IEC 7816-4:2005, Sections 5.2 (Data Objects) and 5.3 (Structures for applications and data) for the organization of all data on the card
  - ISO/IEC 7816-4:2005 Section 5.2.2 (BER-TLV data objects) for the encoding of data
  - ISO/IEC 7816-4:2005, Section 7.5 for the authentication methods
- Contactless smart card should have at least 8K memory and can store data for multiple application.
- Contactless smart card should have corporate 1000 programming to avoid the duplication of the card numbers.
- Contactless smart card should support multi-layered trusted management of secure identities using the portable Secure Identity Object data model.
- All cryptographic algorithms, modes of operation, protocols and mechanisms used by the card shall be based on open standards (such as ISO/IEC, NIST, IEEE, EN, ETSI) and not subject to any patents or royalty payments.
- A secure messaging algorithm established after mutual authentication will protect contactless communication between the card and the off-card application.
- Mutual authentication shall be based on ISO/IEC 24727-3 2008 with NIST SP800-56A or SP 800-108 session key derivation.
- Each secure session relies on diversified keys based on an underlying cryptographic 2-key TDES or AES128 algorithm setup at the start of each session and using secure messaging based on European Standard EN14890-1 as well as ISO/IEC 7816-4.
- The physical access control data stored on the card shall be protected using an encrypted AES128 bit algorithm, signed using a CMAC-96 (message authentication code).
- The physical badge construct shall consist of a composite material to ensure physical stability during Direct-to-Card (DTC) or retransfer printing processes.

1.4.9 Technical Specifications of Passive Equipments

Electro Magnetic Locks (EM Lock)

- The magnetic lock shall consist of a magnet mounted onto door frame and a steel plate attached to the top of the door.
- The door shall be strongly closed when the magnet is energized with the steel plate bonded to it. Instant release shall be possible when power supply is cut off, providing fail safe operation.
- The door controller shall control the EML.
- The EM Lock shall be suitable for mounting single, double, flush, swing type, metal, glass, wooden doors with (or) without frames.
- The Vendor shall consider the required mounting accessories for the above in their lock cost.
- The EM Lock shall have a minimum holding force of 600 LBS for single leaf door & 1200 LBS for double leaf door.

- The rate shall inclusive of all fixing brackets, accessories for Glass Door, Wooden Door, and Metal Doors as per the site conditions. No extra cost shall be provided by client for additional accessories.

Magnetic Contact

- The magnetic contact shall be of flush / surface mount type as required at site.
- The contacts shall be corrosion resistant and completely hermetically sealed.
- 5 million cycles of operation shall not affect the contact.
- This contact shall be used by the door controller to monitor the door status.
- The contact shall contain a hermetically sealed magnetic reed switch.
- The reed shall be potted in the contact housing with a polyurethane-based compound.
- Contact and magnet housing shall snap-lock into a 3/4" or 1" dia. hole.
- Housings shall be moulded of flame retardant ABS plastic.
- Color of housings shall be off-white, grey or mahogany brown.
- The magnet shall be made of Alnico V. Rare Earth Magnet shall be made of neodymium iron boron.
- The contact shall be suitable for wooden, glass & metal doors.

Emergency Release Switch

- The emergency release Switch resettable press to open glass type, similar to a re settable manual call point and shall be green in colour. In case of any emergency, the plastic facia in the switch shall be pressed to cut-off the power supply to the electromagnetic lock.
- A key shall be used to reset the Release Switch Box to normal close position. The emergency release box shall be truly resettable type without any need for changing the glass after every operation. Once the glass is pressed, the same shall be reset by using the reset key.
- There shall NOT be any need to change the glass for every operation. The re settable emergency release box shall have a relay contact which shall be monitored by the door controller.
- Whenever the emergency box is operated, an audio-visual alarm shall pop up in the ACS PC

Door Buzzer

- Vendor shall provide piezo electric type door buzzer. The buzzer shall preferably half white in colour and shall NOT be more than 2” in dia and 2” in height. The door buzzer shall start operating when the door time is elapsed between 2 card swipes and the door is NOT closed. The door buzzer shall keep operating as long as the door is open and when the door is closed the buzzer shall stop operating immediately.
- Also, the buzzer shall not operate if the cards are being continuously swiped in the reader even when the door is opened continuously.
- The vendor shall consider the required power supply for powering the buzzer. The buzzer shall also have the facility to control the volume depending upon the site & situation requirement.

- Vendor shall use the programmable IOs in the access controller to activate this function.

1.4.10 Technical Specifications of Access Control System Server

Server, Windows Server Standard, SQL Server Standard. Intel Xeon Silver 3104 Processor, 8 MB L3 Cache, 6 Cores, 6 Threads 3 x 8GB RDIMM, 2666MT/s 1 x 1TB 10K RPM SAS 2.5in Hot-plug Hard Drive 2GB Network Card Windows Server 2016/2019 Standard, 104, 12 function key DD, 21" LCD Monitor, Wireless Mouse, USB Keyboard, CD/DVD Combo Writer, TCP/IP Connection.

Note: The Configuration mentioned is only Minimum requirement. Vendor to consider as per OEM recommendations in case of higher configurations shall be required as per project functional requirements and the bidder to consider the cost for the same & quote accordingly. The bidder needs to consider the same configuration if OEM will not have an objection for the mentioned specifications. No deviation shall be accepted. The ACS Server shall be Hot Redundant 1+1 Configuration. In the BoQ line item requires cost of redundancy server also. Hence, no additional cost shall be paid by client for Redundancy Server and the ACS Server should be Rack mountable Blade type. Tower type / Tabletop mounted server shall not be accepted.

1.4.11 Technical Specifications of Operator Workstation for Access Control Client & Visitor Management System

Intel core 9th Generation Intel Core i9 Processor by latest generation or better, 16GB DDR3 RAM, 64-bit operating system, 1TB SSD for OS and Security Center applications, with a minimum of 16 GB of free disk space to install the Security Center client application, 1TB SATA Hard disk with 7200rpm, GbE network interface card, DVD-RW standard keyboard & Mouse with Dual NVIDIA® GeForce® RTX 2080 video card with 21" FULL HD LED MONITOR. Minimum 4 HDMI,1 parallel, 8 USB 2.0, 1 serial, 2 Ultra ATA/100, 2optional IEEE1394, 1 USB Keyboard, 1 USB Mouse, 1 video, 1 Microphone jack, 1 Line-in jack, 2 x 1GBPS RJ-45 Interface Port

Note: The Configuration mentioned is only Minimum requirement. Vendor to consider as per OEM recommendations in case of higher configurations shall be required as per project functional requirements and the bidder to consider the cost for the same & quote accordingly. The bidder needs to consider the same configuration if OEM will not have an objection for the mentioned specifications. No deviation shall be accepted.

1.4.12 Technical Specifications of Thermal printer

Print speed	Print speed 250 mm/sec
Column capacity	FONTS & STYLES Column capacity Paper width 80 mm, 48 / 64
Paper size	Paper size 79.50 ± 0.50 (W) mm x dia 83.00 mm, 57.50 ± 0.50 (W) mm x dia 83.00 mm

Print Speed	Print Speed 250 mm/sec
Print Speed receipt	Print Speed receipt 250 mm/sec
Printing Font	Printing Font ANK
Column capacity receipt	Paper width 80 mm, 48 / 64
Paper width	80 mm, 48 / 64
Character set	95 Alphanumeric, 18 set International, 128 x 43 Graphic
Characters per inch	22.6 cpi / 16.9 cpi
Dot density	203 DPI x 203 DPI
Colour Printing	Black
Printing Characters	Text (incl. Euro symbol), Graphics, Barcode
Interfaces	RS-232, USB 2.0 Type B, Drawer kick-out
Data Buffer	4 kB or 45 Bytes
Power Supply	AC adapter, C1
Power Consumption	Standby: 0.1 A, Mean: 1.8 A
Operating Voltage	24 V

1.4.13 Technical Specifications of Workstation Monitor / Display

22" Monitor Detailed Specification	
Monitor	22 Monitor - P2219H
Diagonal Viewing Size	54.61 cm (21.5 inches)
Maximum Preset Resolution	1920 x 1080 at 60 Hz
Aspect Ratio	16:09
Pixel Pitch	0.248 mm x 0.248 mm
Pixel Per Inch (PPI)	102
Brightness	250 cd/m² (typical)
Color Support Color Gamut (typical)	72% (CIE1931)8
Color Depth	16.7 million colours
Contrast Ratio	1000 1 (typical)
Viewing Angle	178°/178°
Response Time	8 ms (Normal) 5 ms (Fast) - (grey to grey)
Panel Type	In-Plane Switching Technology
Backlight Technology	LED Edge light System
Comfort View with Flicker-free screen	Yes
Display Manager Compatibility	Yes
Display Screen Coating	Antiglare with 3H hardness
Connectors	1 x Display Port version 1.2, 1 x HDMI port version 1.4, 1 x VGA port, 1 x USB 3.0 upstream port (bottom), 2 x USB 3.0 downstream ports (side), 2 x USB 2.0 downstream ports (bottom)

22" Monitor Detailed Specification	
Built-in Devices	USB 3.0 super-speed hub (with 1 x USB 3.0 upstream port), 2 x USB 3.0 downstream ports, 2 x USB 2.0 downstream ports
Adjustability	Height-adjustable stand (130 mm), Tilt (-5° to 21°)
Swivel	(-45° to 45°), Pivot (-90° to 90°)
AC input	voltage/frequency/current 100 VAC to 240 VAC / 50 Hz or 60 Hz ± 3 Hz / 1.5 A (typical)
Power Consumption	(Operational) 17W (typical) / 37W (maximum)9
Power Consumption	Standby / Sleep Less than 0.3W
Environmental Compliance	ENERGY STAR®, EPEAT® Gold10, RoHS Compliant, TCO-Certified Display, BFR/PVC free monitor Arsenic-Free glass and Mercury-Free

1.4.14 Technical Specifications for Swing Barrier

- Each Swing barrier lane should have provision for recessed installation of 2 nos. smart reader and 2 nos. of Smart Card Readers and 2 Nos of QR code readers, each 01 on Entry side and each 01 on Exit. These readers should come factory fitted with the flap barrier as per site requirement.
- The design of the gate arrays should be such that the user uses the integrated reader placed on the right-hand side while passing through the gate.
- The gate of retractable type should be with material of enough strength for use in mass transit system.
- If the barrier is forced open, no damage shall happen to gate components and gate should automatically restore to normal. An alarm should be generated during such forced opening.
- There shall not be any sharp edge in the gate, which can hurt user while passing through.
- In case of emergency there should be provision for continuous opening of the gates to facilitate exit of personnel from the building.
- Emergency switch should be provided to facilitate easy exit of personnel.
- Sensor mounted above, below, and sideways the flap to generate an acoustic alarm for each unauthorized attempt, jumping over or crawling under the flap wings.
- There shall be selectively illuminated Lane Indicator sign on both ends of each gate. The display shall be illuminated whenever the gate is intended for use in the direction shown.
- Material to be used: 304 Grade stainless steel with thickness of 2 mm for housing.
- Retractable Flap wing: should be 12 mm thick transparent Acrylic/ toughen glass with rubber safety edge for the panels.
- Power supply:220V AC, 50/60Hz.

- Sensor to detect person in safety zone: fully retract in case of power failure/emergency
- Card readers should be integrated with the flap barrier housing, for entry/exit.
- Motor: DC brushless, Protection IP20
- Minimum Dimensions: 1400 mm X 100 mm x 1000 mm (L x W x H)
- Channel/Passage Width should be in the range of 600mm for Normal Lane & 900mm for Wide Lane
- Pass Speed (Minimum): 40 Person / Min.
- Should be capable of operating in Indoor conditions
- LED indicators
- Operating Temperature: up to 50 Degree Celsius.
- Relative Humidity: 95%
- MCBF: Min 4,000,000 Cycles
- Power Supply: 240 Vac
- Same model shall be capable of expanding into “N” number of lanes.
- Approvals: NABL, CE, FDA, ROHS, FCC, ISO, QCI, NSIC, BS EN 60204-1:2018, EN 61000-6-2-2005, EN 61000-6-3:2007, EN ISO 12100:2010

Note: Successful bidder / Contractor shall be submitted the technical datasheets of above technical requirement in the form of Compliance document. No deviation shall be accepted.

1.4.15 Technical Specifications Multi Zone Door Frame Metal Detector

S No	Specification of MZDFMD
1	Detection: (i) The system should be capable of detecting ferrous, non-ferrous and alloy metals concealed in the body of a person when passed through the archway. (ii) Uniform detection from top to bottom is required. (iii) Should be able to detect multiple metal objects of various weight, size and shape in all the zones simultaneously from head to toe.
2	Passage Dimension: (i) Height - Min 200mm (ii) Breadth - Min 720mm (iii) Width - Min 570mm
3	Speed of Passage: Performance of the DFMD should be independent of the speed of person passing through. This is particularly important as a person's foot may swing through the archway without touching the ground or may come to rest on the ground between the archway pillars.
4	Weight: 80 Kg maximum
5	Power supply: 100 - 260 VAC, 50 -60Hz, 12-24 VDC, should be provided with internal battery backup for 6 hours minimum in operational condition.

6	Alarm indication: (i) There should be Acoustic and Optical alarm with alphanumeric display, height on person bar display (Metal locator) and low battery indication. (ii) There should be a provision for suitable setting for adjustment of volume of the audible alarm to overcome the ambient noise present in the vicinity.
7	Sensitivity & Zones: (i) Dual side detection (ii) 18 overlapping detector multi-zones (iii) Displaying panel (iv) Indication of alarm areas (v) Adjustable area of sensitivity (vi) Two Way operation (vii)Static counting (Directional Counter - In, Out, Net and Alarm)
9	Calibration: DFMD shall have inbuilt feature of both manual and automatic calibration.
10	Security: (i) There should be a provision to secure the access to the control unit by a password protected alpha numeric keypad. (ii) DFMD should reset itself within 3 Sec after alarm condition. (iii) Unit should have traffic and alarm counter. The equipment should work in bidirectional mode.
11	Other features: (i) High discrimination between small masses and personal metallic objects. (ii) Automatic synchronization for DFMDs located close to each other up to a distance of one feet side by side.
12	Static Metal Compensation: DFMD installed closed to fixed sheet or pieces of metal, which form part of the building or its fittings. The DFMD should compensate for the presence of such metal and its performance should not be degraded by the presence of metal as stated above.
13	Health and Safety: (i) Magnetic field should be harmless to magnetic media, electronic devices and should be film safe, (Supplier shall submit test certificates from national/international accredited lab). (ii) Operation of DFMD shall not be affected by infrared, ultraviolet, electromagnetic or RF radiation. Offered equipment shall comply with CE or equivalent safety/ immunity standard (Supplier shall submit test certificates from national/international accredited lab).

	(iii) DFMD should be harmless to pacemaker and pregnant woman (Supplier shall submit test certificates from national/international accredited lab as per ICNIRP guidelines).
14	Interference rejection: (i) Interference, which is 'mains-borne' or radiated by an external source, should not cause the DFMD to raise the alarm spuriously. It should be possible to use equipment such as radio, portable telephone, walkie-talkie sets, X-ray monitors etc. at a distance of one mtr from the archway without causing spurious alarms. (ii) Moving metal beyond one mtr from DFMD should not affect performance of the DFMD. It should be possible to move metallic items like trolleys, metallic gate opening /closing one mtr away from the DFMD without the generation of false alarm.
15	Operating Temperature: DFMD shall work satisfactorily without any deterioration in performance within the temperature range of -20 to +55 °C, RH up to 90% non-condensing.
16	Accessories to provide: (i) Operating manual for the user. (ii) Standard Test Piece (STP) for testing of equipment to be provided by the supplier with each equipment. Optional Should have a ruggedized Polypropylene shock proof container for safe transportation of product compliant to IP-65 and Latest Mil Std. (As per requirement of the user).

Note: Successful bidder / Contractor shall be submitted the technical datasheets of above technical requirement in the form of Compliance document. No deviation shall be accepted.

1.4.16 Technical Specifications for X-Ray Baggage Machine

Tunnel Size - Minimum 600mm W (width) x Minimum 400mm H (Height) or better.
Conveyor best speed should be between 0.18 and 0.3 meter per second Conveyor movement bidirectional.
All machines should operate on 230 VAC. 50 KZ power supply and should be able to withstand voltage fluctuations in the range of 170V to 260 V. Single Phase. 3 to 5 Amp.
Conveyor Capacity -160 kg or more
Through put should be 200 bags per hour or more
Sensors > 1000 diodes, L-shaped detector (Folded array type), in case of defective diode arrays, scanning should be disabled, and error message should be displayed on the screen.
X-Ray Voltage - Maximum 160 XV

X-Ray Source/Generator - It should be capable to operate smoothly for a period j of at least six years.
Duty Cycle- 100%
The X-ray beam divergence should be such that the complete image at j maximum size of bag is displayed without corner cuts.
The radiation level should not exceed accepted health standard (0.1m R/Hr at a distance of 5 CM from external housing). Relevant certificate from AERB.
The operating temperature normally should be 0 deg C to 40 deg C.
Storage temperature 0 degree C to 50-degree C.
Humidity- 90% non-condensing
Resolution: The machine should be able to display single un-insulated tinned copper wire of 38-AWG. All penetration and resolution condition should be met without pressing any functional key and should be online.
Penetration should be 35 mm thickness of steel or more.
Continuous Electronic Zoom facility should be available to magnify the chosen area of an image eight times (8X) or more. Image features shall be keyboard controllable.
Video display- 18.5" or better LCD Monitor SVGA High resolution, low radiation, flicker free, resolution at least 1280 x 1024, 24-bit colour real time processing.
The machine should have features of Multi-energy X-ray imaging facility where materials of different atomic number will be displayed in different colors to distinguish between organic and inorganic materials. With this method to distinguish high density organic materials including explosives. Machine should have variable colour or materials stripping to facilitate the operator to monitor! images of organic materials for *closer* scrutiny. Ail suspicious items (Explosives, High density, material narcotics) should be displayed in one mode and that j should be online
Radiation Safety: The machine must comply with requirements of health and safety regulations with regard to mechanical electrical and radiation hazards. Before installation of the machine, the supplier/manufacturer should furnish relevant certificate from Atomic Energy Regulatory Board of India regarding radiation safety. The company manufacturing the equipment should have ISO certification for manufacturing and servicing *of X-ray* Screening machines.
Film - Safety Guaranteed safety for high-speed films up to IS01600. The machines should be film safe. In other words, photographic films must not be damaged due to X-Ray examination.
Machine should be properly sealed from all the sides for pest proof. Dust proof cover is to be provided for covering when system is not in use.
Facility for variable contrast must be incorporated to allow enhancement of lighter and darker portion of the image.
The machine should be so designed that software enhancement can be easily implemented to take care of new technique in image processing and pattern recognition.

Full diagnostic built in test facility. Ail models should have software-controlled diagnosis report facility and system should give printout if printer Is connected.
All software features of machine should be online, and password protected.
Machine should-be capable for recalling 15 or more previous images.
It should have the capability of archiving 3000 or more images with date & time stamp.
Control desk with security housing and locking provision should be available. The operator personal identification number can be entered the keyboard along with generation of log.
Facility of image enhancement should be available.
All models should have online recording facility and images can be recorded in CD R/W or/and USB and should be able to view images so recorded on stand-alone PC.
Lead impregnated safety screens should be available at either ends of the tunnel. This should be covered by relevant AERB certificate. Idle rollers to be provided at either ends of the tunnel to facilitate placing of baggage at input and output.
All software features should be controlled from keyboard of machine only. Keyboard function should be user friendly. To enable/disable the software features system should not be rebooted
If the machine fails to penetrate a particular item, then an alarm video and audio both should be generated to notify the operator
The threat image projection (TIP) system software to be incorporated in all X- Ray BIS operation as per details given in Annexure-I.
Copy of all software including X-Ray Software with recovery CD must be provided.
Operational Training- Operating staff has to be provided free training.
Operating & service manual shall be provided with each machine.
Other Features a) Edge &. variable edge enhancement. b) Inverse Video c) Set up time not more than 10 minutes d) Pseudo colour e) Date & Time display.
Minimum Computer Configuration: - Dual Core Processor at min 3.6 GHz, 8GB RAM, 4TB Hard disk, With Wired Mouse & Customized Keyboard with Emergency stop function, Linux OS, DVD Writer. 10/100/1000 on board integrated Network Port with remote booting facility remote system installation, remote wake up, cut of band management using any standard management software.
UPS: - 3 KVA or better online with back-up time of 1/2 hour to whole system.
Threat image Projection
Tip software facility shall be incorporated in the offered X-ray machine to assist supervisors in testing the operator alertness and training X-ray screeners to improve their ability in identifying specific threat object. The system will create a threat object and the same will be superimposed on the monitor screen while a bag is being screened. To acknowledge that the operator has seen the false object, operator must

press the control panel key that will cause the computer-generated threat object to disappear from x-rayed bag image on the VDU screen. Each operator's action shall be recorded in the hard disc of the computer for the auditing purpose by the supervisor or other authorized person.
Design of the System:
Tip software should be compatible with other X-ray technologies such as automatic reject unit. Dual X-Ray screen technologies, automatic treat recognition system etc. All x-ray image functions must be available at the same time along with the TIP.
Image Library
The image library should have an image library containing at least 100 explosives devices. 100 knives and 100 firearms in various sizes, shapes, locations, and orientations. However, the system shall have facility to expand the library to incorporate additional images by user without assistance of the manufacture.
The image library should contain images of threats at different orientations both plan and end on orientation should be used. Although these will be assigned different file names and references, it must be possible to cross-reference these as the same threat All threat image Projection images must be realistic, representative, and non-distinguishable from real threat items.
Time Interval
Programming facility shall be available to project threat images in different intervals. The time period for threat image as well as image mix in percentage shall be user programmable e.g., software shall select 40% images of explosive devices, 35% of firearms & 25% knives or random etc.
Once the screener has responded to identify the computer-generated threat image, it should remain on the screen for a predefined user programmatic feedback message shall be visible to the screener.
System Administration
The threat image projection facility shall have *details* of user database such as Department name, screener name, Organization, User ID Number, level of access such screener, administrator Maintenance & Password etc.
Access to start up menu should be restricted only to the authorized individuals. A log-in procedure by means of Password" or "Security Key" could achieve restricted access to each of the comment. The log-in procedure should not take | longer than 20 seconds. The system should have facility to bypass the TIP facility, if programmed so by the system administrator. It is to be ensured that the TIP software shall not be hindrance to normal functioning of x-ray machines.
When the operator logs-in or logs-out message should be displayed on x-ray BIS VDU Screen to confirm that the/she has been correctly togged-in or logged- out.
Feedback Report
The threat image Projection should be capable of giving feedback "HIT, MISS or FALSE ALARM" message. No message will be presented if a screener correctly passed as clear bag.

A “HIT" message to be presented when a screener has correctly identified a Threat image Projection Image. A “MISS”: message shall be presented when screener fails to identify the Tip image. A “False Alarm” message shall be given when screener incorrectly indicate TIP image when in fact no threat image projection is present. The feedback should clearly Indicate in a screen that a tip object has been correctly identified/tip object has been missed/ that a TIP object has been missed/no TIP object was present. Information should be recorded in the database.
Different colour coding shall be used for feedback to the Screener., It is recommended that colour code “Red for MISS” Green for “HIT” and Yellow to False Alarm or interrupt” be used.
The system shall automatically prepare the dally log of events for each shift and for each Screener performance. TIP log shall include particulars of Name of Screener, Time & date of threat image, weather threat image was successfully identified or missed etc.
The report on Threat Image Projection system may have date and time (From - to) as per requirement. Screener particulars, and decision/outcome i.e., MISS, HIT or False Alarm in percentage as well in absolute numbers, numbers of bags screened, categories such as explosives devices knife or weapon etc.
As a standard practice, daily/weekly /monthly report shall be retrieved. Report shall be for any given time and period, as per command.
All data should be stored on the system for a minimum of two months after it has been downloaded No individual, regardless of access rights to the Threat Image Projection components would delete or amend any of threat image Projection data or time i.e. Threat Image Projection data on the actual X-ray machine will be read only file.

Note: Successful bidder / Contractor shall be submitted the technical datasheets of above technical requirement in the form of Compliance document. No deviation shall be accepted.

1.4.17 Technical Specifications for Boom Barrier

Technical Parameters	Technical Parameters to be complied
Model of the Arm	3 Meters & 1.5Meters Telescopic Arm with Red Reflective Strips
Power Supply	220V/110 V +-10%
Operating Temperature	-25°C to 55°C
Housing Dimension	330(Width) x 239.5(Depth) x 931.5(Height) mm
Motor Power consumption	60 W
Frequency	50HZ
LED Light	Display on the front panel
Barrier Weight excluding Boom Barrier	≤ 50 kgs
Maximum Remote-Control Distance	≥ 30 m

Technical Parameters	Technical Parameters to be complied
Sensor	Dual Eye Photo Sensor Cells
Control	DC motor, 24 V
Access Control	Integration with access control system provision
Parking Management System	Integration with parking management system provision
Voltage Fluctuation	Inbuilt Capacitor
Power Distribution System	Single Phase Power Distribution
Internal Spring	100% Duty Cycle Dual Spring
Protective earthing	Should be Provided
PCB Board	Dual Capacitor
Protection from electric shocks and energy hazards	Fully Protected. No access to hazardous parts
Lubrications	No lubrication required for internal motors
Wireless Remote control	2 Numbers
Push button for manual operation	1 Number
Minimum Cycles Before Failure (MCBF)	10 million Cycles
Certifications	ISO, NABL, CE, FDA, RoHS, QCI, NSIC, FCC

1.4.18 Cables & Conduits

- All the cables shall be PVC insulated FRLS copper, multi strand, shielded cables shall be 650V grades and shall generally confirm to IS –1554 – 1988 and meet the signal cabling requirement of the system manufacturer.
- 4 x 1Sq.mm shall be used for Readers & EM Lock (Single Leaf Door) with Door Position Sensor. Door Position Sensor for Double Leaf Door.
- 2 x 1Sq.mm shall be used for EM Lock (Double Leaf Door), Door Position Sensor, Emergency Door Release & Door Buzzer. Cabling between UPS point to the Controllers etc., shall be in the scope of electrical contractor.
- 3 x 1.5Sq.mm Cable from Power point to Controller & Reader Modules.
- All the cables shall be laid in PVC Conduit. PVC conduit shall be FRLS Heavy duty pipes to be used.
- The PVC Conduit shall be FRLS (Heavy duty grade with 2mm thickness).
- The rate shall inclusive of all necessary fixing items, bends, coupler, junction box (2way, 3way, 4way), flexible hose pipe, screw, nut & bolds, clamps, etc to considered within the cost. No additional cost shall be provided.

1.4.19 Testing & Commissioning

General

- The contractor shall perform all tests submitted in the “Test Procedure” section as outlined in the specification.

- Provide a program for the testing and commissioning procedure. Use a qualified representative of the ACS supplier to co-ordinate testing and present at all tests and training courses and remain on-site until the ACS is fully operational.

Factory testing Procedure

- Submit procedure for factory test at least two weeks prior to the test. After test: Submit summary of results and necessary modifications.

Site testing and commissioning

- Carry out the following
  - Attendance at the testing of all equipment that interfaces to the ACS and confirmation of the operation of such equipment from the ACS interface terminals.
  - Testing of all field wiring from terminals to field interface terminal strips.
  - Testing and commissioning of all power supplies and batteries.
  - Verification of communication to remote systems.
- Testing of the operation of each control point from the operator's workstation (if supplied) and verification of the status of all points and alarm functions on graphic displays. Demonstrate the following
  - Operation of each control loop.
  - Globally transferred information such as alarms.
  - Detection and action of all alarm conditions.
  - Communications with PC workstations.
  - Time schedules and after-hours operation.
  - Mapping of system points to operator's workstation(s).
  - Operator's workstation software.
  - Power fails re-starts.
  - Essential power mode operation.
- Fire mode of operation.

Final acceptance Test

- After the testing report and as built drawings have been approved by the customer's representative, the completed system shall be tested in the presence of the customer's representative.
- Acceptance of the system shall require a demonstration of the stability of the system. Should major equipment failure occur, the contractor shall replace or repair component (s)
- Any other test those are required for checking the quality & performance of the system

1.5 IP CCTV Surveillance System

1.5.1 System General Requirement

- The Closed-Circuit Television System (CCTV system) shall provide an on-line display of video images on monitor. Cameras with suitable lenses shall be used to view specific areas of interest. The primary objective of implementing a CCTV

system is to ensure effective surveillance of an area and create a record for post event analysis.

The CCTV System shall comprise of:

- IP Cameras
- CCTV servers, NAS
- Video Management Software & Server
- AI Based Video Analytics server and its software

1.5.2 CCTV Surveillance System Component

The CCTV System shall comprise of

- Dome Cameras,
- Multi directional camera,
- Bullet cameras,
- PTZ cameras,
- Monitoring stations,
- POE switches,
- Video Management Software & Server
- AI Based Video Analytics server and its software.

1.5.3 Specification for IP CCTV Cameras

5MP IP IR Vandal Proof Vari-Focal Bullet Camera		
S. No	Description	Mandatory Required Technical Parameter
1	Image Sensor	1/2.8" 5MP CMOS or better
2	Day/ Night Operation	Yes, with IR Cut Filter
3	Minimum Illumination	Color: 0.05Lux (F1.2, 1/30sec, 30IRE)
		B/W: 0.005Lux (F1.2, 1/30sec, 30IRE), 0Lux (IR LED on)
4	Lens	3~10mm Motorized Varifocal Lens or better
5	Electronic Shutter	1/10 to 1/10,000sec or better
6	Image Resolution	2560 x 1920 or better
7	Compression	H.265 or better
8	Frame Rate and Bit Rate	Upto 30 fps with Controllable bit rate, frame rate and Maximum Bit rate
9	Video Streams	Minimum 4 Nos. individually configurable simultaneous streams in H.265 @ 2560 x 1920 & 30 fps or better
10	Audio In	Selectable (Mic in/Line in), Supply voltage: 2.5VDC(4mA), Input impedance: 2K Ohm
11	Audio Out	Line out, Max. output level: 1Vrms
12	Electronic Shutter	2 to 1/10,000sec or better
13	Lens/ Barrel Distortion Correction & Corridor View	Built in feature required

14	Wide Dynamic Range (WDR)	120 dB or better
15	IR	40 Meter (Built in) IR
16	Alarm	1 Input & 1 Output
17	Video Analytics	Defocus detection, Directional detection, Fog detection, Motion detection, Appear/Disappear, Enter/Exit, Loitering, Tampering, Virtual line, Audio detection, Digital auto tracking, Sound classification, Shock detection, Face/upper body detection, People counting, Queue management, Heatmap
18	Event Triggers	Alarm input, Analytics, Network disconnect
19	Event Actions	File upload(image)- e-mail/FTP, Notification- e-mail, Recording - SD/SDHC/SDXC or NAS recording at event triggers, Alarm output, Handover (PTZ preset, Send message by HTTP/HTTPS/TCP), Audio clip playback
20	Edge Storage capacity	Micro SD/SDHC/SDXC 2slots with 512GB total capacity or better
21	Protocols	IPv4, IPv6, TCP/IP, UDP/IP, RTP(UDP), RTP(TCP), RTCP, RTSP, NTP, HTTP, HTTPS, SSL/TLS, DHCP, FTP, SMTP, ICMP, IGMP, SNMPv1/v2c/v3(MIB-2), ARP, DNS, DDNS, QoS, UPnP, Bonjour, LLDP, SRTP
22	Security	HTTPS(SSL) Login Authentication, Digest Login Authentication, IP Address Filtering, User access log, 802.1X Authentication (EAP-TLS, EAP-LEAP, EAP-PEAP MSCHAPv2), Secure by default certificate, Secure OS/Boot/Storage, Verify firmware forgery, Cyber Security assurance program UL CAP (UL 2900-1), Security Maturity Certificate, CVE Score / CVSS Score, Complete Report for Security Vulnerabilities
23	Firmware Upgrade	The firmware upgrade shall be done though web interface, The firmware shall be available free of cost
24	Interface	RJ-45 (10 / 100 / 1000 BASE-T) or better
25	Memory	4GB RAM, 512MB Flash or better
26	Enclosure	IP67, IK10, NEMA4X or better
27	Privacy Masking	32ea, Quadrangle zones or better
28	Operating Temperature	-30 °C to 55 °C or better
29	Operating Humidity	Max 90% RH or better

30	Certification	ONVIF (S, G, T) Complied, CE, FCC, BIS, UL, NDAA
31	Application Programmers Interface	1. The interface shall be available for integration with 3rd party analytics and applications in public domain
		2. Onvif S, G, T
32	Embedded Applications	The camera shall provide a platform allowing the upload of third-party applications into the camera
33	HEVC Certificate	The camera OEM Should have valid H.265 HEVC Certificate and should be listed on HEVC website at the time of submitting bid. OEM should be paying the licensing fee for using the genuine HVEC Compression legally. The confirmation document of same needs to be submitted with bid & will also be checked on following official website https://accessadvance.com/hevc-advance-patent-pool-licensees/
34	MAC Address	MAC ids of the quoted products shall be provided by OEM and MAC address of the proposed equipment must be registered in name of OEM.
35	Warranty	Camera OEM shall be provided 5 years warranty only for cameras. Execution contractor shall be referred the applicable tender conditions for their execution contractor.
36	General	1. The Intellectual Property Rights of equipment (Camera and VMS) must not reside in China. The equipment supplied should not be manufactured by an entity in which the majority shareholding of the entity is from China.
		2. Any of the proposed item/equipment should not contain Chinese make chipsets/Soc/sensor/parts. Camera OEM needs to submit declaration on letterhead regarding quoted model specific sensor and SoC details (make, model etc.)
		3. OEM Needs to confirm that the proposed item/equipment shall not be installed with restricted GB/T standards/protocols and there shall be no option in camera settings to activate/deactivate such standard/protocol which allow bypassing of all security parameters.
5MP IP IR Vandal Proof Vari-Focal Dome Camera		

S. No	Description	Mandatory Required Technical Parameter
1	Image Sensor	1/2.8" 5MP CMOS or better
2	Day/ Night Operation	Auto (ICR)
3	Minimum Illumination	Colour: 0.05Lux, B/W: 0Lux (IR LED on)
4	Wide Dynamic Range	120dB or better
5	Lens	2.8~8.4mm (+/- 2mm) Motorized Varifocal Lens or better
6	IR view	40mtr or better (Built in or External) IR, External IR
7	Backlight Compensation	BLC/HLC/WDR/DWDR
8	Electronic Shutter Speed	Anti-flicker (2-1/12,000sec)
9	Resolution	5MP or better
10	Compression	H.265 or better
11	Frame Rate	Upto 25 fps with Controllable bit rate, frame rate and Maximum Bit rate
12	Angular Field of View	H: 92.1°(Wide)~38.7°(Tele), V: 67.2°(Wide)~29.0°(Tele), T: 119.9°(Wide)~48.6°(Tele)
13	Audio In	Selectable (Mic in/Line in), Supply voltage: 2.5VDC(4mA), Input impedance: 2K Ohm
14	Video Streams	Minimum 4 Nos. individually configurable simultaneous streams in H.265 @ 2560 x 1920 & 30 fps or better
15	Motion Detection	8ea, polygonal zones
16	Privacy masking	32ea, rectangular zones
17	Alarm Connectors	1 Input & 1 Output for Alarm Interface
18	Video Analytics (In-Built)	Defocus detection, Directional detection, Fog detection, Motion detection, Appear/Disappear, Enter/Exit, Loitering, Tampering, Virtual line, Audio detection, Digital auto tracking, Sound classification, Shock detection, Face/upper body detection, People counting, Queue management, Heatmap
19	Event Actions	File upload via FTP and e-mail, Notification via e-mail, SD/SDHC/SDXC or NAS recording at event triggers, Alarm output. PTZ Preset, Handover, Audio playback
20	Edge Storage capacity	Micro SD/SDHC/SDXC 2slot 512GB (256Gx2) or better
21	Protocols	v4, IPv6, TCP/IP, UDP/IP, RTP(UDP), RTP(TCP), RTCP, RTSP, NTP, HTTP, HTTPS, SSL/TLS, DHCP, FTP, SMTP, ICMP, IGMP, SNMPv1/v2c/v3 (MIB-2),

		ARP, DNS, DDNS, QoS, UPnP, bonjour, LLDP, SRTP (TCP, UDP Unicast)
22	Security	HTTPS (SSL) Login Authentication, Digest Login Authentication, IP Address Filtering, User access log, 802.1X Authentication (EAP-TLS, EAP-LEAP, EAP-PEAP MSCHAPv2), Secure by default certificate, Secure OS/Boot/Storage, Verify firmware forgery, Cyber Security assurance program UL CAP (UL 2900-1), Security Maturity Certificate, CVE Score / CVSS Score, Complete Report for Security Vulnerabilities
23	Audio Out	Line out, Max. output level: 1Vrms
24	Onvif	S/G/T Required
25	Interface	RJ 45 (10/100BASE-T)
26	Enclosure	IP67, IK10 & Nema 4X
27	Power requirements	PoE (IEEE802.3af, Class3)
28	Operating Temperature	(-)20 °C to 55 °C or better
29	Operating Humidity	Max 90% RH or better
30	Certification	ONVIF (S, G, T) Complied, CE, FCC, BIS, UL, NDAA
31	Internal Memory	4GB RAM, 512MB Flash
32	HEVC Certificate	The camera OEM Should have valid H.265 HEVC Certificate and should be listed on HEVC website at the time of submitting bid. OEM should be paying the licensing fee for using the genuine HEVC Compression legally. The confirmation document of same needs to be submitted with bid & will also be checked on following official website https://accessadvance.com/hevc-advance-patent-pool-licensees/
33	MAC Address	MAC ids of the quoted products shall be provided by OEM and MAC address of the proposed equipment must be registered in name of OEM.
34	Warranty	Camera OEM shall be provided 5 years warranty only for cameras. Execution contractor shall be referred the applicable tender conditions for their execution contractor.

35	General	1. The Intellectual Property Rights of equipment (Camera and VMS) must not reside in China. The equipment supplied should not be manufactured by an entity in which the majority shareholding of the entity is from China.
		2. Any of the proposed item/equipment should not contain Chinese make chipsets/Soc/sensor/parts. Camera OEM needs to submit declaration on letterhead regarding quoted model specific sensor and SoC details (make, model etc.)
		3. OEM Needs to confirm that the proposed item/equipment shall not be installed with restricted GB/T standards/ protocols and there shall be no option in camera settings to activate/deactivate such standard/protocol which allow bypassing of all security parameters.
IP PTZ Vandal Proof Camera 8MP (4K)		
S. No	Description	Mandatory Required Technical Parameter
1	Image Sensor	1/2.8" 8MP (4K) CMOS or better
2	Day/ Night Operation	Auto (ICR), Colour, BW, Schedule
3	Resolution	8MP or better
4	Minimum Illumination	Colour: 0.1Lux (F1.6, 1/30sec) or better, BW: 0Lux (IR LED On)
5	High-speed pan-tilt functionality	360° endless pan range and a 110˚ (-20˚~90˚) auto flip tilt range
6	Optical Zoom	5~150mm (+/-2mm) (30x) Optical zoom Minimum & 12x Digital Zoom, or better
7	Auto Tracking	Object auto tracking with Target lock tracking
8	Focus Control	Oneshot AF, Focus saves
9	Backlight Compensation	BLC, HLC, WDR
10	Pan, tilt, manual and preset speed	Pan Speed Max. 500˚/sec, Manual: 0.024˚/sec~250˚/sec, Tilt Speed Max. 350˚/sec, Manual: 0.024˚/sec~250˚/sec the speed shall be applicable for Manual, Tour, and Preset Mode
11	Defog	support
12	Preset Accuracy	±0.1˚, Pan/Tilt correction
13	Compression	H.265 or better
14	Frame Rate and Bit Rate	30 fps with Controllable bit rate, frame rate and Maximum Bit rate

15	GOP/ GOV	Shall be available to change GOV for bandwidth optimization
16	Video Streams	Minimum 4 Nos. individually configurable simultaneous streams in H.265 @ 2560 x 1920 & 30 fps or better
17	Motion Detection	Yes, built in with multiple configurable areas in the video stream
18	Electronic Shutter	2 to 1/10,000sec or better
19	Electronic Exposure & Control	Automatic/ Manual
20	Wide Dynamic Range	120 dB or better
21	Electronic Image Stabilization	Support with built-in gyro sensor
22	Image Freeze on PTZ	through NVR/VMS
23	Privacy Masks	30ea, rectangular Support or better
24	Preset Positions	Minimum 300 or better
25	Image Flip	Yes Automatic
26	Built In Heater & FAN	Required
27	Audio	Bi-directional (2-way audio with classification)
28	Alarm	min 1 in and 1 out
29	On-screen directional indicator	Required
30	Video Analytics (In-Built)	Defocus detection, Directional detection, Fog detection, Motion detection, Appear/Disappear, Enter/Exit, Loitering, Tampering, Virtual line, Audio detection, Digital auto tracking, Sound classification, Shock detection, Face/upper body detection, People counting, Queue management, Heatmap
31	Event Actions	File upload via FTP and e-mail, Notification via e-mail, SD/SDHC/SDXC or NAS recording at event triggers, PTZ Preset, Handover, Alarm output
32	Edge Storage slot	Micro SD/SDHC/SDXC 2slots with 512GB capacity or better
33	Protocols	IPv4, IPv6, TCP/IP, UDP/IP, RTP(UDP), RTP(TCP), RTCP, RTSP, NTP, HTTP, HTTPS, SSL/TLS, DHCP, FTP, SMTP, ICMP, IGMP, SNMPv1/v2c/v3(MIB-2), ARP, DNS, DDNS, QoS, PIM-SM, UPnP, Bonjour, LLDP, SRTP
34	Text Overlay	Date & time, and a customer-specific text, camera name etc

35	Security	HTTPS(SSL) Login Authentication, Digest Login Authentication, IP Address Filtering, User access log, 802.1X Authentication (EAP-TLS, EAP-LEAP, EAP-PEAP MSCHAPv2), Secure by default certificate, Secure OS/Boot/Storage, Verify firmware forgery, Cyber Security assurance program UL CAP (UL 2900-1), Security Maturity Certificate, CVE Score / CVSS Score, Complete Report for Security Vulnerabilities
36	Memory	4GB RAM, 512 MB Flash
37	Firmware Upgrade	The firmware upgrade shall be done though web interface, The firmware shall be available free of cost
38	Interface	RJ-45(10/100BASE-T) or better
39	Enclosure	IP66, IK10 , NEMA 4X or better
40	Mount	Wall / Pole Mount
41	Power	Vendor to Specify
42	Water Removal	Support with built in wiper
43	Operating Temperature	-30°C~+55°C
44	Operating Humidity	95% RH or better
45	Certification	ONVIF (S, G, T) Complied, CE, FCC, BIS, UL, NDAA
46	IR	200 Meter or better built in IR Optimized IR with adjustable intensity and angle
47	Onvif	S, G, T Required
48	HEVC Certificate	The camera OEM Should have valid H.265 HEVC Certificate and should be listed on HEVC website at the time of submitting bid. OEM should be paying the licensing fee for using the genuine HVEC Compression legally. The confirmation document of same needs to be submitted with bid & will also be checked on following official website https://accessadvance.com/hevc-advance-patent-pool-licensees/
49	MAC Address	MAC ids of the quoted products shall be provided by OEM and MAC address of the proposed equipment must be registered in name of OEM.
50	Warranty	Camera OEM shall be provided 5 years warranty only for cameras. Execution contractor shall be referred the applicable tender conditions for their execution contractor.

51	General	1. The Intellectual Property Rights of equipment (Camera and VMS) must not reside in China. The equipment supplied should not be manufactured by an entity in which the majority shareholding of the entity is from China.
		2. Any of the proposed item/equipment should not contain Chinese make chipsets/Soc/sensor/parts. Camera OEM needs to submit declaration on letterhead regarding quoted model specific sensor and SoC details (make, model etc.)
		3. OEM Needs to confirm that the proposed item/equipment shall not be installed with restricted GB/T standards/protocols and there shall be no option in camera settings to activate/deactivate such standard/protocol which allow bypassing of all security parameters.
5MP x 4 No. Multisensor 360 Degree IR Vandal Proof Camera		
S. No	Description	Mandatory Required Technical Parameter
1	Image Sensor	4 x 1/1.8" Progressive Scan CMOS or better
2	Day/ Night Operation	Automatic with IR Cut Filter
3	Minimum Illumination	Colour: 0.2 Lux or better B/W": 0.0 Lux (IR ON)
4	Backlight Compensation	BLC, HLC, WDR,
5	Lens	4~9mm motorized varifocal
6	Image Resolution	Upto 2560 x 1920 or better. The camera shall be capable to provide video stitch image. The same can be from cameras or from software
7	Compression	H.264/H.265 Baseline, Main and High Profiles
8	Frame Rate and Bit Rate	Upto 25 fps with Controllable bit rate, frame rate and Maximum Bit rate
9	Video Streams	Minimum 4 Nos, individually configurable simultaneous streams in H.264, H.265 @ 2560x1920 & 25 Fps and Motion JPEG
10	Motion Detection	Yes, built in with multiple configurable areas
11	Electronic Shutter	1/10 to 1/10,000sec or better
12	Wide Dynamic Range	120 dB or better
13	Pan / Tilt / Rotate Range	Remote adjustment (Max. 200cycles)

		0~360 / 35~80 / 0~90
14	Digital Image Stabilization	Support (built-in gyro sensor)
15	Privacy Masking	32ea, polygonal zones
16	Audio	Two Way, built in or external, required
17	Alarm	1 Input/ Output Ports or better
18	Video Analytics (in-built)	Defocus detection, Directional detection, Fog detection, Motion detection, Appear/Disappear, Enter/Exit, Loitering, Tampering, Virtual line, Audio detection, Digital auto tracking, Sound classification, Shock detection, Face/upper body detection, People counting, Queue management, Heatmap
19	Event Actions	File upload via FTP and e-mail, Notification via e-mail, SD/SDHC/SDXC at event triggers, Alarm output, Handover
20	Edge Storage	Micro SD/SDHC/SDXC 4slot 256GB (each CH) or better
21	Protocols	IPv4, IPv6, TCP/IP, UDP/IP, RTP(UDP), RTP(TCP), RTCP, RTSP, NTP, HTTP, HTTPS, SSL/TLS, DHCP, FTP, SMTP, ICMP, IGMP, SNMPv1/v2c/v3(MIB-2), ARP, DNS, DDNS, QoS, PIM-SM, UPnP, Bonjour, LLDP
22	Ethernet	Metal shielded RJ-45(10/100/1000BASE-T)
23	Security	HTTPS(SSL) Login Authentication, Digest Login Authentication, IP Address Filtering, User access log, 802.1X Authentication (EAP-TLS, EAP-LEAP)
24	Firmware Upgrade	The firmware upgrade shall be done though web interface, The firmware shall be available free of cost
25	Interface	RJ 45, 100 Base TX or better
26	Enclosure	IP66, IK10, NEMA4X rated or better
27	IR Viewable Length	40m (98.43ft)
28	Power requirements	Vendor to specify
29	Operating Temperature	-20 °C to 55 °C or better
30	Operating Humidity	Max 90% RH or better
31	Internal Memory	5GB RAM, 1280MB Flash
32	Certification	ONVIF (S, G, T) Complied, CE, FCC, BIS, UL, NDAA
33	Embedded Applications	The camera shall provide a platform allowing the upload of third-party applications into the camera

34	Application Programmers Interface	The interface shall be available for integration with 3rd party analytics and applications in public domain free of cost
35	Onvif Support	Onvif S/G/T.
36	Embedded Applications	The camera shall provide a platform allowing the upload of third-party applications into the camera
37	HEVC Certificate	The camera OEM Should have valid H.265 HEVC Certificate and should be listed on HEVC website at the time of submitting bid. OEM should be paying the licensing fee for using the genuine HVEC Compression legally. The confirmation document of same needs to be submitted with bid & will also be checked on following official website https://accessadvance.com/hevc-advance-patent-pool-licensees/
38	MAC Address	MAC ids of the quoted products shall be provided by OEM and MAC address of the proposed equipment must be registered in name of OEM.
39	Warranty	Camera OEM shall be provided 5 years warranty only for cameras. Execution contractor shall be referred the applicable tender conditions for their execution contractor.
40	General	1. The Intellectual Property Rights of equipment (Camera and VMS) must not reside in China. The equipment supplied should not be manufactured by an entity in which the majority shareholding of the entity is from China.
		2. Any of the proposed item/equipment should not contain Chinese make chipsets/Soc/sensor/parts. Camera OEM needs to submit declaration on letterhead regarding quoted model specific sensor and SoC details (make, model etc.)
		3. OEM Needs to confirm that the proposed item/equipment shall not be installed with restricted GB/T standards/protocols and there shall be no option in camera settings to activate/deactivate such standard/protocol which allow bypassing of all security parameters.

Compliance Notes for all type of tender required cameras

- All type of tender requirement cameras shall comply the following compliance with certification of approval of BIS, NDAA Compliant, Security Maturity Certificate, CVE

or CVSS Score, Complete Report of Security Vulnerabilities & ULCAP Certification for approval of product.

- HTTPS(SSL) Login Authentication, Digest Login Authentication, IP Address Filtering, User access log, 802.1X Authentication (EAP-TLS, EAP-LEAP, EAP-PEAP MSCHAPv2), Secure by default certificate, Secure OS/Boot/Storage, Verify firmware forgery, Cyber Security assurance program UL CAP (UL 2900-1).
- Cameras shall not be complied with standards like - GB28181, GB/T28181 - 2011, GB / T 28181-2011, GBT 28181 - 2011, GBT28181 - 2011, GB/T28181 - 2016, etc., protocols/standards and there shall be no option in the camera web page/settings to activate or deactivate such protocols/standards any of their version(s).
- All above compliance along with technical requirement mentioned in the tender documents shall be complied with zero deviation.

1.5.4 Specification for Network Joystick

Network Joystick for PTZ Camera		
a	Communication	
	Control Equipment	Network camera
	Interface	Ethernet (Network camera), USB
b	Interface protocol	
	Ethernet	supports
	USB	supports
	Units to control	Max. 255 network cameras, 1 SSM.
	Network Protocol	TCP, HTTP, DHCP, IPv4
c	Operational Mechanical	
	LCD Display	5-inch TFT LCD
	Joystick	3 axis twist zooms
d	Control	
	Camera	Pan/Tilt/Zoom, Focus, Auto focus, Preset, Group, Tour, Swing, Trace, Auto tracking, Alarm off/on, Freeze
	Recorder	Recording, playback control, alarm off, menu
	Device management	Built-in device registration, modification on LCD
	User management	admin + 9 operators
	Import, Export	Configuration import/export
e	Miscellaneous	
	Video snapshot	Still image (network camera) export using USB memory
	Input	Alphabet input (virtual keyboard)
	Environmental	
	Operating Temperature	0°C ~ 40°C (+32°F ~ +104°F)

Network Joystick for PTZ Camera		
	Operating Humidity	20 ~ 85%
	Electrical	
	Input voltage	12V DC
	Power consumption	Max. 6.4 W

Note: Successful bidder / Contractor shall be submitted the technical datasheets of above technical requirement of all type of cameras & joystick in the form of Compliance document. No deviation shall be accepted.

The following approvals are mandate to comply for CCTV Camera.

- EMC
- FCC CFR Part 15 Class B
- EN55022:1998 Class B
- EN61000-3-2:2000
- EN61000-3-3:1995
- VCCI Class B
- AS/NZS 3548
- Safety:
- EN60950 & EN 60950 – 1
- BIS, NDAA Compliant
- UL/ relevant European approvals

1.5.5 Power Supply for Cameras

The camera shall be proposed with integral power supply (PoE and 12VDC Power Supply Jack Connector) with an in-built power supply module.

The cameras shall be energised through POE. External power supply energizing will not be accepted. However, the cameras shall have PoE enablement as well power jack with inbuilt. The cameras shall comply with min IEEE 802.3af class 3 compliant

It shall have a built-in encrypted Web server. It shall have a facility to have an audio input thro LAN from the camera if required.

Min Operating Conditions

- Temp: 5-50 ºC (41-104 ºF)
- Humidity: 20-80% RHG
- Motion detection, tamper alarm, backlight compensation & WDR features

1.5.6 Video Management System (VMS)

The proposed Video Management System (VMS) technical parameters are included for Video Management Software Application, Cyber security certification for Video Management Software, Video Management Software Application Dashboards, Video Management Software Application Configuration User Interface, AI Based Video Analytics Application, Network Attached Storage / Server based Video Storage box, Video Management Mobile client and Video Management Remote control Client.

Video Management Software Application

- The VMS shall support ONVIF - industry standard for the interface of IP-based physical security products. The VMS shall provide ONVIF S & G Compliance in order to provide more advance features of cameras.
- The VMS Module shall allow the Direct configuration of IP camera device with no requirement to ever directly connect via web page of IP camera or encoder to configure these parameters.
- Discover on IP network and set IP Address, Frame Rate, Resolution, Motion detection: within camera or server based, Bit Rate, Key frame interval, Digital I/O, Audio Inputs/Outputs, Ability to update firmware of IP camera or encoder.
- Any configuration changes do not require the server services to be restarted.
- VMS Security Platform shall be compatible with both 32-bit and 64-bit operating systems including latest Windows 2022 support.
- The VMS shall be based on a true open architecture that shall allow for use of non-proprietary workstation and server hardware, non-proprietary network infrastructure and non-proprietary storage.
- The VMS shall offer a complete and scalable video surveillance solution which allows cameras to be added on a unit-by-unit basis.
- All video streams supplied from IP cameras shall be digitally encoded in MJPEG/H.264 / H.265 or better compression formats and recorded simultaneously in real time.
- The VMS shall support configuration of individually configurable multiple streams for Live & Recording. This functionality shall also support configuration of each camera stream separately. Altering the setting of one camera shall not affect the recording & display settings of other cameras.
- The VMS shall be able to use multiple CCTV keyboards to operate the entire set of cameras throughout the system, including cameras of various manufacturers' brands, including their PTZ functionalities.
- The VMS shall be able to retrieve and set the current position of PTZ cameras using XYZ coordinates.
- The Platform shall consist of a role-based architecture, with each Server hosting one or more roles.
- The System shall be managed by the central database role that contains all the system information and component configuration.
- The Database Management Role shall authenticate users and give access to the system based on predefined user access rights or privileges, and security partition settings.
- The Database Management Role shall support the configuration of camera units, PTZ functionalities. Camera sequences, recording schedules.
- The Video Recording Role shall be responsible for managing cameras and encoders under its control and archiving video.
- The system shall have a routing role responsible for routing video and audio streams across the networks from the source to destination.

- The system shall have Health Monitoring Role for monitoring and logging health events and warnings from the various client applications, roles, and services that are part of the Security Platform The role shall also log events within the Windows Event Log, generating reports on health statistics and health history.
- The Surveillance User Interface shall be able to use for monitoring of video from the cameras, events & alarms, Interface shall also facilitate the recorded video.
- The user interface shall provide control & monitor of IP network.
- User Interface shall facilitate the control of Pan Tilt & Zoom functionality and pre-sets of the PTZ cameras.
- User Interface shall also facilitate the control of iris and focus of the camera.
- User Interface shall be possible to perform digital zooming on the live as well as playback video.
- User Interface shall allow administrators and operators with appropriate privileges to monitor, run reports and manage alarms.
- The User Interface shall support following to enhance usability and operator efficiency such as
- Dynamically adaptive interface that adjusts in real-time to what the operator is doing.
- A dynamic dashboard loaded with entity-specific widgets, e.g., camera widget.
- Use of transparent overlays that can display multiple data in a seamless fashion.
- Display tile menus and quick commands.
- Consolidated and consistent workflows.
- Tile menus and quick commands easily accessible within every display tile of the user workspace.
- The User Interface shall have task-based approach for monitoring of video & alarm monitoring.
- User Interface shall have task for investigation of video bookmark, smart motion search, archive reports, audit trails and activity reporting.
- User Interface shall support a sequence of operations an operator or administrator shall execute to complete an activity. The “flow” relates to a clearly defined timeline or sequence for executing the activity.
- The user shall have full control over the user workspace through a variety of user-selectable customization options. Administrators shall also be able to limit what users and operators can modify in their workspace through privileges.
- Once customized, the user shall be able to save his workspace.
- The user workspace shall be accessible by a specific user from any client application on the network.
- Display tile patterns shall be customizable.
- Event or alarm lists shall span anywhere from a portion of the screen up to the entire screen and shall be resizable by the user. The length of event or alarm lists shall be user-defined. Scroll bars shall enable the user to navigate through lengthy lists of events and alarms.

- The User Interface shall support multiple display tile patterns, e.g., 1 display tile (1x1 matrix), 16 tiles (8x8 matrix), and multiple additional variations.
- The User Interface shall support as many monitors as the PC video adapters and
- Windows Operating System can accept.
- The User Interface shall display of all cameras attached to the system.
- Shall support live video monitoring on each display tile within a task in the user's workspace.
- The operator shall be able to drag and drop a camera into a display tile for live viewing.
- The operator shall be able to drag and drop a camera from a map into a display tile for live viewing.
- The User Interface shall allow operators to bookmark important events for later retrieval on any archiving camera. Operators can uniquely name each bookmark to facilitate future searches.
- The operator shall be able to start/stop recording on any camera in the system, which is configured to allow manual recording, by clicking on a single button.
- The operator shall be able to switch one or more video tile to switch for instant replay. This operation shall not affect live monitoring of other cameras.
- Users shall be able to take snapshots of live video and be able to save or print the snapshots.
- The Server Monitoring Service shall be installed on all PCs/servers running with security platform software. In the event of a malfunction or failure, the Server Monitoring Service shall restart the failed service. As a last resort, the Server Monitoring Service shall reboot the server/PC if it unable to restart the service.
- The Platform shall support the Alarm Management functionality. The User shall have the ability to acknowledge alarms, create an incident upon alarm acknowledgement, and put an alarm to snooze. The user shall be able to spontaneously trigger alarms based on something he or she sees in the system.
- The Surveillance User interface's video playback capabilities shall include:
  - Shall support audio and video playback of any time span.
  - Shall support video playback on each display tile.
  - Shall allow operators to switch to instant replay of the video for any archiving camera with the simple click of button.
  - Shall allow the operator to select between instant synch of all video streams in playback mode allowing operators to view events from multiple angles or across several camera fields, or non-synchronous playback.
  - Shall allow the operator to simultaneously view the same camera in multiple tiles at different time intervals.
- Shall allow the operator to control the playback with:
  - Pause, Lock Speed.
  - Forward and Reverse Playback at: 1x, 2x, 4x, 6x, 8x, 10x, 20x, 40x, 100x.
  - Forward and Reverse Playback frame by frame
  - Slow Forward and Reverse Playback at: 1/8x, 1/4x, 1/3x, 1/2x.

- Loop playback between two-time markers
- Shall display a single timeline, or optionally one timeline for each selected video stream, with which the operator can navigate through the video sequence by simply clicking on any point in the timeline.
- Shall display the level of motion at any point on a timeline.
- Shall clearly display bookmarks events on the timeline(s).
- Shall be able to query archived video using various search criteria, including but not limited to, time, date, camera, and area, among others.
- Shall provide the tool to search video and associated audio on user-defined events or motion parameters.
- Shall allow operators to define an area of the video field in which to search for motion as well as define the amount of motion that shall trigger search results. The Surveillance User Interface shall then retrieve all archived video streams which contain motion which meets the search parameters. There shall be a graphical timeline where the time of each search hit shall be indicated.
- Shall allow operators to browse through a list of all bookmarks created on the system and select any bookmarked event for viewing.
- Shall allow the user to add bookmarks to previously archived video for easier searching and retrieval.
- Shall support digital zoom on playback video streams.
- Shall provide still image export to PNG, JPEG, GIF, and BMP format with Date and Time stamp and Camera Name on the image (snapshot).
- Shall provide tools to export video on various media such as a CD-ROM.
- Shall allow operators to load previously exported video files from their computer or network.
- Shall allow queries to be saved upon closing the Archive Player Application and reappear when the application is reopened.
- The Security Platform shall permit the user to select multiple entities to monitor from the Surveillance User Interface by adding the entities one by one to the tracking list.
- The Surveillance User Interface shall provide the option to filter which events shall be displayed in the display tile layout and/or event list layout.
- It shall also be possible to lock the display tile so that it only tracks the activity of a specific entity.
- The user shall be permitted to start or pause the viewing of events within each display tile.
- The Interface shall support the ability to manually track a moving target with the single click of a button.
- The ability to switch from one camera view to an adjacent camera shall be done within a single display tile.
- Switching between camera streams shall be accomplished by simply clicking on the transparent overlay.
- Visual tracking shall be available with both live and recorded video.

- The user interface monitoring client shall be able to take control of other client station based on the privilege level and control the tile of the other client like a video wall application.

Cyber security certification for Video Management Software

- The software shall incorporate stronger security of security mechanism to prevent vulnerabilities, man-in-the-middle attack by providing digital certificate-based authentication between server to server & server to clients. The VMS shall have achieved UL 2900-2-3 Level 3 Cyber security certification.

Video Management Software Application Dashboards

- The USP shall support the ability to create multiple dashboards. Operators shall be allowed to view respective dashboards depending on user rights. A dashboard shall consist of a canvas with various widgets displayed on the canvas. All widgets should offer the ability to specify location and size to the widget, a title to the widget, a background colour to the widget, and the ability to refresh periodically the content of the widget. Dashboard widget types shall be:
  - Image: provides the ability to display an image (JPG, PNG, GIF, BMP) on a dashboard.
  - Text: provides the ability to display a text on a dashboard. The text style shall be configurable, so font, size, colour, and alignment can be specified by the user.
  - Tile: provides the ability to display any entity of the USP inside of a tile.
  - Web page: provides the ability to display a URL on a dashboard.
  - Entity Count: provides the ability to display the total number of a specific entity type in the USP.
  - Reports: provides the ability to display the results of any saved reports in the system. The results shall be displayed either by showing the total number of results in the report, a set of top results from the report, or a visual graph from the data returned by the report.
- The USP shall support the following actions on a dashboard:
  - Print dashboard, export dashboard to PNG file, and automatically email a report based on a schedule and a list of one or more recipients.

Video Management Software Application Configuration User Interface

- The Configuration User Interface shall allow the administrator or users with appropriate privileges to change video configuration. It shall provide the ability to change video quality, bandwidth, and frame rate parameters on a per camera (stream) basis for both live and recorded video. It shall provide the ability to configure brightness, contrast, and hue settings for each camera on the same.
- The Configuration user interface shall provide the capability to enable & change audio parameters, audio recording serial port configuration, I/O configuration on camera device units.
- The Configuration User Interface shall provide the ability to set recording schedules and modes for each individual camera.
- The recording mode shall be Continuous, on motion, manual only, Disabled.

- The Configuration User Interface shall support the creation of schedules to which any of the following functional aspects can be attached:
  - Video quality (for each video stream per camera)
  - Recording (for each camera)
  - Motion detection (for each detection zone per camera)
  - Brightness, Contrast, Hue (for each camera)
  - Camera sequence execution
  - The Configuration User Interface shall support creation of unlimited recording schedules and assign any camera to any schedules.

AI Based Video Analytics Application

- Video Analytics system both as a primary detection system for operational alert use and as an approved event-based recording system for sterile zone monitoring applications.
- User interfaces shall be available in English languages
- Real-time scene analysis and alarms based on user definable rules
- Powerful onsite or remote configuration capabilities
- Rich set of detectable events and behaviours to suit a broad set of system requirements
- Accurate indoor and outdoor applications with patented technology to reduce false alarms
- High performance software that minimizes the need for excessive PC hardware
- Improved Forensics Tool with Smart Search for instantaneous retrieval of incidents even under new rules. The list AI Based Analytics to be a part of this tender.
  - Video Motion Detection
  - Loitering
  - Tamper Detection Alarm
  - Object Tracking
  - Virtual Line Crossing
  - Facial Recognition – 3rd Party Server based Analytic Application Software
  - Masked / Covered Face Identification
  - People Counting - 3rd Party Server based Analytic Application Software
  - Automatic Number Plate Recognition - 3rd Party Server based Analytic Application Software
  - Vehicle Identification - 3rd Party Server based Analytic Application Software
  - Forensic search engine for Appearance / Disappearance - 3rd Party Server based Analytic Application Software

  Technical Note AI Based Video Analytics Application:

  - ✓ The above-mentioned analytics are edge-based analytics wherever is not mentioned as 3rd party Video Analytics Application Software. However, the inbuilt edge-based analytics are not available with proposing CCTV Camera, the vendor shall consider the server-based analytics without any additional cost.

- ✓ The Analytics Servers shall be Rack Mounted. Tower mounted shall not be accepted. The Contractor shall propose Single server with redundancy (N:1) configuration for all 3rd party Video Analytics Application Software subjected to get the confirmation letter from CCTV OEM and 3rd party Analytics Application Software OEM and the same shall be approved by consultant.
- ✓ The Configuration of Server mentioned is a minimum requirement. Vendor shall be considered as per the 3rd party Video Analytics Application Software OEM recommendations, in case of higher configurations shall be required to enable the functional requirements and the cost for the same & quote accordingly. Bidder shall be considered the specified configuration if the 3rd party Video Analytics Application Software OEM do not have an objection. No deviation shall be accepted.

1.5.7 Network Attached Storage / Server based Video Storage box

- The Network Attached Storage / Server based Video Storage box (Recording role) shall use an event and timestamp database for advanced search of audio/video recording storage. This database shall be Microsoft SQL 2012 or SQL 2014 or SQL 2019
- The Network Attached Storage / Server based Video Storage box (Recording role) shall digitally sign recorded video using 248-bit RSA public/private key cryptography.
- The Network Attached Storage / Server based Video Storage box (Recording role) shall offer a plug and play type hardware discovery service with the following functionalities:
- The Network Attached Storage / Server based Video Storage box (Recording role) shall have the capacity to configure the key frame interval (I-frame) in seconds or number of frames.
- The Network Attached Storage / Server based Video Storage box (Recording role) shall support configuration of pre-alarm and post-alarm recording option that can be set between one second and 5 minutes on a per camera basis.
- The Network Attached Storage / Server based Video Storage box (Recording role) shall support minimum 300 cameras or 300 Mbps of recording throughput whichever comes first in case the network is ended to end multicast.
- The Network Attached Storage / Server based Video Storage box (Recording role) shall support “unit level motion detection” as well as “software level motion detection”.
- Software level motion detection shall be able to divide camera field of view in 6 detection zone for setting up individual motion setting in each zone and trigger an event for each zone separately.
- The Network Attached Storage / Server based Video Storage box (Recording role) shall have the capacity to communicate with Camera device using 128 bits SSL encryption.

- The Network Attached Storage / Server based Video Storage box (Recording role) shall have the capacity to communicate with camera device using HTTPS secure protocol.
- The Network Attached Storage / Server based Video Storage box (Recording role) shall have the capacity to receive multicast UDP streams directly from the camera unit.
- For network topologies that restrict the camera device from sending multicast UDP streams, the Network Attached Storage / Server based Video Storage box (Recording role) shall redirect audio/video streams to active viewing clients on the network using multicast UDP.
- The Network Attached Storage / Server based Video Storage box (Recording role) shall have the capacity to redirect audio/video stream to active viewing clients on the network using unicast UDP or TCP.
- The user interface of the monitoring station shall support dynamically switch the Live stream from – High Resolution, Low Resolution & Live (normal). This switching shall happen based on the resolution of monitoring tile & closest stream configuration.
- The Network Attached Storage / Server based Video Storage box (Recording role) shall offer to set retention period for archive video for preset number of days. It shall also delete oldest video data if the disk is full before the retention time occurs.
- The Network Attached Storage / Server based Video Storage box (Recording role) shall allow important video sequences to be protected against normal disk clean-up routines.
- The Network Attached Storage / Server based Video Storage box (Recording role) shall keep a log and compile statistics on disk space usage.
- The Network Attached Storage / Server based Video Storage box (Recording role) shall have the capacity to down-sample video streams for storage saving purposes.
- The Network Attached Storage / Server based Video Storage box (Recording role) shall support camera unit with edge recording capabilities and offer the following capacity:
- The ability to playback at different speeds the video recorded on the Camera device.
- The ability to offload the video on schedule, on event or manually the video recorded on the camera device to store it on the Network Attached Storage / Server based Video Storage box (Recording role).
- It shall be possible to filter the video that is being offloaded using one or multiple of the following filters:
- Time interval, Playback request, Video analytic events, Motion events, Bookmarks, Alarms.
- The Network Attached Storage / Server based Video Storage box (Recording role) shall support analytics events received from camera unit having capability of edge analytics

- VMS shall support Bandwidth Control to for Live view and Playback stream to the clients.
- It shall be possible to configure number of concurrent live and playback stream allows.
- It shall be also possible to control the overall combined bandwidth in kbps
- It shall be possible to limit the bandwidth consumed by live and playback video from the client software to better control the bandwidth across multiple sites. The Server software shall be able to prioritize video streaming to the client based on user level.
- VMS shall have SQL Database info log like Event Count, Source Count, Video file count, Size on disk. VMS shall have provision to set notification for Diskspace and Database usage goes set value, VMS shall support the backup of SQL database from VMS GUI console.
- VMS client shall show on live stream about routing information like unicast, multicast or streaming from recording server
- VMS should support Dual sign in to log in to the system administrator and client - Log in shall be permitted when two authorized persons login. any user can login first and second user will authenticate. There shall be no restriction which user login first or second.
- VMS shall support auto lock of client after specified time with inactivity.
- VMS shall support able to give alarm if specified user is login in, log off.
- VMS shall support able to give alarm if specified user is login failed.
- VMS shall support following password management policies
- Admin shall create the user and set the password shall have provision to change the password on next login of user
- Admin shall have provision to set the user password rule like enforce minimum characters, uppercase, lower case, numerical character, special character.
- Admin shall set the password which can expire with specified time limit
- There shall be possible to lock user based on schedule decided by administrator
- VMS shall provide recommendations relating to the passwords used to access the hardware units in the system. The recommendation should display if the passwords used on the units are weak, average, strong, or very strong.

Video Management Mobile client:

- VMS shall support mobile client in android and iOS
- VMS shall support Mozilla, Edge, Chrome browser-based web client
- VMS shall support Maps, Alarms and Threat level activation support in Mobile client

Video Management Remote control Client:

- It shall be possible to admin user group client can control remotely operator group workstations client and able to see the full screen in its own GUI console.
- This remote-control user client rights shall be configurable

Video Recording Requirement:

- Primary / Main Recording Devices:

- ✓ Storage calculation - 90days/25FPS @ 2MP/1080p FHD resolution and the rate shall inclusive of this line item. Software Generated Storage Calculation Sheet shall be furnished by Camera OEM and the same shall be submitted for approval.
- ✓ Maximum 200 Cameras to be considered per Recording Server with storage of those cameras and the Second Primary Server shall be considered another 200 Cameras Recording with storage of those cameras. Hence 2 Nos of Primary Recording Server with 200 Cameras storages in each server to be considered.
- ✓ Surveillance Hard Disk Drive needs to be considered with Minimum of 7200 RPM or more. Cost shall inclusive of 2 Servers and its camera licenses, and its Video Storage Box as mentioned the above configuration.

- Failover / Redundant Recording Devices:
  - ✓ Storage calculation - 30 days/25FPS @ 2MP/1080p FHD resolution. Generated Storage Calculation Sheet shall be furnished by Camera OEM and the same shall be submitted for approval.
  - ✓ Maximum 400 Cameras and its storage of fail over Facility Needs to be considered in Fail Over Recording Server. Surveillance Hard Disk Drive needs to be considered with Minimum of 7200 RPM or more.
  - ✓ Surveillance Hard Disk Drive needs to be considered with Minimum of 7200 RPM or more. Cost shall inclusive of 2 Servers and its camera licenses, and its Video Storage Box as mentioned the above configuration.

1.5.8 System Hardware - VMS Server

Role	Management Server N+1
Processor	Xeon E-2336 or better
RAM	16 GB or better
Drive	2 x 480GB SSD RAID 1 or better
OS	Windows 2019 (or latest)
Network (NIC)	Minimum 2 x 1G NIC
BIOS Management	The solution must come with a dedicated BIOS Management Port (for example iDRAC dedicated network port or iLO dedicated network port)
Power Supply	2x 600W Dual Power Supply (Redundant)
Antivirus	The solution must have machine-learning based antivirus native to the security appliance
Support	The manufacturer must provide 5-year global onsite warranty & to keep hard drives upon failed
Certification	Must be certified by the VMS manufacturer for the performance.
Safety approvals	The server must hold CSA or UL Listed Safety Approval

Note: The Configuration mentioned is only Minimum requirement. Vendor to consider as per the VMS OEM recommendations in case of higher configurations required as per System requirements to fulfil the complete functionality of the system and Bidder to consider the cost for the same & quote accordingly. The VMS Server shall be Hot Redundant N+1 Configuration. Cost shall inclusive of redundancy server also. No Additional Cost shall be paid for Redundancy Server. The Server shall be Balde Type and its should be Rack mounted. Tower type shall not be accepted. VMS OEM Compliant letter shall be submitted for further approval of VMS Server.

1.5.9 VMS Recording Server (Primary / Main Server)

Processor	2 x Xeon Silver 4210 or better
RAM	32 GB or better
Drive	2 x 512GB SSD RAID 1
OS	Windows 2019 (or latest)
Network (NIC)	2 x 1Gbe NIC and 2 x 10Gbe SFP+
Power Supply	2x 1100W Dual Power Supply (Redundant)
Storage	Storage to be calculated by CCTV OEM to arrive the Storage requirement. However, the storage calculation must be done in CCTV OEM Storage Calculator Software
RAID controller	The solution must have a dedicated storage controller: high-performance RAID controller with a minimum of 2 GB cache optimized for writing intensive video applications. Controller must support RAID 0, 5, 6, and 10
Recording Throughput	Recording: minimum 1000 Mbps. Redirection: 500 mbps Playback: minimum 50 Mbps;
Antivirus	The solution must have machine-learning based antivirus native to the security appliance
Support	The manufacturer must provide 5-year global onsite warranty & to keep hard drives upon failed
Certification	Must be certified by the VMS manufacturer for the performance.
Safety approvals	The server must hold CSA or UL Listed Safety Approval

Note: The Configuration mentioned is only Minimum requirement. Vendor to consider as per OEM recommendations in case of higher configurations required as per System requirements to fulfil the complete functionality of the system and Bidder to consider the cost for the same & quote accordingly. Client / Customer will not pay extra cost for storage box. Hence contractor shall be added the cost of the storage box in the Recording & fail over Server itself. 100% CCTV Camera OEM Compliance shall be submitted by successful contractor post awarded the contract. No deviation shall be accepted.

1.5.10 VMS Recording Server (Redundant / Failover Server)

Processor	Xeon Silver 4210 or better
RAM	16 GB or better
Drive	2 x 512GB SSD RAID 1
OS	Windows 2019 (or latest)
Network (NIC)	2 x 1Gbe NIC or better
Power Supply	2x 1100W Dual Power Supply (Redundant)
Storage	Storage to be calculated by CCTV OEM to arrive the Storage requirement. However, the storage calculation must be done in CCTV OEM Storage Calculator Software
RAID controller	The solution must have a dedicated storage controller: high-performance RAID controller with a minimum of 2 GB cache optimized for writing intensive video applications. Controller must support RAID 0, 5, 6, and 10
Recording Throughput	Recording: minimum 1000 Mbps. Redirection: 500 mbps Playback: minimum 50 Mbps;
Antivirus	The solution must have machine-learning based antivirus native to the security appliance
Support	The manufacturer must provide 5-year global onsite warranty & to keep hard drives upon failed
Certification	Must be certified by the VMS manufacturer for the performance.
Safety approvals	The server must hold CSA or UL Listed Safety Approval

Note: The Configuration mentioned is only Minimum requirement. Vendor to consider as per OEM recommendations in case of higher configurations required as per System requirements to fulfil the complete functionality of the system and Bidder to consider the cost for the same & quote accordingly. Client / Customer will not pay extra cost for storage box. Hence contractor shall be added the cost of the storage box in the Recording & fail over Server itself. 100% CCTV Camera OEM Compliance shall be submitted by successful contractor post awarded the contract. No deviation shall be accepted.

1.5.11 CCTV Monitoring station LED screen

Screen Size (inch, measured diagonally)	55 (54.6) inches
Wi-Fi Standard	Wi-Fi Certified 802.11a/b/g/n/ac
WI-FI FREQUENCY	2.4 GHz/5 GHz (for Wi-Fi Direct: 2.4 GHz Only)
Bluetooth profile support	Version 4.2, HID (mouse / keyboard connectivity) / HOGP (Low Energy device connectivity) / SPP (Serial Port Profile) / A2DP (stereo audio) /AVRCP (AV remote control)

RF (Terrestrial / Cable) Connection Input(s)	1(Side)
Composite Video Input(s)	Hybrid with S-Centre Speaker Input x1 (Side, Mini jack)
HDMI inputs total	4 (4 Side)
HDCP	HDCP2.3 (for HDMI™1/2/3/4)
Features specified in HDMI2.1	4K120/ eARC /VRR/ALLM
HDMI Audio Return Channel (ARC)	Yes (eARC / ARC)
Variable Refresh Rate (VRR)	Yes (for HDMI™3/4)
Auto Low Latency Mode (ALLM)	Yes (for HDMI™3/4)
Digital Audio Output(s)	1(Side)
Headphone Output(s)	1(Side)
USB ports	2 (Side)
USB drive format support	FAT16/FAT32/exFAT/NTFS
USB playback codecs	MPEG1: MPEG1/MPEG2PS:MPEG2/MPEG2TS (HDV, AVCHD): MPEG2, AVC/MP4 (XAVC S): AVC, MPEG4, HEVC/AVI: Xvid, MotionJpeg/ASF (WMV): VC1/MOV: AVC, MPEG4, MotionJpeg/MKV: Xvid, AVC, MPEG4, VP8.HEVC/WEBM: VP8/3GPP: MPEG4, AVC/MP3/ASF WMA)/LPCM/WAV/MP4AAC/FLAC/JPEG, WEBM: VP9/AC4/ogg/AAC/ARW (Screen nail only)
Display resolution (H x V, pixels)	3,840 x 2,160
Backlight type	Direct (Full Array LED)
Backlight dimming type	Local Dimming
PANEL REFRESH RATE	100 Hz
HDR (High Dynamic Range) compatibility	Yes (HDR10, HLG, Dolby Vision)
Picture processor	Cognitive Processor XR
Clarity enhancement	XR 4K Upscaling
Video signal support	HDMI™ signal: 4096 x 2160p (24, 50, 60 Hz), 3840 x 2160p (24, 25, 30, 50, 60, 100, 120 Hz), 1080p (24, 30, 50, 60, 100, 120 Hz), 1080i (50, 60 Hz), 720p (24, 30, 50, 60 Hz), 576p, 480p
Picture modes	Vivid, Standard, Cinema, IMAX Enhanced, Game, Graphics, Photo, Custom, Dolby Vision (Vivid/Bright/Dark), Netflix calibrated, BRAVIA CORE calibrated

SENSOR	Light
Audio Power Output	10 W + 10 W + 5 W + 5 W
Sound modes	Standard, Dialog, Cinema, Music, Sports, Dolby Audio
ACOUSTIC CENTRE SYNC	Yes (Sony-compatible Soundbar)
Headphone 3D Surround Ready	Yes (with WLA-NS7)
Operating System	Android TV™
SMART TV	Google TV™
On-board Storage (GB)	32 GB
ECO DASHBOARD	Yes
Voice Search	(Voice Search) Yes/(Built-in Mic)Yes
BUILT-IN MIC SWITCH	Yes
Electronic Programmed Guide (EPG)	Yes
Internet Browser	Yes
Application Store	Yes (Google Play Store)
On/Off Timer	Yes
Sleep Timer	Yes

Note: The display shall be mounted 2 x 2 matrix and the output shall be connected with Server / Client / CCTV Monitor Station. Switcher / Encoder / Decoder / Software cost shall be added on this cost itself If any hardware to be required to make the required solutions. Only one Output directly driven from the CCTV Operator Workstation and the same output shall be configurable with all the 4 Display Panel. Bidders needs to be considered the necessary additional equipment cost in this line item. No additional cost shall be provided if will require to comply the above requirement.

1.5.12 CCTV Operator Workstation

Intel core 9th Generation Intel Core i9 Processor by latest generation or better, 16GB DDR3 RAM, 64-bit operating system, 1TB SSD for OS and Security Center applications, with a minimum of 16 GB of free disk space to install the Security Center client application, 1TB SATA Hard disk with 7200rpm, GbE network interface card, DVD-RW standard keyboard & Mouse with Dual NVIDIA® GeForce® RTX 2080 video card with 21" 4K / UHD LED MONITOR. Minimum 4 HDMI,1 parallel, 8 USB 2.0, 1 serial, 2 Ultra ATA/100, 2optional IEEE1394, 1 USB Keyboard, 1 USB Mouse, 1 video, 1 Microphone jack, 1 Line-in jack, 2 x 1GBPS RJ-45 Interface Port

Note: The Configuration mentioned is only Minimum requirement. Vendor to consider as per OEM recommendations in case of higher configurations shall be required as per project functional requirements and the bidder to consider the cost for the same & quote accordingly. The bidder needs to consider the same configuration if OEM will not have an objection for the mentioned specifications. No deviation shall be accepted.

1.5.13 Camera Poles, Fixtures and Mounting Accessories

Description	Minimum Specifications
Camera pole - 6Mtr	6 Metre Length Pole with Base Plate (250 x 250 x 6mm) 76.10mm OD x 3.65mm Thick x 6000mm Length Integral junction chamber flush with the pole for termination of CAT-6A and power cables. Including Bakelite sheet. Provided with a camera mounting plate - fixed to the pole with provision of holes for camera mounting - holes dimensions to be provided by you. PU coated through 5 tank cleaning process and with 2 coats of primer and 2 coats of PU paint and topcoat for extra weather protection. Poles are fine finished. The rate shall inclusive of all the necessary camera mounting accessories, back boxes, Termination Junction Boxes for power supply (if required), 4 Nos of Anchor bolt shall be 25mm dia and 500mm length, 2 Nos of 32mm GI pipe medium class collar bend for cable entry at the bottom of the foundation etc., to be considered. The Pole Cost shall be inclusive of all required RCC foundations as mentioned the foundation details of 450mm (L) x 450mm (W) x 1000mm (H) RCC M25 Grade. The Pole cost shall inclusive of excavation, shuttering, foundations and backfilling the soil etc. no extra cost shall be provided to Civil contractor.
Camera pole - 3Mtr	3 Metre Length Pole with Base Plate (250 x 250 x 6mm) 76.10mm OD x 3.65mm Thick x 3000mm Length Integral junction chamber flush with the pole for termination of CAT-6A and power cables. Including Bakelite sheet. Provided with a camera mounting plate - fixed to the pole with provision of holes for camera mounting - holes dimensions to be provided by you. PU coated through 5 tank cleaning process and with 2 coats of primer and 2 coats of PU paint and topcoat for extra weather protection. Poles are fine finished. The rate shall inclusive of all the necessary camera mounting accessories, back boxes, Termination Junction Boxes for power supply (if required), 4 Nos of Anchor bolt shall be 25mm dia and 500mm length, 2 Nos of 32mm GI pipe medium class collar bend for cable entry at the bottom of the foundation etc., to be considered. The Pole Cost shall be inclusive of all required RCC foundations as mentioned the foundation details of 450mm (L) x 450mm (W) x 1000mm (H) RCC M25 Grade. The Pole cost shall inclusive of excavation, shuttering, foundations and backfilling the soil etc. no extra cost shall be provided to Civil contractor.

Note: General Arrangement (GA) drawings and sample 4K Resolution images (previously executed at any of large-scale project) needs to be submitted by vendor before procuring the material at site. The material shall be rejected without any further

reason by Consultant / Client if the material will be arrived at site without prior approval of above.

1.5.14 Weatherproof housing for Outdoor application

The Housing should be made of extruded aluminium and should be weatherproof.

The minimum internal dimensions of the housing should be capable of housing the camera.

The camera housing should be:

- Compatible to enclose the outdoor type cameras
- Suitable for the make and model no of cameras offered and as specified by the manufacturer
- Outdoor application enclosures shall be as per the approved camera OEM post order awarded.
- Should be compact and indoor / outdoor type as required.
- Suitable for operation in upright and inverted position'
- Minimum IP 67 Class or higher weatherproof enclosure shall be proposed in case of outdoor mounting.

1.5.15 Testing & Commissioning

The entire CCTV System will be tested in the following aspects

The correctness of cabling with continuity as per the approved shop drawings

System design & configuration check

Functional test of the cameras & checking video quality on the PC & monitors

Any other test that is required for checking the quality & performance of the system

1.6 Parking Guidance & Management System

System Description

The presence of car shall be detected using ultrasonic sensor and LED Indicator wired with zonal controller for each car.

Each car parking slot will have a visible LED lamp which glow in Standard Colour to differentiate Empty Slot, Occupied Slot, Electric Vehicle Slot, Women Reserved Parking Slot, Differently Able Person Reserved Parking Slot.

Each Zone controller will be connected to sensors of its zone, master controller, floor controller and zonal/floor display units using RS-485/Ethernet communication.

Zonal display unit for driver guidance shall be installed with 4-digit LED display.

The master unit will be connected to PGS Server through TCP-IP. It will calculate the parking slot availability based on the information received for both type of vehicle and pass the information to master display unit.

Parking programming will be done in Master Controller based on selection switch/display provided in Parking slots.

UPS power will be provided to PGS server, master controller, zone controllers etc.

Necessary cable (4-core) cables to be provided for connecting ultrasonic detectors with zone controllers.

The car park guidance system shall be integrated with ICCC platform via open protocols such as Web API; BACNET/OPC/MODBUS; RESTful API

Long Range Reader

- The card reader shall be of non-contact UHF RFID technology. The card readers shall be of high reliability, consistent read range characters, low power consumption and easy to install.
- The card readers shall have a read range of min 6mtrs.
- They shall include tri colour LED (red/green & Amber) to indicate normal/pass/fail status.
- The reader shall be sealed in a rugged weatherized vandal resistant enclosure designed to withstand harsh environments as well as providing high degree of vandal resistance for outdoors.
- The Reader shall be connected to the controller on a Wiegand interface to meet the site requirements.
- The reader shall be capable of two-way communications with the controller and have bi-colour LED indication to indicate access granted / denied status. The readers shall support user defined reader keys offering higher security. The reader keys shall be stored in encrypted format in non-volatile memory
- The reader shall be compact and shall be suitable for outdoor operation from temperature of -35°C to 65°C.
- The access readers shall be housed in environmentally protected housing with at least IP65 protection class for outdoor applications
- The card reader shall be mounted on a SS304 framework with a hood to protect the card reader.
- The long-range card reader make shall be selected from the Access Control System Approved make list.

Read Range	Up to 6 mtr
Communication Interface	TCP/IP, Wiegand 26/34, RS232 and RS 485
Buzzer	Beep Sound
Frequency Range	865-867 MHz
Read Rate	Multi tag (200 pcs/sec), Single tag (2000 pcs/min)
Read Mode	Periodic Scan or External Trigger
Environmental Rating	IP 67
Operating Temperature	-35°C to 65°C
Operating Voltage	9 VDC
Power Consumption	50W
Certification	UL, FCC, CE

Ultrasonic Detectors with Integrated LED Indicator

The ultrasonic detectors shall be ceiling mounted to detect car presence in designated parking bay. The detectors shall be housed in ABS material the preferable baud rate shall be 9600 Bps, and the detector shall have a minimum detection angle of 15deg. The sensor shall be provided with RS 485/ TCP-IP communication protocol. The detectors shall be with self-testing and self-diagnostic capability.

Sr. No.	Description	Technical details
Ultrasonic Detectors		
1.	Voltage rating	DC 24V
2.	Current rating	10 mA
3.	Power Consumption	0.5W
4.	Operational principle	Ultrasonic
5.	Communication port	RS 485
6.	Detection Range	0.3 – 4.5 M
7.	Detection range setting	Range tolerance 0.5m
8.	Max error	0.05M
9.	Detection angle	15°
10.	Baud Rate	9600bps
11.	Response time	30ms
12.	Overall Size	Dia 118 mm, 127 mm
13.	Operating Temp	-20 to +65 Deg C
14.	Shell material	ABS
15.	Certification	CE
Sr. No.	Description	Technical details
LED Indicators		
1.	Voltage rating	DC 5 V
2.	Current rating	<30 mA
3.	Power Consumption	0.5W
4.	Luminance	As per colour configuration
5.	Communication port	RS 485
6.	Visible Distance	>50m (360° downwards)
7.	Baud Rate	9600bps
8.	Operating Temp	10 to 90°C
9.	LED Color	Standard Colour shall be indicated to differentiate Empty Slot, Occupied Slot, Electric Vehicle Slot, Women Reserved Parking Slot, Differently Able Person Reserved Parking Slot
10.	Certification	CE

Zone Controllers / Floor Controllers

Sr. No.	Description	Technical details
1.	Voltage rating	AC 230V - 50Hz
2.	Output Power Supply	DC 24Volt/3A
3.	Current rating	45 mA
4.	Power Consumption	<10W
5.	Communication port	RS 485 / Ethernet
6.	Baud Rate	9600bps
7.	Display Mood	LCD / LED indicators
8.	Overall Size	To be specified by Bidder
9.	Weight	To be specified by Bidder
10.	Operating Temp	-20 to +60°C
11.	Enclosure	Powder Coated MS Enclosure / 1U Rack Mount

Master Controller

Sr. No.	Description	Technical details
1.	Voltage rating	AC 230V - 50Hz
2.	Current rating	45 mA
3.	Power Consumption	10W
4.	Communication	RS485 / Ethernet
5.	Baud Rate	9600bps
6.	Rate	Half Duplex
7.	Display Indicator	Red power, Green Output ON
8.	Input port	Upto 16 Channels (16 devices/channel); RS 485/ TCP-IP interface.
9.	MS Enclosure	Bidder to specify
10.	Mounting	Wall mount/Desktop/ 1U Rack Mount
11.	Operating Temp	-20 to +60°C
12.	Enclosure	Powder Coated MS Enclosure

Automatic Number Plate Recognition (ANPR) Camera

The ANPR Camera shall be integrable with CCTV Network for the purpose of security and surveillance. ANPR must capture license plate image and must convert the image through OCR converter.

Sr. No.	Description	Technical details
1.	Voltage rating	12Vdc
2.	Power	POE
3.	Power Consumption	<11.5W
4.	Max. IR LEDs length	50M
5.	Day/Night	Auto (ICR) /Color/ B/W

Sr. No.	Description	Technical details
6.	Focal length	2.7mm ~ 12mm
7.	Identification	Vehicle Color & Type like SUV, Car Bike
8.	Focus Control	Motorized
9.	Communication	TCP-IP
10.	Resolution	1080P
11.	Image sensor	1/2.7" 2 mega pixel
12.	Overall Size	Bidder to specify
13.	Processing	In Built Processing
14.	Accuracy	Greater than 85%
15.	Operating Temp	-20 to +60°C
16.	IP Grade	IP67
17.	Certification	CE

Central Parking Management Software (CPMS)

Sr. No.	Description	Technical details
1.	Database	The databases used shall be latest versions of OEM Recommended database. The database licenses shall be supplied as part of the system. All the licenses shall be valid for the entire contract period.
2.	Reports	The CPMS shall have provision for taking reports of parking entry & exit reports (daily wise, monthly wise, yearly wise, shift wise, operator wise, vehicle type wise etc.). It shall have provisions for taking detailed reports of vehicle movements, movement of vehicle using Passive proximity cards/ duration of stay of each vehicle and number of vehicles on timely wise, daily wise, monthly wise, yearly wise, gate/unit wise etc. The software shall generate daily reports/ alerts for the vehicles exceeding 12/24-hour parking duration for security monitoring at the management console The reports shall be able to be exported in Excel, PDF format
3.	Integration	System should be integra table with stackable parking system and with external security system with no extra cost
4.	Server and Client Software	The server and PCs shall be provided with genuine latest version of Operating System, Application software and antivirus software. Preferred OS: Windows/ Linux.

Sr. No.	Description	Technical details
5.	Updates/Patches	All the regular software updates/ patches for the server and client software, database, operating systems, antivirus software etc for the entire contract period shall be provided without additional cost.
6.	Authority levels	The software shall have multi-level of administrator, supervisor, and operator level of control. The operator level shall have no authorization to modify or edit data other than doing transactions. One user shall be able to login only to one machine at a time.
7.	Security	The server/ client machines shall be provided with latest antivirus software and shall be periodically updated.
8.	Dashboard CPMS	win 8 Style.

Server Components

Sr. No.	Description	Technical details
1.	Processor	Latest Processor as per OEM Recommendation
2.	No of processors	2
3.	Memory	16GB DDR4 DIMMS
4.	No of Drive bays	4 Hot Pluggable SFF
5.	HDD capacity	2 x 1 TB
6.	RAID	Internal controllers: PERC S130 (SW RAID), PERC H330, PERC H730, PERC H730P, External HBAs (RAID): PERC H830, External HBAs (non-RAID): 12Gbps SAS HBA
7.	Networking	4 x 1GbE
8.	Form Factor	Rack mountable with rack mounting kit- 2U RACK
9.	Accessories	18.5" / 19" TFT Color monitor, DVD RW
10.	Keyboard	USB Keyboard (104 Keys) and Optical USB Mouse
11.	Operating System	Latest Windows/Linux Operating System

Main Display Board

Main display the below are the specifications:

- Multi-Color LED Matrix Display unit
- Cabinet Color: Black/White
- Cabinet Dimension: 1800 x 750 x 250
- LED Color: Red /Green Super bright.

- Communication: Ethernet
- Led Type 5mm Oval
- Logic card
- Visibility 120mtr
- Brightness in Day 5500 mcd & in night 600mcd
- Enclosure Weatherproof IP grade
- Power Supply Unit
- Suitable Pole or Structure

Floor/Zone Display Board

There are Single -rows floor display with single row the below are the specifications apply to both:

- Multi-Colour LED Matrix Directional Display unit
- 3/4 Digit Display with Arrow indication
- Cabinet Colour: Black
- Cabinet Dimension: 200 x 320
- LED Color: Multi Colour.
- Communication: RS485/Ethernet.
- Led Type 5mm Oval
- Visibility 120mtr
- Brightness in Day 2200 mcd & in night 600mcd
- Enclosure Weatherproof IP grade
- Suitable installation structure

1.7 Integrated Building Management System - IBMS

System Architecture of IBMS

- The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate both the ANSI/ASHRAE Standard 135-1995 BACnet, and Modbus technology communication protocols in an interoperable system.
- The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI / ASHRAE™ Standard 135-1995, BACnet TCP to assure interoperability between all system components is required. For each BACnet device, the device supplier must provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet at all levels.
- All components and controllers supplied under this contract shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a Master / Global / Host to pass data shall not be acceptable.
- Structured Query Language (SQL) or Java Database Connectivity (JDBC) or ORACLE compliant server database is required for all system database parameter storage. This data shall reside on a server for all database access.

Systems requiring proprietary database and user interface programs shall not be acceptable.

- Two (2) level hierarchical topology is required to assure fast system response times and to manage the flow and sharing of data.

Requirement of IoT Based BMS System

- Proposed Building Management System with IoT Platform server, which is located at the Integrated Building Management System (IBMS) server room & Integrated Centralized Control Center (ICCC) server room on the second floor.
- It requires cloud-based server storage for the data collected by the IoT based BMS controller. Here are a few considerations for such a system:
  - ✓ Integration Protocol: Determine the protocol for integrating the IoT based BMS system with cloud server. Common protocols include MQTT, CoAP, or HTTP/HTTPS.
  - ✓ Security: Implement robust security measures to protect data during transmission and storage. This includes encryption, authentication, and access control mechanisms. Security shall comply with the requirement of cyber security UL-2900-1 compliances.
  - ✓ Backup and Redundancy: Implement backup and redundancy mechanisms to ensure data availability and integrity in case of system failures or disasters. Redundancy shall be complied with N : 1 configuration.
  - ✓ Compliance: Ensure compliance with relevant data protection and privacy regulations, especially when using cloud-based storage solutions.
  - ✓ Monitoring and Analytics: Implement monitoring and analytics tools to gain insights from the collected data, optimize building operations, and identify potential issues or inefficiencies. Controlling & Monitoring the BMS system as mentioned below-
    a. Field equipments (Field level) shall be connected / interfaced to IoT Based BMS - DDC controller (automation level).
    b. IoT Based BMS - DDC controller (automation level) shall be connected to BMS server (process level - I).
    c. BMS 3D graphical software shall be installed / maintained at BMS server (process level).
    d. IoT Based BMS - DDC controller shall be directly connected to Cloud Server (Process Level – II)
    e. Incase Process Level – I will get failure at any point of time, The process Level – II will take over the operations.
  - ✓ Maintenance and Support: Establish procedures for ongoing maintenance, updates, and support for the IoT system to ensure its reliability and performance.
  - ✓ Management: IoT based BMS allows for a more seamless and efficient management of building systems. IoT technology enables the integration of various devices and systems of the building, creating a unified network that can be monitored and controlled remotely.
- Smart energy management with IoT involves using interconnected devices and

sensors to monitor, control, and optimize energy usage in various applications.

- ✓ IoT BMS Controller: IoT enabled BMS controller shall collect the data from the field level to measure energy consumption at various points in the system and the same shall be processed at process level I & II. It will used to track electricity, gas, water, and other forms of energy consumptions.
- ✓ Data Collection and Analysis: Collect data from the sensors in real-time and analyse it to identify patterns, trends, and inefficiencies in energy consumption. Machine learning algorithms can be employed to predict energy demand and optimize energy usage based on historical data and current conditions.
- ✓ Demand Response: Implement demand response strategies to adjust energy consumption in response to peak demand periods or pricing signals from utilities. This could involve automatically adjusting thermostat settings, dimming lights, or temporarily shutting down non-essential equipment.
- ✓ Energy Efficiency Measures: Implement energy efficiency measures based on insights gained from data analysis. This may include upgrading to more energy-efficient appliances and equipment, optimizing building layouts for natural lighting and ventilation, and improving insulation and weather sealing.
- ✓ Integration with Renewable Energy Sources: Integrate IoT systems with renewable energy sources such as solar panels and battery storage systems. This allows for better coordination between energy generation and consumption, maximizing the use of clean energy and reducing reliance on traditional grid sources.
- ✓ Predictive Maintenance: Utilize IoT sensors to monitor the health and performance of energy infrastructure and equipment in real-time. Predictive maintenance algorithms can detect potential faults or failures before they occur, allowing for proactive maintenance and minimizing downtime.
- ✓ User Engagement and Feedback: Provide users with feedback on their energy consumption habits through smart meters, mobile apps, or web interfaces. This encourages energy-saving behaviours and empowers users to make informed decisions about their energy usage.

Web Browser Clients

- The system shall be capable of supporting an unlimited number of users using a standard Web browser. Systems requiring additional software (to enable a standard Web browser) to be resident on the DDC / client machine, or manufacture-specific browsers shall not be acceptable. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser.
- The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.
- The Web browser client shall support at a minimum, the following functions:

- ✓ User log-on identification and password shall be required. If unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
- ✓ Graphical screens developed for the GUI shall be the same screens used for the Web browser client.
- ✓ HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
- ✓ Storage of the graphical screens (Static) shall be stored in DDC directly and should not depend on any other hardware.
- ✓ The Web page shall get automatically refreshed without any user intervention.
- ✓ Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
- ✓ Modify common application objects, such as schedules, calendars, and set points in a graphical manner. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator and set holidays
- ✓ View logs and charts
- ✓ View and acknowledge alarms
- ✓ The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to adjust their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
- ✓ Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

System Description & Input Output Summary

- The proposed system shall be a Direct Distributed Digital Control (DDC) system. It shall be a PC based system and shall combine latest state of the art technology with simple operating techniques. The entire Monitoring of Building Management System (BMS) shall be comprised of a network of interoperable, stand-alone digital controllers communicating on an open protocol communication network to a host computer within the facility and communicating via the Internet to a host computer in a remote location. The BMS shall communicate to third party systems such as Chillers, Energy meters, UPS, DG, Lifts, VFDs & breakers, fire-life safety systems and other building management related devices with open, interoperable communication capabilities.
- The BMS framework shall utilize built-in Internet connectivity to a broad range of distribution partners in the building automation, energy services, power/utility, and industrial sectors. The Framework shall bring together the ongoing computerization of control applications under single integrated system

architecture.

- The features shall be distributed both physically and functionally over the field controllers. Microprocessor based Direct Digital Distributed Controllers (DDC) shall interface with sensors, actuators and environmental control systems and carry out followings functions:
  - ✓ Individual input/output point scanning, processing, and control.
  - ✓ Centralized operation of the plant (remote control).
  - ✓ Static / Dynamic graphic details of plant and building.
  - ✓ Energy Management through optimization of all connected electrical and mechanical plants.
  - ✓ Alarm Detection and early recognition of faults.
  - ✓ Time, event and holiday scheduling as well as temporary scheduling.
  - ✓ Prevention of unauthorized or unwanted access.
  - ✓ Communication interface and control.
  - ✓ Suggestive preventive maintenance for all equipment as well as own error diagnosis.
  - ✓ Report generation.
  - ✓ Optimum support of personnel.
  - ✓ Data Visualization Tool
- These Controllers shall be capable of functioning on a stand-alone mode i.e. in case of loss of communication with the central control station / Server, these shall function independently. DDC shall have microprocessors built-in as standard, which control the respective operation centers based on the required logic and also offer fast communication of data via the network communication system. The local access to these shall be either through an in-built display with keypad for each outstation or through a portable operator's terminal. The controllers shall be capable of executing advanced control algorithms like Optimum Start stop, PID control, auto PID tuning and schedule management. They shall also execute logic functions based on time and/or event. Totalization and averaging functions shall be an inherent feature of the controller.
- Each stand-alone intelligent DDC Controller shall have a Dual 32-bit processor, on board Ethernet connectivity. These shall also control any other operations on the floor and shall be sized to suit the operation centers or system requirement. This shall help in reducing the site electrical installation.
- The number of controllers for central plant room equipments shall be decided by the contractor. Overall, the system shall be provided with 20% spare capacity, with spare of at least 20% points in each type of IO point in each controller.
- There shall be one BMS control station located in Control Room. The Operator Station should use a simple Web Browser in conjunction with the BMS Server software. The computer shall be sized to cover the graphic display memory, planning information, software & data storage requirement. The display shall be in the form of dynamic colour graphics and text format with menu driven pop-up windows and help facility.
- The following software packages shall be loaded into the system as minimum

standard: -

- ✓ Complete system operational software
- ✓ Site specific data manipulation software
- ✓ 3D Graphical software
- ✓ Alarm indication software
- ✓ Internet Enabled Remote Monitoring Package.

Central Stations Software and Hardware

- A central server, located at IBMS Server Room, shall be provided. The server shall support all DDC's connected to the customer's dedicated common network and remotely connected to the cloud server.
- Local connections shall be via an Ethernet LAN. Remote connections can be via ISDN, PSTN or dial-up connection.
- It shall be possible to provide access to all DDC & 3rd party integration units via a single connection to the server. In this configuration, each DDC can be accessed from the Graphical User Interface (GUI) or from a standard Web browser (WBI) by connecting to the Local Area network.
- The server software shall provide the following functions, at a minimum
  - ✓ Complete control and monitoring of IBMS system from colour graphics pages on the machine, or from a remote web browser.
  - ✓ Full client-server operation.
  - ✓ SQL / JDBC / ORACLE Database.
  - ✓ Comprehensive alarm handling with alarm retransmission and logging.
  - ✓ Scheduled recording of logged data from DDC.
  - ✓ Management of multiple controller occupation times.
  - ✓ Multilevel security system.
  - ✓ International language support
  - ✓ Display of HTML pages from company Intranet, or Internet.
  - ✓ Display of live, logged, or recorded data in multi-trace graphs.
  - ✓ Simple engineering path using drag and drop operations.
  - ✓ Self-learning of all local networks.
  - ✓ Help file in PDF format for viewing or printing.
  - ✓ Access to the configuration mode of devices.
  - ✓ Display all devices on the system connected via LANs, internet works, autodialled links, and Ethernet Network connections.
  - ✓ Customised program creation environment.
- The BMS software shall be simple, flexible, and convenient to use such that an operator with minimal programming knowledge can use it to perform control / monitoring and to build programs for control applications, graphics to generate management information systems (MIS) reports. As well, on higher end it shall be possible to create customized programs to suite the site requirement by a software programmer. All necessary documents required to make customization possible should be available along with the software without any additional charge.
- The operating system shall be the Microsoft Windows 11 / 64-bit multitasking

environment. The networking software shall use the TCP / IP LAN protocol. The system shall be capable of supporting up to 25 simultaneous operator workstation connections but however presently we need Five User Option.

Monitoring and Control Functions

Monitoring:

- The system shall support data acquisition using periodic scanning, exception reporting or on operator request. The system shall support a range of scan intervals, ranging from less than 5 second up to several minutes as desired / required. The system shall allow certain selected points to be scanned more often / faster than other points.
- The communication techniques shall be optimized to minimize network traffic while providing good system response and reliability. The system shall also provide utilities to compile aggregate statistics on communication link usage.

Control:

- Control transactions issued by the operator shall be communicated to control devices using a write followed by read to ensure the integrity of the transaction. If the read following the write to the device indicates that the control action has failed, the operator shall be informed by means of a control failure alarm. The priority of the control failure alarm shall be configurable by the user.

System Database

- The system shall provide a real-time database incorporating data from analogue, logical or pulse inputs. The database shall be configurable by the end user without the need for any programming and shall be able to modify on-line without interrupting operation of the system. In addition to point-based information, the database shall also provide historization capabilities for analogue, digital, pulse; event-based information and calculated values. This information shall be accessible by all facilities of the system such as custom displays, reports, trends, user written application, etc.,
- The real-time database shall use suitable data structures to collect and store the following categories of data, as minimum.
  - ✓ Access points
  - ✓ Analogue points
  - ✓ Status points
  - ✓ Accumulator points
  - ✓ Historical data
  - ✓ Event data
- The facility shall also exist to accommodate user defined data structures.
- Each of the point database structures shall be comprised as a composite point with a number of associated parameters that may be referenced relative to a single tag name. Specifically, each of these parameters shall be accessible by various sub-systems such as the graphical operator interface, report generation system and application program interface in a simple format without the need to know any internal storage mechanism.

- The system shall maintain portions of the data base requiring frequent high-speed access as memory resident information and other less frequently accessed data as disk resident data.
- Database backup shall be possible with the system on-line including backup of historical based data. The database backup shall be part of GUI software & shall be possible to configure automatic backup at regular interval without any user interference / attention. All other backup such as graphic pages / drawing etc can be windows based where simple copy & paste should be enough for taking backup other than database. Long term storage of this data shall be possible using the zip drive. The system shall have the provisions for importing this data at later date for analysis and long terms MIS reports.
- Point data shall be stored in a composite point database structure that provides a wide range of configurable information including but not limited to:
  - ✓ Point name and description
  - ✓ Multiple locations for data storage and device scanning addresses.
  - ✓ Scan period
  - ✓ Multiple dead-band or hysteresis settings
  - ✓ Monitoring and control access restriction information.
  - ✓ Location of operator alarm handling instructions
  - ✓ Location of ancillary information associated with the point.

Historical Data Storage

- Collection of historical point data shall be configurable as part of the point definition. Once configured, this data shall be collected automatically. Historical data collection shall be provided for both snapshots and averages with intervals ranging from 5 seconds to several hours.
- The system shall provide the necessary means to easily locate the particular value of interest for any of the historical points. The graphical operator interface, trend, report generation and application interfaces shall be able to access historical data.

Trending

- The system shall provide flexible trending allowing real-time, historical, or achieved data to be trended in a variety of formats. In addition, trend data types shall be able to combine to allow for comparisons between data e.g., current real-time data versus archived data. The system shall provide trending capability with following functions.
  - ✓ Real time trending
  - ✓ Historical trending
  - ✓ Archived history trending
  - ✓ Trend scrolling
  - ✓ Trend zooms
  - ✓ Export option / Copying of currently displayed trend data to the clipboard for pasting into spreadsheet or document.
- The system shall allow the trending of a minimum of 5 points in a single trend

display set. For each trend set display it shall be possible for operators to configure the number of historical samples and ranges displayed. Points configured in trend sets shall be changeable on-line.

- Operators shall be able to zoom in on information displayed on trend sets for closer inspection by dragging out an area of interest with the mouse or other pointing devices. From such a selection, it shall be possible to copy the underlying data to the windows clipboard for subsequent pasting into spreadsheet application such as Microsoft excel

Alarm Management

- The software shall include a well-organized alarm management facility to enable the operator to react quickly and efficiently to alarm conditions. Apart from the specific points identified for alarm annunciation in the I/O points schedule, the alarm types supported shall include:
  - ✓ Very high value alarm
  - ✓ Very low value alarm
  - ✓ Large deviation alarm
  - ✓ Rate of change alarm
  - ✓ Unreasonable value alarm
  - ✓ Delay to avoid nuisance alarm / short time change in value
- The system shall permit any of these alarm types to be applied to the analog and accumulated points.
  - ✓ The software shall permit at least 90 levels of alarm priorities to be assigned to each alarm ranging from the lowest to the highest. These levels shall be easily distinguished by the way they are presented such as the colour of the alarm message, blinking of the alarm message, varying audible alarms, etc., All alarm shall be logged in the event / alarm file and / or on the alarm printer. On acknowledgement of an alarm, it shall be possible to automatically issue a reset command to the controller so as to attempt to reset the alarm point.

Reporting

- The system shall support a flexible reporting package to allow easy generation of report data. The reports provided shall include pre-configured standard reports for common requirements such as alarm / event reports and custom report generation facilities that are configurable by the user.
- The following pre-formatted reports shall be available on the system:
  - ✓ Alarm / event report
  - ✓ Operator trail report
  - ✓ Point trail report
  - ✓ Alarm duration report
  - ✓ All point reports
  - ✓ Point attribute report
  - ✓ Lockout summary
  - ✓ Over-ride summary
- Configuration of these reports shall only require entry of the schedule information, and other parameters such as point name or wildcard, filter information, time

interval for search and destination printer to fully configure the report. No programming shall be required.

- The requirement of the above-mentioned reports shall be as follows:

Alarm/Event Report

- This report shall be summary of all events of a specified type for nominated points occurring in a time period. The time period may be specified as an absolute start and end date and time, or as a period to the current time.

Operator trail report

- This report shall be a summary of all operator actions relating to a specific operator in a specified period.

Point trail report

- This report shall be provided to produce a summary of all events of a specified type occurring in a period on nominated points.

Alarm duration report

- This report shall be provided to calculate the total amount of time a nominated point or group of points has been in an alarm condition over a given time period.

All point reports

- A report shall be provided to produce a list of point information, including point name, description, point type, engineering units, and current values.

Point attributes report

- A report shall be provided for summaries of the points selected as per the following criteria:
  - ✓ Out of service
  - ✓ Alarm suppressed
  - ✓ Abnormal input levels
  - ✓ In manual mode.

Over-ride summary

- This report shall be used to provide the summary of all points / commands that have been over-ridden by the operator.

Time Schedules

- The system shall include the facility for time scheduling activities on both a periodic and one-off basis. All time schedules shall be configurable via the Operator workstation. Each time schedule entry shall consist of:
  - ✓ Date
  - ✓ Time
  - ✓ Point name
  - ✓ Point Parameter
  - ✓ Target Value
  - ✓ Type of scheduling
  - ✓ The available time schedule type shall include:
    - ❖ Daily – to be executed everyday
    - ❖ Workday – to be executed on the weekdays
    - ❖ Holidays – to be executed on holidays

- ❖ Individual days – to be executed on a particular day

- The system shall also have the provision for programming temporary schedules that over-ride the normal schedule.

Energy Monitoring & Analysis

- Energy Monitoring & Analysis should be integral part of GUI. It shall support minimum of 50 Energy points for analysis purpose. The software shall provide the following feature but are not limited to,
  - ✓ It shall be possible to generate & view detailed Daily, Weekly & monthly graphs of the energy meter / point identified.
  - ✓ It shall be possible to see and analyse the total energy usage in a building and also shall be possible to identify by which system is major user of the energy.
  - ✓ It shall be possible to compare the energy points week against week, day against day in a month, identify Maximum, Minimum & average daily values & Energy usage for different periods of time of the day.
  - ✓ It shall be possible to make cost and consumption analysis or CO2 reports on consumption.
  - ✓ Based on the energy consumed it shall be possible to rank the systems or building (in case of multi-location buildings)
  - ✓ Software shall allow the user to compare the predicted / forecasted energy or based on historic performance with current performance.
  - ✓ It shall be possible to create energy signature with respect to ambient / outside temperature of the day
  - ✓ Software shall allow the user to identify the exceptions happened in the system due to which energy consumption was increased.
  - ✓ It shall be possible to compare the energy consumption after introducing a energy saving strategy for further fine tuning or to visualize the savings achieved.

Operator Interface

- The operator interface provided by the system shall through an intuitive graphical user interface and shall allow for efficient communication of operational data and abnormal conditions. It shall provide a consistent framework for viewing of information. Critical areas (such as alarm icons) shall be visible all the time. A predefined area on the screen shall provide operator messaging, and this area shall also be visible at all times.
- The operator interface shall be interactive and based on graphics and / or icons. Standard tool bar icons and drop-down menus shall be available on all standard and custom display to allow easy access to common functions.
- The system shall provide an operator interface with the following minimum capabilities:
  - ✓ Window re-size, zoom in, zoom out.
  - ✓ Dedicated icons and pull-down menus to perform the following:
  - ✓ Associated display
  - ✓ Alarm summary

- ✓ Alarm acknowledgement
- ✓ Previous display recall
- ✓ Graphic call-up
- ✓ Trend call-up
- ✓ Point detail
- ✓ Current security level
- ✓ Alarm annunciation
- ✓ Communication fail annunciation
- ✓ Operator message zone.

Area Assignment / Area Profile

- Each operator shall be assigned one or more specific areas / functions of the facility with the appropriate monitoring and control responsibility. An area shall be defined in this context as a logical entity comprising of a set of points in the system. This is turn may represent a physical space in the facility or a particular utility or a particular equipment.
- The system shall provide the facility to create area profiles, which combine areas and time periods, and which can be assigned to operators with the same area access requirements. By using area profiles in this way, area access can be specified to apply during certain time periods, allowing different areas of access at different times of the day or week.

Command Partitioning

- It shall be possible to assign to each operator a set of allowed commands / operating for each assigned area. With this feature, it shall for example be possible to configure an operator to set a digital point to On, but to disallow the same operator from setting the same digital point to OFF.

Standard System Displays

- The following displays shall be included as part of the system:
  - ✓ Alarm summary display
  - ✓ Event summary display
  - ✓ Point detail template displays
  - ✓ Trend set template displays
  - ✓ Communication status displays
  - ✓ System status displays
  - ✓ Operator scratch-pad display.

System Status Displays

- These shall display the following information
  - ✓ Points in alarm condition pending acknowledgement
  - ✓ Points which remain in an alarm condition state, but which have been acknowledged.
  - ✓ Communication failure
  - ✓ Printer Status
  - ✓ Operator workstation status
  - ✓ Controller status

Administrative Displays

- The system shall provide the following full screen display
  - ✓ Master system menu
  - ✓ Report summary
  - ✓ Alarm summary
  - ✓ Event summary
  - ✓ Display summary.
  - ✓ Area assignment
  - ✓ Holiday assignment
  - ✓ History assignment
  - ✓ Push-button assignment
  - ✓ Operator definition
  - ✓ Operator message board
  - ✓ Events archive and retrieval
  - ✓ Time period summary

Other Requirements

- It shall be possible to launch any windows-based applications, such as Microsoft word or Microsoft excel, from within the operator interface.

Help Facility

- Software shall be provided to facilitate programming and storage of the system operation manuals in the hard disk. The operation manual shall be retrieved by Online Help mode so as to enable the operator to self-learn the system operation, command, or function as and when needed.
- This `help' facility shall be made available to the operator by use of a dedicated key, or a single key click on the mouse. A minimum help shall be available for every menu item and dialogue box.
- The facility shall contain both text and graphics to provide information about the selected function directly.
- The information provided shall be in simple clear language and shall be possible to search the help based on typical word included in the process.
- When a point is overridden by operator command from an operator workstation or a local workstation, an alarm message shall be output to the appropriate alarm printer and to respective operator workstation. Alarm messages shall require operator acknowledgement.
- When a point returns to normal, the event shall be recorded in control stations as 'Return to Normal'.
- The Operator workstations shall be capable of displaying a list of all points in alarm for the building in a single summary. Systems which require the operator to make a separate summary for alarms shall not be acceptable. The software shall also provide details of particular alarm occurred on a point.

Compliance

- The computer system software and hardware should be 21 CFR part 11 compliant.

- Therefore, vendor to carry out system qualifications accordingly
- All instruments, software supplied shall be validated, tested, and certified complying to 21 CFR Part – 11.
- Contractor shall strictly follow the procedures as laid down in the necessary guidelines.

Third Party System Integration Units

- The 3rd party Integration unit shall provide the interface between Ethernet LAN and the 3rd party field control devices such as DDC or PLC or any other devices which need to be integrated. These shall also provide supervisory capability of functions over the devices connected to it. The purpose of using these units should be limited to integrate devices only, not for any DDC interface with GUI, provided by others.
- The Unit must provide the following hardware features as a minimum:
  - ✓ One no. on board RS-232 port
  - ✓ One No. on Board RS-485 port
  - ✓ Provision to include / add additional communication card
  - ✓ Battery Backup
  - ✓ Minimum RAM of 128 MB & Flash of 64MB
- The Unit must communicate over TCP/IP with communication speed of 10/100MBPS.
- The Integration unit shall have built in drivers for open protocol such as
  - ✓ BACnet over MSTP
  - ✓ BACnet over IP
  - ✓ Modbus over MSTP
  - ✓ Modbus over IP
  - ✓ Lon FTT
  - ✓ Lon IP
  - ✓ Mbus over TCP
  - ✓ Mbus Serial
  - ✓ SNMP

  If the above drivers are add-on products, it shall be made available / considered while selecting the unit & the same to be confirmed in writing.
- The Integration unit shall provide flexibility of adding communication ports (RS485) by adding communication cards, minimum one slot, when required rather than adding additional unit itself.
- The Integration unit shall have inbuilt JAVA engine and it shall be possible to configure the IO, if required, of the 3rd party devices.
- The Integration unit should be capable of handling multiple protocol simultaneously and should not be restricted to single protocol.
- The Integration unit should have inbuilt memory for program storage.
- The Integration unit should automatically backup its database for the user defined interval.
- User authentication should be integral part of the unit.

- All vendors are required to provide the documentation highlighting the capabilities mentioned above.
- All units shall have LEDs for fault / status identification such as
  - ✓ LAN active (one per port in case of multiport units)
  - ✓ LED to display proper functionality / Status of the unit.
  - ✓ LED to display healthiness of CPU of the unit.

Direct Digital Controller (DDC)

DDC Hardware Requirement

- DDC controllers shall be capable of fully "stand- alone" operation i.e. In the event of loss of communication with other DDC's or Control Station, they shall be able to function on their own.
- The controllers shall be built in Dual 32-bit microprocessors for reliable throughput, with EEPROM based operating system on BACNET
- The memory available to the controller board should serve as working space and there should not be any limitation of using particular function block other than the memory.
- The controllers shall be UL listed and conforming to CE.
- The controller shall have support programs built in RAM for minimum of 120 hours in the event of a power failure and it shall be possible to fit any battery thus expanding the time limit to 5 years. An alarm shall be generated on low battery voltage. The battery shall not be required to supply power to actuators, valves, dampers etc.
- DDC shall have embedded TCP/IP connectivity so that it can be hooked into the Local Area Network (LAN) provided by the client / can be on dedicated network created by the vendor. Each DDC can be accessed from the Graphical User Interface (GUI) or from a standard Web browser Interface (WBI) by connecting to the server.
- Controller shall have capability to communicate with other controllers for any interlock or data sharing using peer to peer technology. The Controller which routes the messages or data sharing through the system, or any intermediate hardware / controller shall not be acceptable.
- Vendor to demonstrate this capability during the commissioning time and the same shall be verified at the time of handing over.
- Each controller shall have an inbuilt 1 Nos of RS-232 Port and Dual RS-485 Ports. So that any trouble shooting required at field level can be carried out without removing the controller from the network (LAN).
- Power provision via 230V, 50Hz Uninterrupted power supply shall be provided by end user, the conversion to 24V AC power to cater to the controller shall considered as part of the DDC panels supplied by BMS vendor. Hardware such as transformers and SMPS etc to be considered accordingly by BMS vendor.
- Controller shall support DHCP addressing over Local Area Network (LAN) so that the static IP requirements are reduced however a single static IP shall be provided for system so that it can be hosted on to internet in consultation with end user /

consultant.

- All controllers shall have capability to provide 24V DC auxiliary power supply for the sensor which requires power, however the same shall not be required to high power consuming devices / equipments such as actuators, dampers etc.
- Vendors to provide details on the same at the time of offer.
- The Controllers shall have proportional control, Proportional + Integral (PI) Control, Proportional plus Integral plus Derivative (PID) Control, Two Position Control and Time Proportioning Control and algorithms etc, all in its memory and all available for use by the user, i.e., all the control modes shall be software selectable at any time and in any combination. The analog output of Proportional Control, PI Control, and PID Control shall continuously be updated and output by the program shall be provided. Between cycles the analog output shall retain its last value. Enhanced integral action in lieu of Derivative function shall not be acceptable.
- Automatic loop tuning facility should be available to tune the loop at regular interval and adjust the gain or the integral / derivative time.
- The controllers shall have a resident real time clock for providing time of day, day of week, date, month, and year. These shall be capable of being synchronized with system / time master clocks in the network.
- Upon power restoration all clocks shall be automatically synchronized to the time master controller which will be set during the commissioning phase.
- The microprocessor based DDC's shall be provided with power supply, A/D and D/A converters, memory, and capacity to accommodate a maximum of 160 input/output (I/O) hardware points (with or without an expansion board).
- If the controllers provided by the contractor have the configurable plug-in function cards, then the following minimum specifications shall have to be met:
- The cards shall provide for analog or digital, input or output, hardwired connections to the installed plant.
- The quantity and combination of these cards shall be determined by the requirements of the plant in that location with the concurrence of the Owner/ Consultant.
- The DDC's shall have 20% spare capacity for each type of point (digital/analog input/output) of each DDC Panel to give flexibility for future expansion.
- All DDC controllers shall have 10 / 12-bit A/D resolution and be capable of handling voltage, milli-ampere, resistance, or open and closed contacts inputs in any mix, if required.
- Analog inputs/outputs of the following minimum types shall be supported:
  - ✓ 4-20 mA.
  - ✓ 0-10 volts.
  - ✓ 2-10 volts.
  - ✓ Resistance Signals (either PTC or NTC such as PT 1000, PT 3000, NTC20K)
- Digital input/output types to be supported shall be, but not limited to the following:

- ✓ Normally open contacts.
- ✓ Normally closed contacts.
- ✓ Pulse inputs

Note: Modulating outputs shall be true proportional outputs and not floating control type.

- It shall be possible to change the analog inputs to accept any of the above depending upon the site condition or system requirement using a jumper. The DDC which is configured using software trigger / switch shall not be acceptable.
- Controller's packaging shall be such that, complete installation and check out of field wiring can be done prior to the installation of electronic boards.
- All board terminations shall be made via plug-in connectors to facilitate troubleshooting, repair, and replacement. Soldering of connections shall not be permitted.
- Controllers shall preferably be equipped with diagnostic LED indicators with at least indication for Power up Test OK, Watch dog and Bus Error. All LEDs shall be visible without opening the DDC cover.
- It shall be possible for the controllers to accept regulated uninterrupted power supply to maintain full operation of the controller functions (control, logging, monitoring, and communications) in the event of a localized mains failure.
- Controllers requiring fan cooling are not acceptable.
- There shall be the facility for accessing controller data information locally, via a portable plug-in colour LCD display which will be common to all controllers and normally removed to prevent unauthorized tampering. In either case, access to the system thus provided shall be restricted by passwords in the same way as at the main operator terminal.
- In case the Portable operator Terminals (POT) are required to program the controllers, sockets shall be provided for same. Attachment of POT shall not interrupt or disable normal panel operation or bus connection in any way.
- The controllers shall be housed in vandal proof boxes to protect them from tampering by any unauthorized personnel. All DDC controllers used in plant room spaces and external application shall be housed IP66 rating enclosures. All DDC located inside the building shall be with a minimum of IP 55 rating enclosures.
- It shall be possible to add new controllers to the system without taking any part of the system off-line.
- All DDC should have XML web service option which can be enabled in later stage for any higher interface with IT infrastructure or any other service.
- Individual DDC should be BTL (BACnet Testing Lab) tested.

DDC Capabilities:

- The Controllers shall have a self-analysis feature and shall transmit any malfunction messages to the Control Station. For any failed chip the diagnostic tests, printout shall include identification of each and every chip on the board with the chip number/location and whether the chip "Passed" or "Failed" the diagnostic

test. This is a desired requirement as it would facilitate troubleshooting and ensure the shortest possible down time of any failed controller. Controllers without such safety feature shall be provided with custom software diagnostic resident in the EEPROM. The tenderer shall confirm in writing that all controllers are provided with this diagnostic requirement.

- Operating system (O.S.) software for controllers shall be EPROM resident.
- Controllers shall have resident in its memory and available to the programs, a relevant library of algorithms, intrinsic control operators, arithmetic, logic and relational operators for implementation of control sequences.
- In the event of failure of communication between the controllers and/or Control Station terminal, alarms, reports, and logs shall be stored at the controllers and transmitted to the terminal on restoration of communication.
- In the event of memory loss of a Controller or the expiration of back-up power, on start-up of the unit the necessary database shall be downloaded manually so that the logic built are verified by the user. However, controllers requiring a manual intervention for the re-boot of software are not desired.
- Where information is required to be transmitted between controllers for the sharing of data such as outside air temperature, it shall be possible for global points to be allocated such that information may be transmitted either on change of incremental value or at specific time intervals.
- Controllers must be able to perform the following energy management functions as a minimum,
  - ✓ Time & Event programs
  - ✓ Holiday Scheduling
  - ✓ Maximum and Distributed power demand
  - ✓ Optimum start and stop program
  - ✓ Night purge
  - ✓ Load reset
  - ✓ Zero energy band
  - ✓ Duty cycle
  - ✓ Enthalpy analysis and control
  - ✓ Run Time Totalization
  - ✓ Sequencing and Optimization
  - ✓ Exception scheduling

  Note: Detailed description of software features and operating sequence of all available energy management software shall be submitted with the tender for evaluation by the consultant.
- The DDC Controllers shall have Adaptive Control capability whereby the control software measures response time and adjusts control parameters accordingly to provide optimum control. The software shall allow self-tuning of the variable control loops (all or any of P, P+I, P+I+D) of the AHUs to provide the most efficient and optimized controls at different load conditions. The energy management programs shall update their parameters based on previous experience & current

operating conditions.

- Alarm Lockout shall be provided to prevent nuisance alarms. On the initial start-up of air handler and other mechanical equipment a “timed lockout” period shall be assigned to analog points to allow them to reach a stable condition before activating an alarm comparison logic.
- Tenderers shall indicate their proposed system alarm handling capability & features.
- Run time shall be accumulated based on the status of a digital input point. It shall be possible to total either ON time or OFF time. Run time counts shall be resident in non-volatile memory.
- It shall be possible to accommodate Holiday and other planned exceptions to the normal time programs. Exception schedules shall be operator programmable up to one year in advance.
- All DDC shall have trend / log storing capacity in built into it. It shall be possible to have stored the data for at least 40 days @ 1 hour sampling time for all the points of the DDC (used or unused).
- Minimum communication should be 10MBPS for each of the controller.
- DDC should be forward compatible type so that any expansion or upgrade of the system required in the future is easily taken care off without scrapping / removing / disturbing the existing working system.
- DDC Should allow user to include graphics, if required, however it shall be of static in nature.
- All DDC Should be capable of sending email to specific user in the event of alarm, identified by end user / consultants.

Portable Operators Terminal (POT)

- POT shall be provided to allow operator readout of system variables, override control and adjustment of control parameters. The POT shall be portable and plug directly into individual controllers for power and data.
- The minimum functionality of POT shall include:
  - ✓ Set points to a fixed value or state.
  - ✓ Display diagnostic results.
  - ✓ Display sequentially all point summary and sequentially alarm summary.
  - ✓ Display/change digital point state, analog point value.
  - ✓ Display/change time and date.
  - ✓ Display/change analog limits.
  - ✓ Display/change time schedule.
  - ✓ Display/change run time counts and run time limits.
  - ✓ Display/change time and/or event initiation.
  - ✓ Display/change programmable offset values.
  - ✓ Access DDC initialization routines and diagnostics.
  - ✓ Enable/disable points, initiators and programs.
  - ✓ Display/change minimum ON/OFF and maximum OFF times.
- The POT shall be complete with command keys, data entry keys, cursor control

keys or liquid crystal display (LCD). Access shall be via self-prompting menu selection with arrow key control of next menu/previous menu and step forward/backward within a given menu.

- Connection of a POT to a controller shall not interrupt or interfere with normal network operation in any way, prevent alarms from being transmitted, or interfere with Control Station commands and system modifications.
- Connection of POT at any controller shall provide display access to all controllers on that bus. In case the controller has a fixed LCD display and entry keyboard, then the display access shall be available on each screen.
- It should be possible to override the commands given through POT by the Operator Control Station.
- POT shall have touch screen colour display and it shall be possible to hook this to Local area Network so that the entire system data can be visualized.
- POT shall have self-learning capability so that it can recognize the DDCs on the network and update all points without any manual programming.

Data Communications

The communication between controllers shall be via a dedicated or customer provided Ethernet communication network as per standards. Controller's microprocessor failures shall not cause loss of communication of the remainder of any network. All networks shall support global application programs, without the presence of a host PC.

Each controller shall have equal rights for data transfer. There shall be no separate device designated as the communication's master. Those systems using dependent controllers shall be pointed out by the contractor and a dual Hot redundant transmission media with automatic switching and reporting in the event of line faults will have to be provided.

The communication network shall be such that:

- Every DDC must be capable of communicating with all DDC's on its own.
- Network connected devices shall be capable of sending message after successive retries shall constitute a communication or device failure.
- Each controller is to be provided with a communication watchdog to assure that the failure is reported to central station.
- Error recovery and communication initialization routines are to be resident in each network connected device.
- The communication protocol shall incorporate CRC (Cyclic Redundancy Check) to detect transmission errors.

Single or multiple standalone controller failures shall not cause loss of communication between active DDCs connected on the communication network. Full communication shall be sustained as long as there are at least two operational standalone control panels active on the communication network.

All the System Integration Units shall be linked together on a Local Area Network.

The communication network shall include provision for automatically reconfiguring itself to allow all operational equipment to perform as efficiently as possible in the

event of single or multiple failures.

The BMS supplier shall be required to provide details of standards to which their system conforms.

Field Devices

Electric and Electronic Controls Related Equipment

General Requirements

- All controls shall be capable of operating in ambient conditions varying between 0-55 deg. C and 90% R.H. non-condensing.
- All Control devices shall have a 20 mm conduit knockout. Alternatively, they shall be supplied with adaptors for 20 mm conduit.

Ancillary Items

- When items of equipment are installed in the situations listed below, the BAS contractor shall include the following ancillary items:

Weather Protection

- All devices required to be weatherproofed are detailed in the Schedule of Quantities. IP ratings for the equipment are mentioned in the respective section.

Pipework Immersion

- Corrosion resisting pockets of a length suitable for the complete active length of the device, screwed ½" (13 mm) or ¾" (20 mm) NPT suitable for the temperature, pressure and medium.

Duct Mounting (Metal or Builders Work)

- Mounting flanges, clamping bushes, couplings, locknuts, gaskets, brackets, sealing glands and any special fittings necessitated by the device.

Temperature Sensor

- Temperature sensors for space, pipes, and ducts, shall be of the Resistance Temperature detector (RTD) type or thermistor. These shall be two wire type and shall conform to the following specifications:
  - Immersion sensors shall be high accuracy type with a high resistance versus temperature change. The accuracy shall be at least ± 2 deg C.
  - Immersion sensors shall be provided with separate Brass thermo-well. These shall be manufactured from bar stock with hydrostatic pressure rating of at least 10 kgf/cm2.
  - The connection to the pipe shall be screwed type. An aluminum sleeve shall be provided to ensure proper heat transfer from the well to the sensor. Terminations to be provided on the head. Flying leads shall not be acceptable.
  - The sensor housing shall plug into the base so that the same can be easily removed without disturbing the wiring connections.
  - Duct temperature sensors shall be with rigid stem and of averaging type. These shall be suitable for duct installation.
  - Outdoor air temperature sensor shall be provided with a sun shield.
  - The sensors shall not be mounted near any heat source such as windows, electrical appliances etc.

- The temperature sensors may be of any of the following types:
  - ✓ PT 1000, PT 3000
  - ✓ Thermistor

Humidity Sensor

- Space and duct humidity sensors shall be of capacitance type with an effective sensing range of 0% to 93% RH. Accuracy shall be + 2% or better.
- Duct mounted humidity sensors shall be provided with a sampling chamber.
- Wall mounted sensors shall be provided with a housing.
- The sensor housing shall plug into the base so that the same can be easily removed without disturbing the wiring connections.
- The sensors shall not be mounted near any heat source such as windows, electrical appliances etc.

Pressure Transmitter – Water Type

- Pressure transmitters shall be piezo-electric type or diaphragm type. (Bourdon Tube type shall not be acceptable).
- Output shall be 4-20mA or 0-10V DC and the range as specified in the data sheet depending on the line pressure.
- Power supply shall be either 24 V AC, 24 VDC or 230 V AC.
- Connection shall be as per manufacturer's standards. The pressure detector shall be capable of withstanding a hydraulic test pressure of twice the working pressure.
- The set point shall fall within 40%-70% of the sensing range and detector shall have sensitivity such that change of 1.5% from the stabilized condition shall cause modulation of the corrective element.
- The sensor must be pressure compensated for a medium temperature of -10° C to 60° C with ambient ranging between 0° C to 55° C.

Differential Pressure Switch – Water Type

- These shall be used to measure pressure differential across suction and discharge of pumps.
- The range shall be as specified in the data sheet. Switch shall be ON with increase in differential.
- Housing for these shall be weatherproof with IP 55 protection.
- The pressure switch shall be capable of withstanding a hydraulic test pressure of 1.5 times the working pressure.
- The set point shall fall in 40-70% of the scale range and shall have differentials adjustable over 10%-30% of the scale range.
- The switches shall be provided with site adjustable scale and with 1 NO/NC contacts.

Differential Pressure Switch – Air Type

- These shall be diaphragm operated. Switches shall be supplied with air connections permitting their use as static or differential pressure switches.
- The switch shall be of differential pressure type complete with connecting tube and metal bends for connections to the duct.

- The housing shall be IP 54 rated. The pressure switches shall be available in minimum of 3 ranges suitable for applications like Air flow proving, dirty filter, etc. The set point shall be concealed type.
- The contact shall be SPDT type with 230 VAC, 1A rating.
- The switch shall be supplied suitable for wall mounting on ducts. It should be mounted in such a way that the condensation flow out of the sensing tips. Proper adaptor shall be provided for the cables.
- The set point shall fall within 40%-70% of the scale range and I has differentials adjustable over 10%-30% of the scale range.
- The switches shall be provided with site adjustable scale and with 1 NO/NC contacts.

Air-Flow Switches

- Air flow switches shall be selected for the correct air velocity, duct size and mounting attitude. If any special atmospheric conditions are detailed in the Schedule of Quantity the parts of the switches shall be suitably coated or made to withstand such conditions.
- These shall be suitable for mounting in any plane. Output shall be 1 NO/NC potential free. Site adjustable scale shall also be provided.

Air-Pressure Sensor

- The pressure sensor shall be differential type. The construction shall be spring loaded diaphragm type.
- The movement of the membrane in relation to the pressure should be converted by an inductive electromagnet coupling which would give an output suitable for the controller.
- The pressure sensor shall be in a housing having IP 54 ratings in accordance with IEC 529. Suitable mounting arrangement shall be available on the sensor. The sensor shall come complete with the PVC tubes & probes.

Water Flow Switch

- These shall be paddle type and suitable for the type of liquid flowing in the line. Output shall be 1NO/1NC potential free.

Corbon-Monoxide Sensor

- CO Sensor shall be integrated Surface mounted type on the field.
- These shall work on 24V AC/DC supply with the output being standard type i.e. 4-20 mA / 0- 10 Volts etc.
- Response time of the detector shall be <10 minutes. Range of the sensor shall be 0 to 2000 PPM

Air Velocity Sensor

- Air Velocity Sensor shall be integrated Surface / Duct mounted type on the field. These shall work on 24V AC/DC supply with +/- 10% variation the output being standard type i.e., 4-20 mA / 0- 10 Volts etc with an accuracy of +/- 3%.
- It shall be possible to select the different ranges by changing the jumpers on the sensor. At least 3 selection ranges on the sensors are required.

Co2 Sensor – Space Type

- Co2 Sensor shall be wall / Surface mounted type on the field. These shall work on 24V AC/DC supply with the output being standard type i.e., 4-20 mA / 0-10 Volts etc. The sensing range required shall be 0-2000 PPM with good resolution.
- The preferred type of sensing element / method is NDIR type with accuracy of +/-30PPM or +/-5% of measured value. Warm up time of sensor shall be <2 minutes & response time is better than 150 seconds.
- Sensor shall be suitable to fix & operate at 1500 to 1750mm above the finished floor level.

Water Level Sensor

- Type : Float /Capacitance /Conductivity
- Mounting : To suit application.
- Connection : Flanged ANSI 150 lbs RF Carbon steel
- Float material : 316 SS
- Stem Material : 316 SS
- Output : 4 – 20 mA
- Enclosure : IP 68

Enclosures for DDC Panel

- All the controllers shall be housed in Lockable Vandal proof boxes which shall either be floor mounted or wall mounted. These shall be free standing, totally enclosed, dust and vermin proof and suitable for tropical climatic conditions.
- The panel shall be metal enclosed 18 SWG CRCA sheet steel cubicle with gaskets between all adjacent units and beneath all covers to render the joints dust proof. All doors and covers shall be hinged and latched and shall be folded and braced as necessary to provide a rigid support. Joints of any kind in sheet metal shall be seam welded with welding slag grounded off and welding pits wiped smooth with plumber metal.
- All panels and covers shall be properly fitted and secured with the frame and holes in the panels correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with nuts. Self-threading screws shall not be used in the construction of control panels. Knockout holes of approved size and number shall be provided in the panels in conformity with the location of incoming and outgoing conduits/cables. Lamps shall be provided to support the weight of the cables. The dimension of the boxes shall depend on the requirement with the colour decided in consultation with the Architect/Consultant.
- Note: All panel enclosures used in plant room spaces and external to building shall be suitable for outdoor application (IP 66 protection).

Cable, Wiring & Conduits

The latest IS standards & codes, rules shall be applicable for all conduits & cabling. Control and interlock wiring and installation shall comply with national and local electrical codes.

Cables

- All wire will be copper and meet the minimum wire size and insulation class listed

below:

Wire Class	Wire Size	Isolation Class
Power	12 Gauge	600 Volt
Class One	14 Gauge Std.	600 Volt
Class Two	18 Gauge Std.	300 Volt
Class Three	18 Gauge Std.	300 Volt
Communications	Per Mfr.	Per Mfr.

- Cables shall meet the signal cabling requirement of the system manufacturer.
- Fiber optic cable shall include the following sizes: 50/125, 62.5/125 or 100/140.
- Only glass fiber is acceptable, no plastic.
- Fiber optic cable shall only be installed and terminated by an experienced contractor. (The MSI shall submit to the Engineer the name of the intended contractor of the fiber optic cable with his submittal documents.)
- The cable shall meet minimum the following requirements:
  - ✓ Cables used shall be Armoured/ Flexible cables.
  - ✓ Cables used shall have minimum 98% conductivity copper.
  - ✓ Minimum 16 twists/m should be present for twisted pair cables.
  - ✓ Minimum sheath thickness should be 0.90mm or greater and PVC material.
  - ✓ Minimum 2 Core, 4core, 6 core cable connecting the Field devices to DDCs shall be PVC insulated copper, multi strand,
  - ✓ Shielded cables shall be minimum 1100V grades and shall generally confirm to latest IS standards and meet the signal cabling requirement of the system manufacturer.
  - ✓ For Analog IO"s, Digital input Screened cables should be used.
  - ✓ For Digital output, power cables - unscreened cables can be used.
  - ✓ For shorter distance 1.0sq.mm cable and for longer distance 1.5sq.mm cables should be used.
  - ✓ Minimum 2 core twisted pair screened cable of 18AWG should be used for third party integrations/communication in order to avoid Electromagnetic interference (EMI).
  - ✓ Cables from List of Makes to be proposed based on system architecture and site conditions assuring high level of reliability.
  - ✓ The cable shall be manufacturer tested as per the latest IS standards.
  - ✓ The signal cable shall be of the following specifications:
    - Type of Conductor : Shielded ATC Conductor
    - Size : 1 sq. mm
    - Insulation Material : Polyethylene /PVC
    - Shielding : Overall beld foil Aluminium polyester shield.
    - Jacket : Chrome PVC
    - Nominal DCR for shield : 17.6 ohm/km for conductor, 57.0 ohm/km
    - Nominal OD : 8.5 mm

- Nominal capacitance : 130 pF/m between conductors at 1 KHz, 180 pF/m between one conductor and other conductors connected to shield.
- Outer Sheath Material : FRLS
- Screened/Unscreened : Screened
- Shielded/Unshielded : Shielded
- Armoured/Un-armoured : Armoured
- Colour : Black and Red, Black, and White

✓ Communication cables for Third Party Integration shall have the below spes:

- Type of Conductor : Shielded ATC Conductor
- Copper Size of Conductor : 1.5 Sq. mm.
- Insulation Material : Polyethylene /PVC
- Shielding : Overall beld foil Aluminium polyester shield.
- Jacket : Chrome PVC
- Nominal DCR : 78.7 ohm/km for conductor, 55.8 ohm/km for Shield
- Nominal capacitance : 131 pF/m between conductors at 1 KHz, 243 pF/m between one conductor and other conductors connected to shield.
- Outer Sheath Material : FRLS
- Screened/Unscreened : Screened
- Shielded/Unshielded : Shielded
- Armoured/Unarmoured : Armoured
- Colour : Black and Red, Black and White

Note: The Communication cables shall be shielded and grounded properly

Conduits

- Conduits and accessories shall conform to relevant Indian Standards. PVC conduits shall be with a minimum of 2 mm thick and of required diameter shall be used.
- Separate conduits shall run for all power wiring. Connections between conduit and controller metal boxes shall be by means of brass hexagon smooth bore bush, fixed inside the box and connected through a coupler to the conduit. The joints in conduits shall be smooth to avoid damage to insulation of conductors while pulling them through the conduits. Where necessary, bends or diversions may be achieved by means of bends or circular inspection boxes with adequate and suitable inlet and outlet screwed joints. In case of recessed system each junction box shall be provided with a cover properly secured and flush with a finished wall surface. No bends shall have radius less than 2.5 times the outside diameter of the conduit.

Cable Trays

- The tray shall be shop fabricated and shall be free from burr and sharp edges.

- The cable trays M.S. Material used shall confirm to IS-2062 & Galvanizing shall confirm to IS-2629. The Zinc coating shall confirm to IS-4759.
- Width of ladder shall be 100mm to 1000mm as per requirement, length shall be 2.5mtr and depth shall be 50mm. Thickness of the tray shall be 1.6 mm.
- The trays shall be powder coated GI tray with cover and shall have support rods and brackets at regular intervals to fix the cables in position with necessary accessories like bends, couplers etc.
- The fire partitions penetrations by cable trays shall be protected by approved sealing methods, maintaining the same fire resistance rating as the partition.
- Fire sealant shall be provided to cover all gaps around the Cable trays routed through partitions / walls.

1.8 Data Networking & Telecom Services - ICT

Technical Specifications of Active Components

48 port Core Switch

S No	Mandatory Technical Parameters Requirement
A	Hardware and Architecture
1	Device Should have 48 x 1/10/25G SFP+ ports
2	Device Should have 8 x 40/100G QSFP28 ports or more uplinks
3	Dual Power Supply Module
4	Device Should have total Throughput of 2.5 Tbps and latency packet forwarding less than 850 nanoseconds
5	Device Should support upto 250K MAC address
6	Device Should support upto 250K IPv4 Prefix routes
7	Device Should support Unified Forwarding Table (UFT) feature to flexibility allocate forwarding table resources to taddress type Mac-addresses, Layer 3 Host entries and Longest Prefix Match for IpV4 and IPv6
8	Device Should have Max power draw of upto 315W
B	L2 features
1	Device Should support 4K VLANs, 9216 Jumbo frame
2	Device Should support MST, per-vlan RSTP, BPDU Guard, Loop Guard
3	Device Should support port ACL with l2, L3 and L4 parameters
4	Device support LLDP and LACP to bundle links and detect miscabling issues.
5	Device Should support IEEE 802.1D, 802.1Q, Q-in-Q, 802.1w, 802.1s and 802.1x
C	L3 features
1	Device Should support Routing Protocols: OSPFv2 with multiple instances, OSPFv3, BGP, MP-BGP, IS-IS, and RIPv2
2	Device Should support graceful restart for BGP, OSPF v2 and v3 and ISIS
3	Device Should support BFD
4	Device Should support Policy Based Routing (PBR) for IPv4 and IPv6, VRRP V4 and V6, Resilient ECMP, Unicast Reverse path forwarding (urpf), and Inter-VRF route leaking

S No	Mandatory Technical Parameters Requirement
5	Device Should support VXLAN+EVPN leaf-spine overlay technology supporting type-1 to type-5 routes
6	Device Should have support for symmetric and asymmetric IRB with EVPN with distributed gateway functionality.
7	Device Should support IPv4 and IPv6 clients in EVPN based overlay network
8	Device Should support active-active EVPN multi-homing
9	Device Should support Dynamic NAT options like Many-to-Many NAT and Many-to-One NAT (PAT) at line rate with no additional latency.
10	Device Should support IGMP v2/v3, PIM-SM / PIM-SSM, Anycast RP (RFC 4610) and Multicast Source Discovery Protocol (MSDP)
D	High availability
1	Device Should support maintenance mode/ Graceful insertion and removal (GIR) to isolate device from the network in order to perform debugging or an upgrade while gracefully steering traffic to peer nodes.
2	Device Should 1+1 redundant & hot-swappable Fans with support for both front-to-rear and rear-to-front airflow options
3	Device Should support 1+1 redundant & hot-swappable power with support for both AC and DC power supply options.
E	Security
1	Should support Storm control and Control Plane protection (CoPP)
2	Should support port ACL with l2, L3 and L4 parameters
3	Should support limiting number of mac address on a link
4	Device Should protect against ARP and DHCP spoofing by ensuring that a port will only permit IP and ARP packets with IP source addresses that have been authorized.
5	Device Should support IEEE 802.1x Authentication framework, MAC authentication, Dynamic VLAN assignment, Dynamic ACL assignment and CoA.
6	Device Should support multicast accounting to AAA servers
F	Management
1	Device Should support secure Zero touch provisioning
2	Should support tracking changes in MAC table, ARP, IPv6 neighbour table and IPv4, v6 route table for troubleshooting purpose.
3	Should support real time state streaming for advance monitoring from day 1
4	Should Support telnet, industry standard hierarchical CLI, SSHv2, HTTPS, SCP, SFTP, CLI task scheduler and configuration session.
5	Should support NTP and IEEE 1588 PTP (Transparent Clock and Boundary Clock)
6	Should support SNMP v1/2/3 and OpenConfig model over gRPC/Netconf
7	Device Should support Digital Optical Monitoring (DOM)

S No	Mandatory Technical Parameters Requirement
8	Device Should support real time data collection with sflow/netflow.
G	Automation & Visibility
1	The Device Should monitor output queue lenghts for all Device interfaces and Log and stream events related to congestion
2	The Device Should have OpenStack Neutron for ML2 integration with EVPN VXLAN control plane support.
3	Device Should support advanced mirroring features: Mirror to CPU, ACL filters and truncation on Mirror sessions, and tunnelling of mirror packets to remote servers.
4	Should support measure the two-way metrics such as delay, jitter, packet loss rate between two network elements using Two-Way Active Measurement Protocol (TWAMP) as per RFC 5357 or IP SLA
5	Should have programmability and automation support with on board python, bash and docker containers.
H	QOS
1	Should support 8 queues per port
2	Should support priority queue
3	Should support Weighted Fair Queue or Weighted round robin or equivalent
4	Should support WRED and DSCP for CPU generated traffic
5	Should support ACL based classification for QoS
6	Should support IEEE 802.1Qaz DCBX (Data Center Bridge Exchange), 802.1Qbb PFC (Priority-based Flow Control) and Explicit Congestion Notification (ECN)
7	Should support rate limiting function like policing and shaping
I	Others
1	Should have IPv6 ready logo certification
2	Should be 19" rack mountable with 4-post rail mount kit provided for easy installation
3	Hardware replacement warranty and TAC support Should be directly from the OEM. OEM email-id and India Contact support no. to be provided.
4	Transceivers Should be from Same OEM as of Device.

48 Port PoE+ Edge / Distribution Switch

S No	Technical Requirement
A	Hardware Features
1	Device should have 48*100M/1G Ethernet Ports and 4*1/10/25G or better Uplink Ports in 1 RU fixed Form Factor.
2	Min PoE budget (48Port * 30W = 1440W) 1440 Watts.
3	Dual Power Supply Module
4	Device should have total Throughput of 396 Gbps.

S No	Technical Requirement
5	Device should support copper Base-T (1G & 10G) connectivity over CAT6 cable and 1G, Dual rate 10G/25G SFP+ fiber connectivity over MM and SM cable for the Uplink ports.
6	Device should support upto 60K MAC address and 60K IPv4 simultaneously
7	Device should support Unified Forwarding Table (UFT) feature to flexibility allocate forwarding table resources to address different type of use cases.
8	The switch should support minimum of 30W (802.11at) on all 48 ports simultaneously
9	Device should have 1G management port, USB port and console port
10	Device should have Max power draw of upto 200 W (excluding POE)
B	L2 features
1	Device should support 4096 VLANs, 9216 Jumbo frame
2	Device should support MST, per-vlan, RSTP, BPDU Guard, Loop Guard
3	Device support LLDP, LLDP-MED and LACP to bundle links and detect miscabling issues.
4	Device Should support IEEE 802.1D, 802.1Q, Q-in-Q, 802.1w, 802.1s, 802.3x and 802.1x
C	L3 features
1	Device should support Routing Protocols: OSPFv2 with multiple instances, OSPFv3, BGP, MP-BGP, IS-IS, and RIPv2
2	Device Should support graceful restart for BGP, OSPF v2 and v3
3	Device Should support BFD inclusive of BFD for Lag links, BFD for V4 and V6 VRF, Multi-hop BFD and BFD on IP unnumbered interfaces.
4	Device Should support Policy Based Routing (PBR) for IPv4 and IPv6, VRRP V4 and V6, Resilient ECMP, Unicast Reverse path forwarding (urpf), and Inter-VRF route leaking
5	Device Should support Accumulated IGP Metric (AIGP), BGP Monitoring Protocol (BMP) and BGP Prefix Origin Validation with Resource Public Key Infrastructure (RPKI)
6	Should support GRE tunnel interface and GRE IP Decap
7	Device should support VXLAN+EVPN overlay technology.
8	Device should have support for symmetric and asymmetric IRB with EVPN with distributed gateway functionality.
9	Device should support IPv4 and IPv6 clients in EVPN based overlay network
10	Device should support active-active EVPN multi-homing
11	Device should support Dynamic NAT profiles and Multicast NAT
12	Device should support IGMP v2/v3, PIM-SM / PIM-SSM, Anycast RP (RFC 4610), VRF Support for IP Multicast, Multicast Source Discovery Protocol (MSDP)and IP Multicast Multipath.
D	High availability
1	Device should support Hitless upgrade & reloads in MLAG/Vpc setup and standalone (non-stack) setup.

S No	Technical Requirement
2	Switch should Provide constant PoE power even when switch is under maintenance or reload.
3	Device should have N+1 redundant field-replaceable Fans with support for both front-to-rear and rear-to-front airflow options
4	Device should have 1 + 1 field replaceable power supply
5	Device should support Low-Memory mode wherein during out of memory condition the device kills non-essential agents until the system recovers the necessary amount of memory.
E	Security Features
1	Should support Storm control and Control Plane protection (CPP)
2	should support ACL with L2, L3 and L4 parameters upto 8K ACLs
3	should support limiting number of mac address on a link
4	Device should support security-group based segmentation of hosts independent of the network constructs like VLAN, VRF and NVO.
5	Device should protect against ARP and DHCP spoofing by ensuring that a port will only permit IP and ARP packets with IP source addresses that have been authorized.
6	Device should support IEEE 802.1x Authentication framework, MAC authentication, Dynamic VLAN assignment, Dynamic ACL ID/name assignment, AAA assigned ACL rules and CoA.
7	Device should support Web-authentication for guest users,
8	Device should support critical/auth fail VLAN, guest VLAN, Phone VLAN and NAC server unreachable VLAN.
9	Device should support priority between 802.1x and Mac based authentication
10	Device in DHCP relay mode when in VxLAN fabric should support suppression of DHCP packets which are head end replicated to ensure the DHCP server is not overwhelmed by multiple copies of the same DHCP broadcast packet
11	Device should support mDNS and mDNS gateway capabilities
12	Device should support multicast accounting to AAA servers
F	Management
1	Device Should support secure Zero touch provisioning with options to provision Certificates artifacts on the device when it boots.
2	should support tracking changes in MAC table, ARP, IPv6 neighbour table and IPv4, v6 route table for troubleshooting purpose.
3	should support real time state streaming/ telemetry for advance monitoring from day 1
4	Should Support industry standard hierarchical CLI, SSHv2, HTTPS, SCP, SFTP, CLI task scheduler and configuration session.
5	should support NTP and IEEE 1588 PTP (Transparent Clock and Boundary Clock)
6	should support SNMP v1/2/3 and OpenConfig model over gRPC/Netconf
7	device should support Digital Optical Monitoring (DOM)
8	Device should support real time data collection with sflow/netflow and IPFIX support.

S No	Technical Requirement
G	Automation & Visibility
1	Device should support multi-OEM hypervisor environment and should be able to sense movement of VM and configure network automatically
2	The Device should have OpenStack Neutron for ML2 integration with EVPN VXLAN control plane support.
3	Device should support multiple simultaneous mirroring sessions across all ports and tunnelling of mirror packets to remote server
4	Should support measure the two-way metrics such as delay, jitter, packet loss rate between two network elements using Two-Way Active Measurement Protocol (TWAMP) as per RFC 5357
5	Device should support hardware-based Flow tracking and exporting flow records with IPFIX format
6	should have programmability and automation support with on board python, bash and docker containers.
H	QOS
1	should support 8 queues per port
2	should support priority queue
3	should support Weighted Fair Queue or Weighted round robin or equivalent
4	should support WRED and DSCP for CPU generated traffic
5	should support ACL based classification for QoS
6	Should support PFC (Per-Priority Flow Control) and Explicit Congestion Notification (ECN)
7	Should support rate limiting function like policing and shaping
I	Others
1	should be certified for NDcPP common criteria
2	should have IPv6 Phase 2 logo certification
3	Hardware replacement warranty and TAC support should be directly from the OEM. OEM email-id and India Contact support no. to be provided.
4	Transceivers should be from Same OEM as of Device.

24 Port PoE+ Edge / Distribution Switch

S No	Technical Requirement
A	Hardware Features
1	Device should have 24*100M/1G Ethernet Ports and 4*1/10/25G or better Uplink Ports in 1 RU fixed Form Factor.
2	Min PoE budget (24Port * 30W = 720W) 720 Watts.
3	Dual Power Supply Module
4	Device should have total Throughput of 396 Gbps.
5	Device should support copper Base-T (1G & 10G) connectivity over CAT6 cable and 1G, Dual rate 10G/25G SFP+ fiber connectivity over MM and SM cable for the Uplink ports.
6	Device should support upto 60K MAC address and 60K IPv4 simultaneously

S No	Technical Requirement
7	Device should support Unified Forwarding Table (UFT) feature to flexibility allocate forwarding table resources to address different type of use cases.
8	The switch should support minimum of 30W (802.11at) on all 48 ports simultaneously
9	Device should have 1G management port, USB port and console port
10	Device should have Max power draw of upto 200 W (excluding POE)
B	L2 features
1	Device should support 4096 VLANs, 9216 Jumbo frame
2	Device should support MST, per-vlan, RSTP, BPDU Guard, Loop Guard
3	Device support LLDP, LLDP-MED and LACP to bundle links and detect miscabling issues.
4	Device Should support IEEE 802.1D, 802.1Q, Q-in-Q, 802.1w, 802.1s, 802.3x and 802.1x
C	L3 features
1	Device should support Routing Protocols: OSPFv2 with multiple instances, OSPFv3, BGP, MP-BGP, IS-IS, and RIPv2
2	Device Should support graceful restart for BGP, OSPF v2 and v3
3	Device Should support BFD inclusive of BFD for Lag links, BFD for V4 and V6 VRF, Multi-hop BFD and BFD on IP unnumbered interfaces.
4	Device Should support Policy Based Routing (PBR) for IPv4 and IPv6, VRRP V4 and V6, Resilient ECMP, Unicast Reverse path forwarding (urpf), and Inter-VRF route leaking
5	Device Should support Accumulated IGP Metric (AIGP), BGP Monitoring Protocol (BMP) and BGP Prefix Origin Validation with Resource Public Key Infrastructure (RPKI)
6	Should support GRE tunnel interface and GRE IP Decap
7	Device should support VXLAN+EVPN overlay technology.
8	Device should have support for symmetric and asymmetric IRB with EVPN with distributed gateway functionality.
9	Device should support IPv4 and IPv6 clients in EVPN based overlay network
10	Device should support active-active EVPN multi-homing
11	Device should support Dynamic NAT profiles and Multicast NAT
12	Device should support IGMP v2/v3, PIM-SM / PIM-SSM, Anycast RP (RFC 4610), VRF Support for IP Multicast, Multicast Source Discovery Protocol (MSDP)and IP Multicast Multipath.
D	High availability
1	Device should support Hitless upgrade & reloads in MLAG/Vpc setup and standalone (non-stack) setup.
2	Switch should Provide constant PoE power even when switch is under maintenance or reload.
3	Device should have N+1 redundant field-replaceable Fans with support for both front-to-rear and rear-to-front airflow options

S No	Technical Requirement
4	Device should have 1 + 1 field replaceable power supply
5	Device should support Low-Memory mode wherein during out of memory condition the device kills non-essential agents until the system recovers the necessary amount of memory.
E	Security Features
1	Should support Storm control and Control Plane protection (CPP)
2	should support ACL with L2, L3 and L4 parameters upto 8K ACLs
3	should support limiting number of mac address on a link
4	Device should support security-group based segmentation of hosts independent of the network constructs like VLAN, VRF and NVO.
5	Device should protect against ARP and DHCP spoofing by ensuring that a port will only permit IP and ARP packets with IP source addresses that have been authorized.
6	Device should support IEEE 802.1x Authentication framework, MAC authentication, Dynamic VLAN assignment, Dynamic ACL ID/name assignment, AAA assigned ACL rules and CoA.
7	Device should support Web-authentication for guest users,
8	Device should support critical/auth fail VLAN, guest VLAN, Phone VLAN and NAC server unreachable VLAN.
9	Device should support priority between 802.1x and Mac based authentication
10	Device in DHCP relay mode when in VxLAN fabric should support suppression of DHCP packets which are head end replicated to ensure the DHCP server is not overwhelmed by multiple copies of the same DHCP broadcast packet
11	Device should support mDNS and mDNS gateway capabilities
12	Device should support multicast accounting to AAA servers
F	Management
1	Device Should support secure Zero touch provisioning with options to provision Certificates artifacts on the device when it boots.
2	should support tracking changes in MAC table, ARP, IPv6 neighbour table and IPv4, v6 route table for troubleshooting purpose.
3	should support real time state streaming/ telemetry for advance monitoring from day 1
4	Should Support industry standard hierarchical CLI, SSHv2, HTTPS, SCP, SFTP, CLI task scheduler and configuration session.
5	should support NTP and IEEE 1588 PTP (Transparent Clock and Boundary Clock)
6	should support SNMP v1/2/3 and OpenConfig model over gRPC/Netconf
7	device should support Digital Optical Monitoring (DOM)
8	Device should support real time data collection with sflow/netflow and IPFIX support.
G	Automation & Visibility
1	Device should support multi-OEM hypervisor environment and should be able to sense movement of VM and configure network automatically

S No	Technical Requirement
2	The Device should have OpenStack Neutron for ML2 integration with EVPN VXLAN control plane support.
3	Device should support multiple simultaneous mirroring sessions across all ports and tunnelling of mirror packets to remote server
4	Should support measure the two-way metrics such as delay, jitter, packet loss rate between two network elements using Two-Way Active Measurement Protocol (TWAMP) as per RFC 5357
5	Device should support hardware-based Flow tracking and exporting flow records with IPFIX format
6	should have programmability and automation support with on board python, bash and docker containers.
H	QOS
1	should support 8 queues per port
2	should support priority queue
3	should support Weighted Fair Queue or Weighted round robin or equivalent
4	should support WRED and DSCP for CPU generated traffic
5	should support ACL based classification for QoS
6	Should support PFC (Per-Priority Flow Control) and Explicit Congestion Notification (ECN)
7	Should support rate limiting function like policing and shaping
I	Others
1	should be certified for NDcPP common criteria
2	should have IPv6 Phase 2 logo certification
3	Hardware replacement warranty and TAC support should be directly from the OEM. OEM email-id and India Contact support no. to be provided.
4	Transceivers should be from Same OEM as of Device.

8 Port PoE+ Industrial Grade Switch Specification

S No	Technical Requirement
1	Operating Temperature: -40°C to +75°C
2	Humidity: 5% to 95% relative humidity, non-condensing
3	Mounting: DIN Rail
4	Power Supply: Dual DC Input, External PSU
5	Rated Input: 12-56VDC (46-56V for IEEE 802.3af/at)
6	Qualified PSUs: PoE Budget with 640W PSU
7	8-Port 30W PoE+ Gigabit with 4-Port SFP / dual DC power inputs, fan less
8	1000Base X SFP: 4 Port
9	Aggregate Bandwidth: Min 24 Gbs or Better
10	Forwarding Rate: Min 17.85Mpps or better
11	VLANs: 4K
12	VLAN IDs: 1-4095
13	MAC Table: 8K

S No	Technical Requirement
14	ARP Table: 1K
15	IPv4 Route Table: 32
16	IP Interfaces: 8
17	Access Control Entries: 256
18	IGMP Groups: 1024
19	Port Mirroring Groups: 1
20	L2 and Multicast : Flow Control IEEE 802.3x (Full Duplex) and Back-Pressure (Half Duplex) Protocol-based VLANS and Port-based VLANs; MAC-based VLANs; IP Subnet-based VLANs* IEEE 802.1Q tag-based VLANs IEEE 802.1ad Double Tagging (Q in Q) IGMP v1, v2, v3 with up to 1000 multicast groups IGMP snooping and querying Immediate leave and leave proxy Throttling and filtering IEEE 802.1ab Link layer Discovery Protocol (LLDP)
21	Network Redundancy Fast Failover Ring Protection with single and multiple rings, ring coupling, dual homing and chain modes IEEE 802.1D STP, IEEE 802.1w RSTP, IEEE 802.1s MSTP Static trunk or Dynamic via LACP (Link Aggregation Control Protocol) ITU G.8032 Ethernet Ring Protection Switching (ERPS)
22	Traffic Management and QOS Priority - IEEE 802.1p QoS Queues per port - 8 Scheduling - Strict, Weighted Round Robin Port-based shaping
23	Security Port Security: IP and MAC-based access control, IEEE 802.1X Authentication: Network Access Control, RADIUS, and TACACS+ AAA (Authentication, Accounting and Authorization) Storm Control: Multicast/Broadcast/Flooding Storm Control
24	Vibration, Shock and Freefall Certifications IEC 60068-2-6 (Vibration) IEC 60068-2-27 (Shock) IEC 60068-2-32 (Freefall)
25	Transportation NEMA TS 2-2016

S No	Technical Requirement
26	Railway EN50121-1-2017 EN50121-4-2016
27	Regulatory and Safety North American ITE UL 60950-1 UL/CuL 62368-1 Listed CSA 22.2 No. 60950-1 2nd edition 2014 (Canada) Complies with FCC 21CFR 1040.10 (U.S. Laser Safety) European ITE EN 62368-1 EN 60825-1Class 1 (Lasers Safety) 2014/35/ EU Low Voltage Directive International ITE CB Report & Certificate per IEC 60950-1 CB Report & Certificate IEC 62368-1 AS/NZS 60950-1 (Australia /New Zealand)
28	EMI/EMC Standards North American EMC for ITE FCC CFR 47-part 15 Class A (USA) ICES-003 Class A (Canada) European EMC Standards EN 55032 Class A EN 55035 EN 55011 EN 61000-3-2,2014 (Harmonics) EN 61000-3-3 2013 (Flicker) EN 300 386 (EMC Telecommunications) 2014/30/EU EMC Directive

Technical Specification of SDN controller

SDN controller/ Campus fabric manager	
Generic Clauses	
1	Centralized management appliance or SDN Controller should not participate in Data plane and control plane path of the fabric.
2	In Event of all Centralized management appliances or SDN Controllers fails, the fabric must function without any performance degradation and with the current configuration.
3	Centralized Management / SDN Controller must be from the same switch OEM and must have licenses to support the entire fabric infrastructure for the next 5 years.
4	SDN Controller must provide Centralised Management - Single pane of Glass for managing, monitoring, and provisioning the entire campus Fabric.

SDN controller/ Campus fabric manager	
5	SDN Controller must support a single GUI based network management tool for Network Visibility and management.
6	SDN Controller must provide insight into the traffic flow patterns utilising standards like netflow or sFlow or IPIFX
7	SDN Controller should have support to create Custom Dashboard as per customer requirement
8	SDN Controller must support role-based access control.
9	SDN Controller should support On-Prem and Cloud Deployment options
10	SDN Controller should leverage the centralized network database to provide network analytics using machine learning. This feature should be Natively supported from Day 1.
11	All devices must retain full CLI access for troubleshooting, management, and configuration purposes even when controlled via a central management tool. CLI Changes made from Fabric switches should be reconciled from the SDN controller.
12	SDN Controller or devices shall support: ssh, JSON/HTTPS, SNMPv2c/v3
13	The SDN controller should be equipped with the analytics Engine capable of Big Data and Machine learning
14	SDN controller Should provide network wide search facility on MAC and IP address
Third Party Integration	
15	SDN controller Should be able to integrate with third party overlay controllers
16	SDN controller should be able to integrate with third party overlay controllers irrespective of hardware and software versions running on the devices in network
17	SDN controller should support out of box Integration with Next Gen Firewalls to redirect and offload the Firewall Policies at Leaf.
18	SDN controller Should support API integration with management platforms and workflow tools
19	SDN Controller should support for ServiceNow, Remedy and Ansible integration.
20	SDN Controller must support the integration with Open stack via the ML2 framework.
21	SDN Controller should support APIs that allow integration to custom or commercially available change management systems
22	SDN Controller should support integration with Ansible for ease of provisioning across the fabric.
23	Centralized management appliance or SDN Controller communication with the south bound devices must be encrypted
Provisioning and Change Management	

SDN controller/ Campus fabric manager	
24	SDN Controller must support a single GUI based network management tool for management of Zero Touch Provisioning & Zero touch replacement
25	SDN Controller should support for automated state snapshot for pre- and post- change management.
26	Should provide configuration templates for change management
27	Fabric Must support a single GUI based network management tool for automated state snapshot for pre- and post- change management.
28	SDN Controller must have ability to automate VXLAN control plane and provide topology information of the fabric.
29	SDN Controller shall support automation of configuration changes (e.g. pushing common network changes across all devices, such as (QoS, security credentials or access control lists)
30	SDN Controller should support GUI based Flexible Change Control workflow to carry operation task like upgrades and configuration change with ability to review and approve those changes.
31	SDN Controller should support GUI based orchestration of automated upgrades of Device software to minimize service disruption
32	SDN Controller must support network wide state-based rollback to last known good state after a failed change management task.
Telemetry	
33	SDN controller should provide Real Time state streaming from network devices for Network wide Analytics
34	SDN Controller should support centralized network database, that leverages real-time state-streaming, to provide an aggregate view of the physical network state
35	SDN controller Should provide Historical state for forensic troubleshooting
36	Proposed Solution support event triggered email notification
37	SDN controller Should notify about Network events with correlated metrics
38	SDN controller should provide visibility of traffic in the network with real-time streaming of flow records
39	SDN controller should provide the flow records. The flow records should be available in time series, graphs and heat maps views.
40	SDN controller Should be capable of providing anomaly detection and predictive events alert to prevent outages
41	All Switches shall have licence for sub-second real-time or sub-second streaming telemetry information from day 1. Sub-second Telemetry Solution should be from the Switching OEM to provide seamless integration
Inventory and Topology	
42	SDN Controller must provide dynamic device inventory of the Fabric as well as current network topology of the fabric.

SDN controller/ Campus fabric manager	
43	SDN Controller must support Topology view with details like; Real time Bandwidth Utilization; Traffic Throughput; Error Rates; etc
44	SDN controller should provide inventory of all connected end points with traffic analytics, trend analysis and anomaly detection
45	SDN Controller should provide dynamic device inventory of the Switches as well as current network topology of the Solution with ability to detect and depict the logical overlay networks over physical one.
46	SDN Controller should discover and build the complete topology automatically
Security and Compliance	
47	Centralized management appliance or SDN Controller must provide necessary report for compliance and audit, and security vulnerabilities in an automated way
48	SDN Controller should support proactive notifications for software bugs and security vulnerability (CVE) specific to any deployment based on hardware platform, device configuration and deployed software version
49	Fabric should support ability to run compliance checks for configuration against a base line configuration and should be able to highlight noncompliance in an automated way
50	Fabric should support automated way of running compliance checks against security vulnerabilities released against the deployed OS image and configuration
51	SDN Controller shall support configuration compliance checking to detect config drift (e.g. manual configuration changes that no longer match templates or automated configs)
Other Points	
52	Scale: SDN controller should support upto 1000 Network switches devices

Technical Specification of WAN Router

WAN router: 24 port 1/10G SFP+ switch
Hardware and Architecture
Device should have minimum 24 x 1/10G SFP+ ports
Device should have minimum 2 x 40/100G QSFP28 uplink ports with support for breakout
Device should have non-blocking architecture with wire speed L2 and L3 forwarding with Avg packet size of 300 Bytes or more
Device should have minimum 2GB of packet buffer with VOQ based architecture.
Device should support reversible air flow option (front-to-back & back-to-front)
L2 features
Device should support 4K VLANs, 9200 Jumbo frame
Device should support minimum 128K MAC address

WAN router: 24 port 1/10G SFP+ switch
Device should support MST, per-vlan RSTP, BPDU Guard, IEEE 802.1D, Q-in-Q, 802.1w, 802.1s
Device should support port ACL with l2, L3 and L4 parameters
Device support LLDP and LACP to bundle links and detect miscabling issues.
L3 features
Device should support 128K IPv4 LPM routes
Device should support 64K IPv6 LPM routes
Device should support Routing Protocols: OSPFv2, OSPFv3, BGP, MP-BGP, IS-IS
Device Should support Graceful restart for BGP & OSPF
Device Should support IP unnumbered interfaces and Multi-hop BFD
Device Should support Policy Based Routing, VRRP v2 and v3, inter-VRF route leaking
Device Should support MPLS
Device should support open standard VXLAN+EVPN leaf-spine based SDN technology
Device should have support for symmetric IRB with type-2 routes providing distributed gateway functionality in the fabric.
Device should support IGMP v2/v3, PIM-SSM, Anycast RP, Multicast Source Discovery Protocol.
High availability
Shall support active-active layer2 and Layer3 redundancy with Multi-chassis Link Aggregation (MLAG) or equivalent technology while keeping control plane and management plane distributed.
Should have redundant hot-swappable fans and redundant host-swappable power supplies with front-to-back and back-to-front air flow option.
security
Should support Control Plane protection to protect switch from DoS attacks
should support port ACL with l2, L3 and L4 parameters
Device should support Role based access control to restrict admin access as per authorization
Should support TACACS+ and RADIUS for authentication and accounting
QOS
Device should support priority queuing
should support Weighted Fair Queue or Weighted round robin or equivalent queuing
should support ACL based classification for QoS
Should support Priority-based Flow Control
Should support rate limiting function like policing and shaping
Management
Should Support SSHv2, SCP, SFTP, CLI task scheduler, configuration session.
should support NTP and IEEE 1588 PTP Boundary Clock

WAN router: 24 port 1/10G SFP+ switch
should support SNMP v1/2/3 and Open Config model over gRPC/gNMI
Device should support traffic visibility with sflow/netflow/IPFIX
Should support encapsulated remote port mirroring over L3 networks using GRE
Automation & Visibility
device should support onboard tcpdump/wireshark to capture control plane and data plane traffic for troubleshooting.
Should support measure the two-way metrics such as delay, jitter, packet loss rate between two network elements using Two-Way Active Measurement Protocol (TWAMP) or IPSLA
Should support installation of custom apps using RPM/SWIX expanding use cases
should have programmability and automation support with on board python interpreter, bash script support and docker containers.
Others
Transceivers should be from Same OEM as of Device.
Direct OEM 24x7 TAC support with Next business day hardware replacement
All licenses should be included on day-1 to support all mentioned features for the asked period of support.
Hardware replacement warranty and TAC support should be directly from the OEM. OEM email-id and India Contact support no. to be provided.

Technical Specification of Wi-Fi Access Points

Wi-Fi Access Points:

- Cloud Controller based.
- Should be Wi-Fi CERTIFIED 6 and Wi-Fi CERTIFIED WPA3
- Supports 802.11b/g/n/ax radio (2.4 GHz) and 802.11a/n/ac/ax radio (5 GHz)
- Should support 802.3at/af POE/POE+
- Should have multi gigabit (2.5 or 5G) ethernet uplink and at least one gigabit downlink for LAN (bridged network).
- Should support WPA2 and WPA3.
- All Access point should have a dedicated 3rd radio that functions as a network location and security sensor,
- Should support 20/40/80/160 MHz channel width.
- Should have WIPS functionality and license for the same shall be included from day 1
- Should support plug and play configuration.
- Solution should have an Analytics and Correlation Engine to understand the actual end user experience on the network by measuring key parameters such as Time to Connect, Throughput, Coverage, Capacity, Roaming, Successful Connects and AP Health in real time
- Should have Guest Access functions from day 1 with fully customizable Captive Portal to include, Guest SSID, Guest VLAN, Captive Portal, Time limits before re-authentication and Access Control Lists (ACL) preventing guest VLAN from accessing internal LAN. Guest Access should support Sponsored Guest Access,

Authentication via Email, Authentication via SMS, pass phrase and Social Sign-In including Google, Amazon, Microsoft Azure and Facebook

- Should support AI Based Radio Resource Management (RRM) to allow viewing channel and transmit power across all APs on the network and support auto cancellation and auto conversion to ensure the most efficient use of available spectrum.
- Must be ceiling/wall mountable.

Wi-fi Access points 2x2:

- The switch should be a tri-radio 2x2:2SS 802.11ax Wireless Access Point with maximum data rates of 1,200 Mbps in the 5GHz band and 575 Mbps in the 2.4GHz band.
- It should have an integrated 3rd radio that functions as a network, location & security sensor, and a spectrum monitor.
- It should have 1 x 1GBaseT RJ-45 with 802.3af PoE In, 1 x 1GBase-T RJ-45 with PoE Out and additional 2 x 1GBase-T RJ-45 ports and should support Two spatial stream Multiuser (MU) MIMO for up to 1,200 Mbps wireless data rate to up to four MU-MIMO-capable client devices simultaneously. The AP shall be having minimum 4 no of ports with a configuration of 1 incomer and 3 outgoings from which LAN points shall be feeded.
- The switch should have a dedicated internal Omni-directional BLE Antenna
- Mounts: To be mounted on Wall plate. Hence, appropriate OEM mounts to be included
- The Access Point Should Support Advanced security features including Rogue Detection, WIPS, Neighbor AP and Honeypot AP Detection. Any license required for the same shall be provided from the start.
- It should support 802.11ax (Wi-Fi 6), including support for OFDMA, 1024-QAM, MU-MIMO, Target Wake Time (TWT), and Spatial Frequency Reuse (BSS Coloring).
- It should support Proactive Analytics and Correlation technologies that leverage machine learning to analyze user experience, correlate problems and automatically detect the root cause of problems
- It should support Transmit Beamforming & Maximal Ratio Combining with modern WIFI authentication protocols such as, Pre-shared Key (PSK), Captive Portal, Extensible Authentication Protocol (EAP), 802.11i
- Essential support for Wireless Security features of WPA2 or later with AES Encryption technology
- Should support WPA3 Enterprise as well as Opportunistic Wireless Encryption (OWE) that adds encryption to open networks.
- Should support 802.1x for Client Authentication and Rad Sec to allow RADIUS servers to transfer data over TCP and TLS for increased security.
- Should have Guest Access functions from day 1 with fully customizable Captive Portal to include, Guest SSID, Guest VLAN, Captive Portal, Time limits before re-authentication and Access Control Lists (ACL) preventing guest VLAN from accessing internal LAN.

- The Access Point Should support 802.11k, 802.11r, and 802.11v for client roaming.
- Shall support a WLAN Rate limit option to provide per client rate limit and application rate limit that allows to limit total bandwidth available for specific applications
- Monitoring and Reporting: Using various graphs, the offered WIFI solution shall have the ability to monitor the system on a client, AP, application, and port level makes managing the network
- Solution should have an Analytics and Correlation Engine to understand the actual end user experience on the network by measuring key parameters such as Time to Connect, Throughput, Coverage, Capacity, Roaming, Successful Connects and AP Health in real time
- Should support Client Roaming Visualization in UI and should provide a graphical representation of client roams with granular view of all roam events, including short interval roams.
- Should support Zero Touch Provisioning and have ability to do Auto provisioning for AP assignment to sites and getting the relevant configuration. Should support Site Assignment, Device Profile Assignment & AP Name Generation
- Should support Radio Resource Management (RRM) to allow viewing channel and transmit power across all APs on the network.
- Radio Resource Management should support auto cancellation to automatically disable 2.4 GHz radios to ensure the most efficient use of available spectrum.
- Should provide Current Radio Values per AP and Channel Occupancy with historical data
- Should support Backwards compatibility with 802.11a/b/g/n/ac devices and also have option to disable legacy wireless standards such as 802.11b/g.

Wi-fi Access points 4x4:

- The switch should be a 6 stream 802.11ax access point supporting 4x4:4SS in the 5GHz band, delivering a maximum data rate of 2,400 Mbps and 2x2:2SS in the 2.4 GHz band, delivering a maximum data rate of 575 Mbps
- The switch should have an integrated 3rd radio that functions as a network, location & security sensor and a spectrum monitor.
- The switch should have 1 x 2.5GBaseT RJ-45 with 802.3at PoE and additional 1 x 1GBase-T RJ-45 ports with a support of Four spatial stream Multi User (MU) MIMO for up to 2,400 Mbps wireless data rate to up to four MU-MIMO capable client devices simultaneously.
- It should have a dedicated internal Omni-directional BLE Antenna
- Mounts: To be mounted on Ceiling. Hence, appropriate OEM mounts to be included and shall be fixed in GI boxes at required locations
- The Access Point Should Support Advanced security features including Rogue Detection, WIPS, Neighbor AP and Honeypot AP Detection. Any license required for the same shall be provided from Day 1.
- It should support 802.11ax (Wi-Fi 6), including support for OFDMA, 1024-QAM, MU-MIMO, Target Wake Time (TWT), and Spatial Frequency Reuse (BSS Coloring).
- It should support Proactive Analytics and Correlation technologies that leverage

machine learning to analyze user experience, correlate problems and automatically detect the root cause of problems

- It should support Transmit Beamforming & Maximal Ratio Combining
- Support for modern WIFI authentication protocols such as, Pre-shared Key (PSK), Captive Portal, Extensible Authentication Protocol (EAP), 802.11i
- Essential support for Wireless Security features of WPA2 or later with AES Encryption technology
- It should support WPA3 Enterprise as well as Opportunistic Wireless Encryption (OWE) that adds encryption to open networks.
- It should support 802.1x for Client Authentication and Rad Sec to allow RADIUS servers to transfer data over TCP and TLS for increased security.
- It should have Guest Access functions from day 1 with fully customizable Captive Portal to include, Guest SSID, Guest VLAN, Captive Portal, Time limits before re-authentication and Access Control Lists (ACL) preventing guest VLAN from accessing internal LAN.
- The Access Point Should support 802.11k, 802.11r, and 802.11v for client roaming.
- Shall support a WLAN Rate limit option to provide per client rate limit and application rate limit that allows to limit total bandwidth available for specific applications.
- Monitoring and Reporting: Using various graphs, the offered WIFI solution shall have the ability to monitor the system on a client, AP, application, and port level makes managing the network
- Solution should have an Analytics and Correlation Engine to understand the actual end user experience on the network by measuring key parameters such as Time to Connect, Throughput, Coverage, Capacity,
- Roaming, Successful Connects and AP Health in real time
- Should support Client Roaming Visualization in UI and should provide a graphical representation of client roams with granular view of all roam events, including short interval roams.
- Should support Zero Touch Provisioning and have ability to do Auto provisioning for AP assignment to sites and getting the relevant configuration. Should support Site Assignment, Device Profile Assignment & AP Name Generation
- Should support Radio Resource Management (RRM) to allow viewing channel and transmit power across all APs on the network.
- Radio Resource Management should support auto cancellation to automatically disable 2.4 GHz radios to ensure the most efficient use of available spectrum.
- It should provide Current Radio Values per AP and Channel Occupancy with historical data

Convertors and Adaptors:

- The requirement of adaptors with QSFP+ 40GBase SM Optics, up to 2km Transmission
- Supplying, installation, testing and commissioning of Optical Transceiver, multi-mode SFP+ (10G) Module minimum 550m inside the LIU panel before distribution switches.

Technical Specification of IP-PBX System

Architecture

- The system should be based on Distributed IP Architecture with redundancy of CPU. The connectivity from Server to Gateway shall be on IP. The offered IP PBX must be approved by TEC under GR vide No: TEC/GR/SW/PBX-005/01/SEP-16 for IP PBX with Media Gateway. TEC Certificate based on IR or ER for conventional / Hybrid EPABX shall not be acceptable.
- Standalone FXO and FXS and PRI Gateways shall not be accepted
- The proposed IP based EPABX system shall be expandable to Capacity up to 1500 subscribers (inclusive of all types of Subscribers).
- The IPPBX system should be able to provide a single unified platform connecting signal units for catering to current requirement of ports. This should be possible with a single system using same processing unit and NOT through networking of multiple IP EPABX systems and Cascading/clustering of Servers
- The IP based EPABX system should have non- blocking architecture at all levels like System processing, Switching fabric & other resources like DTMF receivers, R2 Receivers.
- The system shall have universal slots shall support the digital ports with simultaneous voice &data, and analog ports with DTMF / CLI Signaling, standalone DTMF receiver ports, IP ports, E1 ports, CO ports, GSM Ports/support for GSM, ISDN PRI ports, Alarm ports, paging Port and In Skin Fiber card

Redundancy and Self Survivability

- System redundancy: The system shall be provided with 100% duplicated in 1+1 Hot Standby mode. The CPU shall be provided in hot-standby mode in such a manner that if one CPU fails the second CPU shall be able to take the complete load of calls automatically (without any manual intervention) without dropping any existing calls (IP, TDM & PRI). System should be providing Geographical redundancy using self-survivable Gateway architecture
- During an event of CPU Failure Media Gateways/IP PBX must work on redundancy mode and without any disconnection of ongoing calls and must provide same class of service to all the extensions (Analog, IP and Digital) and with same numbering scheme without any manual changes.

Security

- The entire solution should have inbuilt firewall protection for security. The entire stack shall have inbuilt FW application with AES 256-bit encryption employing SRTP/TLS protocols.
- The offered PBX should be supplied with Firewall solution either in skin or external for security of IP Phones.
- Account access authentication/restriction using external RADIUS resources.
- The Operating System used by the call server must not use or natively support network resource sharing services such as NFS, samba, LPR etc.
- The System must support Syslog services for both internal and external command and configuration control accounting with a minimum of 5-day history.

- The offered system should be supplied with Necessary license to view the log history of the admin users with commands, changes made in the programming.
- Usage of MD5 algorithm (or stronger) for password encryption

IP PBX Application Features

- A web interface application should be available to selected or all Users.
- This web interface should be accessed from all internet browsers (IE, Chrome etc.) on PC, tablet or smart phones should be available.
- The IP- EPABX system shall support voice mail, email integration and fax messaging in an integrated multimedia messaging and Collaboration system, CTI Presence, and Instant Messaging. All these features should be available from same IP- EPABX. Call Management system and Media gateway shall be from same OEM.
- System should be integrated with Open LDAP and Active directory systems for services like phonebook.
- System shall support T.38 protocol to send fax over IP network.
  System should have default feature of integration with MS Outlook with click to dial, presence and IM Features.

Web Page

- It should be possible to define more than one number to a user.
- User should be able to see these numbers from his/her web page and edit settings of these numbers by switching between them
- Using this web page, the following facilities should be available.
- Call should be started,
- Missed calls should be seen,
- Reminders can be set,
- Private speed dial list should be created by accessing common pool and all internal numbers through phonebook,
- Call Forwarding should be set according to day night modes,
- Call records should be seen,
- Conference room should be managed.
- User web page should be dynamic so user should not need to refresh page to see new events like missed calls etc.

VOIP Parameters

- The IP based EPABX call switching for internal calls (i.e., limited to a single location) should be based on the G.711 uncompressed PCM standard, but WAN calls outside the location may use the G.711, G.729A/B compression algorithm.
- The IP based EPABX system should be fully compliant to VOIP standards like H.323, SIP (Session Initiation Protocol).
- The offered system should support both H.323 Trunk as well as
- The IP based EPABX system must support Network Time Protocol (NTP) to synchronize the system data/time of network devices.
- The SIP proxy, SIP registrar should be inbuilt in the system and should support any SIP compliant Hard Phones or Soft Phones.

- The IP based EPABX system be enabled with the QOS features for the VOIP implementation it should be compliant with both QOS standards (layer 2 – 802.1 p/q) and layer 3 – diffserv/tos)
- The system must be enabled with Echo Cancellation mechanism in IP Telephony to improve voice quality.
- Session Traversal Utilities for NAT (STUN) method should be supported by the system.
- Media Gateway /IP PBX must be standard rack-mountable (19") solution having universal-slots architecture for flexibility in putting in any type of interface cards/modules for Analog & Digital Subscriber & Trunk. The IP PBX/MGW and its supporting cards must be from the same OEM. FXO/FXS based gateway solutions will not be considered. Vendor should offer the same GW Model at all the locations in such a way that, it should be possible to interchange the peripheral and Control cards between the Gateway locations.
- No separate PRI Gateway is not accepted.
- Media Gateway must have SELF SURVIVABILITY. Media Gateway(s) shall have IP connectivity to Core Servers of IP based EPABX system. Under normal circumstance Media Gateway(s) shall work in conjunction with or under the control of Core Servers as an integral part of IP based EPABX system. However, under isolation/disconnection condition (at IP connectivity level) of Media Gateway from Core Servers of IP based EPABX system, the Media Gateway shall support survival mechanisms that allow it to maintain 100% of the telephony services for its subscribers /trunks. Once the IP connectivity between Media Gateway & Core Servers is restored back, the Media Gateway shall work in conjunction with Core Server(s).
- All the Cards such as Analog/Digital Subscriber Card, VOIP Card, and Digital Phones etc must be interchangeable between all Gateway locations. Vendors to strictly quote for the same family of IP PBX/Gateway so that cards can be interchanged between the Gateways based on the need.
- The Media Gateway/EPABX must work on 48VDC normal with positive grounded and supply voltage varying from 42 to 58 Volts. The Gateway must have /PSU card which shall be able to work directly on AC Mains as well as option of working on external Float cum Boost Chargers (FCBC).
- Media Gateway should have modular architecture with the ability to stack multiple gateways in a single location. One or more such stacks should be placed in each location under the same Core Server control.
- Media Gateway should be able to restart automatically & shall support providing 100% of telephony service without human intervention at Media Gateway as well as at Core Server level when the input power supply to the Media Gateway is resumed after complete power failure, even under the failure of IP connectivity with Core Servers of IP based EPABX system.
- The cards and slots must be universal and interchangeable without switching off the exchange

IP PBX Features

- MOBILE TWINNING: The System must allow a Parallel ringing of Extn and Mobile phone.
- The proposed system should be capable to provide the following features /facilities to the subscribers through user-friendly system programming.
- Abbreviated dialing
- Alternating between parties (broker call)
- Appointment reminder
- Assigned night answer for Trunks.
- Automatic call back on Busy trunk/network
- Automatic call back on free/busy extension
- Automatic lockout of faulty lines
- Boss-Secretary feature- digital and IP subscribers.
- Call by name and number from the digital & IP station
- Call forwarding to extension or hunting group, voice mail, operator, paging, etc.
- Call Forwarding (Internal and External) – no answer / busy/immediate/follow-me/fixed/variable
- Call Park
- Call Pickup from any extension (individual and in a group)
- Call transfer
- Camp on busy extension/line
- CLI on the selected terminal.
- Choice of supervisory tones or voice announcements.
- Class of service changeover by station/operator/administration.
- Digit suffixing / prefixing – For the incoming calls, either from other exchanges or trunk, it shall be possible to insert/suppress at least 6 number or more of digits.
- Direct Inward Dialing supporting DP (dial pulse)/ DTMF (dual tone multi frequency) / mixed
- Directory Services (System should support minimum 10000 entries – name and numbers).
- Do not disturb
- Emergency call – by dialing a code (can be single digit) the user should be able to be routed to an emergency destination: external, internal, or attendant.
- Executive Override.
- Group Hunting
- Hold facility
- Hot-line services on extensions and trunks individual directory internal/external
- It shall be possible to suppress or add digits for outgoing calls.
- Last number redials
- Local and external call
- Mobile class of service for selected users or all users; this should include the mobility of the individual extension number across the network.

- Private incoming / outgoing trunk (Dedicated Trunks for Priority Users)
- Recorded announcement / music on hold (internal & external) for waiting party
- Selection of night service – at least 3 options should be selectable from console that is a line transfer to predefined extension, to voice mail, to a hunting group. It should also be possible to allocate each trunk line a different Night Destination.
- Special night answer points.
- Support the flexible numbering plan for dialing up to ten digits.
- Time of day barring of Local/STD/ISD calls from specified extensions.
- Timed reminder – wakeup call
- Toll / code restriction for trunk/tie or station-to-station calls.
- Auto attendant messages should be programmable.
- Extension to Cellular: The offered platform should provide embedded licenses (quantity as per bill of material) for users for achieving one-number accessibility by bridging calls that come to an office extension to any cellular phone.
- Dial tone, ringtone, busy tone, greeting tone should be programmable
- Conference: The system shall have 3-party conferencing. Moreover, there shall be a conference room feature.
- Conference Room: The offered system should have minimum 10 such conference rooms. To conference management, it shall be possible to monitor, mute/unmute, invite/disconnect the participants. Conference room shall be combination of IP, Digital and analog extensions) and shall be able to manage conference rooms through web-based interface. The offered system should have minimum 10 such conference rooms.
- The system shall support LCR (Least Cost Routing) feature. The system shall be able to analyses the numbers dialed by extensions and shall automatically divert them to pre-programmed trunk lines based on days of week or hours of day. Further, the system shall be able to automatically add/remove digits to/from dialed numbers.
- There shall be a common memory in which minimum 10000 numbers with 32 digits can be stored. It shall be possible to call these numbers by short dialing codes. If required, users having restricted authorization levels shall also be able to dial from common memory.
- In the system, there should be private pool where ten different numbers can be stored for each subscriber. One of them will be last dialed number. The subscriber will be able to call these numbers with short codes
- It shall be possible to connect GSM gateway/FCT interface device to the system's external lines and it shall be possible to make economic tariff mode calls to GSM numbers over this device. Moreover, it shall be possible to capture the called/ caller extension details and date and time details of GSM calls through the optional CRL (Call Record Listing) software. The offered system should have the option to connect 8 GSM Trunks/channel for Main office location
- GSM lines should support Call Back feature like trunk lines. If an extension of the system calls a GSM number and if GSM number misses that call, when GSM number

calls back the missed number, the system should automatically divert this call to original caller (the extension who made the call).

Numbering Plan

- 1 to 8 Digits or More

System Management

- Access to the system should be secure. To access over IP network, system should only allow secured access mechanism like SSH and HTTPS.
- There should be provision of defining password aging, one-time passwords. Provision shall be available to bar unauthorized user to connect to the system. The system should monitor and report the following types of security violations like Login violations, etc
- All management functions like: System Configuration, Programming, Fault/Alarm management, System database backup, Accounting/Logging of traffic / calls etc. for the connected Media Gateway shall be provided remotely from the Core Server. It should not require separate login to Media Gateway.
- It shall be possible to connect IP-PABX system to any LDAP protocol-based server (including windows active directory) to get the directory information. IP-PABX shall use any standard directory protocol (LDAP etc.) or propriety protocol to send the directory to its IP phone users. The supplied IP phones shall support directory search and dial by name using this feature

Fault and Alarms

- It shall have the provision for instant fault information, provision of automatically identifying and isolating faulty extensions & trunks and capability for malicious call tracing.
- It should also manage all the incidents and generate event/alarms reports informing date, hour & severity level.
- This module must be able to centralize the alarms and events of the total system (including remote units). The system should also have provision for configuring of automatic email alerts for notification of faults to predefined Maintenance Staff.
- A single incident of fault/failure in any of the critical resource elements of EPABX system shall not disrupt/affect all its extension & trunk telephony services.

Call Buffer Capacity - Native

- The Gateway must have its native capacity to store details of all incoming and outgoing calls up to a minimum capacity of 1.25 lac calls.

IPV4 and IPV6 Support

- The GW must support IPV 4 and IPV 6 from Day 1 and corresponding TEC certificate must be attached based on GR.
- The hardware architecture of the IPPBX system shall be of latest and IPv4 and IPv6 ready from day one.
- It shall be possible to assign IPv6 addresses to the system, as well as IPv4 addresses.

- The system shall be capable of directly responding to IPv6 requests (establishing a call over IPv6, IPv6 supported IP telephone operation etc.) without requiring any converters.
- The system shall also support hybrid IP networks in which both IPv6 and IPv4 protocols are used. The system shall be able to communicate over IPv4 and IPv6 networks, simultaneously

TDM & IP Support

- The Gateway must Support Analog CO, GSM Trunks ISDN PRI Trunks, and SIP Trunks.
- The Gateway must have universal slots to support Analog, Digital and IP Extensions

Integrated GSM

- The gateway must support integrated card-based GSM Trunks with minimum 2 ports per card or more

Certification

- The offered model of IP based EPABX system should have approval from TEC for interfacing with PSTN SIP Trucking with Ipv4 & Ipv6 as per GR number TEC/GR/SW/PBX-005/01/SEP-16 for IP PBX with Media Gateway.
- Integrated Voice Mail Card (In the main gateway unit) and Voice Logger
- Capacity should be 16 or more channels per card
- It should be inserted in the Main Gateway Unit and also interchangeable with other Gateways
- Minimum 1000 Voice Mail Boxes could be programmed
- Auto Attendant should be available with minimum 16 different types of announcements
- 4 Channels IVR must be part of this solution
- The system shall answer the incoming call & guide the caller through a voice guidance menu of various options to choose extension, operator, or directory service.
- It must be possible to customize the announcements.
- The system should have in Skin Voice logger for conversation recording.
- The system should be supplied with min 4 Port Voice logger. The system shall have dedicated to automatic voice recording (voice logger) of pre-defined user (all types of extension Analog, Digital and IP) or trunk groups (Analog CO, PRI or SIP Trunk) or a combination of user/trunk groups (16 channels min.).
- Voice logger also record internal calls (extension to extension). Voice records in the system shall be sent to an e-mail address as wav attachments.
- It should be possible to record conversations on an HDD or USB memory to be directly connected to the system.

- It should also be possible to store conversations on a storage device on the IP network. If storage disk on IP network is full or about to be full, alarm should be sent by system via e-mail.
- Before a call to be recorded begins, the system shall automatically playback an announcement that the conversation will be recorded. It shall be possible to change this announcement by loading a wav file to the system

Integrated Audio Conference

- The solution must have integrated Conference facility with minimum 30 party Audio conference in any combination of Trunks and extensions
- It must be possible to have multiple simultaneous conferences of 30 parties each
- It must be possible to define Virtual Conference Rooms which shall be PIN protected for Senior Officers
- It should support web-based GUI tool to manage this conference and allow multiple concurrence log in.

Technical Specifications of IP Phone

- SIP phone should be from the same OEM of IP telephony system.
- Two SIP accounts
- 128x48 LCD with backlight
- 2 Line Keys with LED Indicator
- Full-duplex hands-free speakerphone
- HD voice: HD handset, HD speaker
- One touch speed dialing.
- Hands free operation.
- Ring volume control.
- Speaker volume control.
- Should have Headset Jack
- Message waiting indication LED.
- Call Log - Missed Call, Called & Dial Number Details at least 100 No's
- Should support alternate server discovery in case the primary server fails.
- Should support Local & Remote phone book, should support LDAP
- Should have an integrated 2-port 10/100 / 1000 T Ethernet ports switch to allow connection of a PC directly to it and no separate cabling should be required for this. Should support IPv4 & IPv6
- Static/DHCP/PPPoE
- G.711, G.722, G.723, G.726, 729, iLBC, Opus
- SIP v1 (RFC2543), v2 (RFC3261), SRTP/ HTTPS/ TLS, 802.1x, Transport Layer Security (TLS)
- DTMF: In-Band, RFC2833, SIP Info
- It should have PoE 802.3af class 2.
- Must be of OEM make Only as of IPPBX. Details of Make & Model to be furnished.

Passive Components

Structural/generic cabling system manufacturer

Please find below a summary of minimum requirements for manufacturers of the proposed structural cabling system. These requirements must be demonstrated with relevant certificates and manufacturer's representations.

- ISO 9001
  Structural cabling manufacturer must pursue ISO 9001 quality assurance system which must be in place for at least 5 years and must be demonstrated with relevant Certificate.
- ISO 14001
  Structural cabling manufacturer must feature a valid ISO 14001 certificate regarding: Design, development, production and supply of information and data management solutions that enable infrastructure owners to effectively plan, purchase, implement, secure, and manage their own physical layer infrastructure throughout its lifetime.
- RoHS Directive
  All structural cabling components offered by the manufacturer must conform with the RoHS directive (RoHS – Restriction of use of hazardous substances) 2002/95/EC of the EUROPEAN PARLIAMENT and of the COUNCIL of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment with amendments (2005/747/EC of 21 October 2005) as well as with the Regulation of the Minister of Economy of 6 October 2004 (Journal of Laws No. 229 item 2309 and 2310) on specific requirements regarding the restriction of the use of certain substances in electronic and electrical equipment that may have a negative impact on the environment.

Structural/generic cabling system

- Please find below a summary of minimum requirements for the proposed structural cabling system.
- These requirements must be demonstrated with relevant certificates and manufacturer's representations.

Uniformity of components

- All passive components of structural cabling must feature the name or trademark of the same cabling manufacturer and originate from a single manufacturer for the complete system.
- Elements from different manufacturers must not be installed on the transmission path, this is concern to transmission cables.

Passive cable Warranty scheme

- The implemented structural cabling must be subject to a 25-year System Performance and Application Assurance Warranty certificate issued by cabling manufacturer.
- The following Warranties must be available during that period:
  - Component warranty
    - ✓ All components of the certified system will be free from material and workmanship defects, provided they are properly assembled and used. If any component in the Certified Cabling System is found to be defective and prevents correct transmission of electrical signals, the manufacturer will

repair such components or replace them with new components to enable the transmission of such signals.

- System operation warranty
  - ✓ Connections/channels of the Certified Cabling System will meet performance parameters according to the category to which the certificate applies.
  - ✓ Should performance of the Certified Cabling System prove to be non-conforming with the category to which the certificate applies (based on results of test procedures as per standards), the manufacturer will repair or replace the components to ensure performance conformity with the certificate.
- Warranty for applications
  - ✓ The Certified Cabling System will be free of defects that prevent operation of applications and protocols as per relevant standards within the performance category of the entire transmission path to which the certificate applies.
  - ✓ This applies to applications/protocols recognized by IEEE, ANSI and ATM Forum and intended specifically for transmission using the cabling defined in TIA /EIA/ 568, ISO IEC 11801, EN 50173.
  - ✓ Should the Certified Cabling System prevent the end user from using the application/protocols as per system performance category, to which the certificate applies, the manufacturer will diagnose the problem and repair or provide new components that will ensure effective transmission of these applications and protocols.
- Reviews of independent laboratories
  - ✓ Structural cabling must be supported by positive feedback from an independent testing laboratory on the compliance with minimum structural cabling standards (Permanent Link and Channel).
  - ✓ Detailed requirements for these documents are included below in the specification for individual transmission elements.
- Contractor
  - ✓ The installation of structural cabling must be performed by a company with valid qualifications and a certificate issued by the manufacturer of structural cabling. The document mentioned above must be attached to the offer in this tender procedure.
  - ✓ Installer's certificate must not be more than two years old. Extension of the authorization for subsequent period is made by the cabling manufacturer based on installer's application and following retraining.
  - ✓ The contractor must hire at least two installers with cabling manufacturer's authorization, covering the design, performance, supervision, measurements, and qualification to be covered by the warranty. It must be confirmed with registered certificates issued by the manufacturer of the offered structural cabling.

Horizontal copper cabling Specification

Technical Specification		Compliance YES / NO
CAT6 A 10G Shielded LSZH U/FTP or F/UTP Cable		
The cable is constructed of 4 Aluminium screened pairs and a drain wire. Cable should minimize alien crosstalk, provides excellent signal isolation, and provides superior electromagnetic interference (EMI) protection.		
System is compliant with the latest ISO/IEC 11801 A1.1 draft and ratified TIA/EIA 568-B.2-10 for the support of 10GBASE-T.		
ETL verified to TIA/EIA-568-B.2-10 Category 6A standard		
Commercial Standards:	ISO/IEC 11801 amendment 2:2010 Class EA, TIA/EIA-568-C.2 Category 6A, IEC 61156-5, ETL independent testing, EN50288-6-1 and PoE++ IEEE 802.3bt Standards	
Manufacturer	All passive cabling must be from same OEM (UTP and Fiber) & OEM should have minimum 10 Years of presence in India in same business and should be ISO Certified and Restrictions to supply the product manufactured from country which shares a land border with India and recommend to supply make in India product. The material shall be rejected without any further investigation, if the proposing material had been rejected by any of Govt Organization (Employer) projects like AAI, Defence, Railway, Metro, Ministry of India Legislative etc since last 10 years.	
Fire Propagation Test	IEC 60332-1	
Application	IEEE 802.3 10GBASE-T 10Gb/s, IEEE 802.3 1000GBASE-T 1Gb/s, TIA/EIA-854 1000BASE-TX 1Gb/s, ATM 155Mb/s 155Mb/s	
Operating Temperature	Operation: --20˚C to +70˚C	
	Installation: 0˚C to +50˚C	
Conductor Size	23AWG / Primary Insulation: Polyolefin/Foamed Polyethylene	
Screen material	Laminated Aluminium	

Technical Specification		Compliance YES / NO
Sheath Type: LSOH	LSOH - Low Smoke Zero Halogen	
Screen	Each pair enclosed in laminated aluminium foil	
Drain Wire	Tinned Copper	
Electrical Characteristics		
DC Resistance	≤ 9.38Ω/100m	
Propagation Delay:	514 + 36f1/2 nS/100m max @1-500 MHz	
Mean Impedance:	100 ± 15Ω	
Capacitance	Nom.< 5.6nF/100m	
Propagation Delay Skew:	45 nS/100 max @ 1-500 MHz	
Coupling Attenuation:	45dB min @30-100 MHz 40-20 Log (f/100) @ 100-500 MHz	
Voltage Rating:	72V dc maximum	
PoE Power	IEEE 802.3bt from Type 1 to Type 4, and PoE+, HD Base-T PoH up to 100W RP3 compliant as defined by EN 50174-2:2018, ISO/IEC 14763-2:2019 and AS/NZS 14763.2:2020	
CAT6 A 10G Unloaded Patch Panel with Rear Cable Manager		
RJ45 I/O Compatibility	Should be compatible with CAT6A 10G Shielded Jack	
Material	CRS - Cold Rolled Steel (Thickness - 1.5mm) with ROHS Compliant All Information Outlets (CAT6A – RJ45) IO's in Patch Panel Side shall be Tool less crimping. Tool crimping shall be rejected.	
Dimension	19" Width, 1U Height / 1.75Inch for 24Port Straight and Angled and 2U Height / 3.5Inch for 48Port Straight and Angled Panel	
Cable Manager	Flat type Perforated Metal Rear Cable Manager (Iron or Steel Rod will not be accepted)	
	If Rear Cable Manager is not part of the Unloaded Panel, please share Rear Cable Manager with Price and Data Sheet	

Technical Specification		Compliance YES / NO
Labels	Should include labels and clear label covers at the front and back	
CAT6 A 10G Shielded Jack		
Jack Construction	Should be 360Degree Shielded Metal housing	
Standards	TIA-568-C.2 Augmented CAT6A, ISO 11801 Amd 1 Class EA, IEC 60603-7, FCC Subpart F 68.5	
Approval	ETL independent testing and UL-1863 Approval required	
Mechanical Characteristics	Operating Life: Min 750 insertion cycles	
Electrical / Optical Characteristics	Interface Resistance: 20m Ohms	
	Initial Contact Resistance: 2.5m Ohms	
	Insulation Resistance :> 100M Ohms	
Dust Cover	Shad cover the RJ45 interface to avoid dust & Contaminants	
Should have ROHS Compliant		
CAT6A Shielded Patch Cord -1/ 2 /3 mtr length		
Cable - Conductor Size	24-28AWG Stranded bare copper with Pre-Terminated with RJ 45 Plug	
Characteristics - Cable		
Screen material:	Aluminium/polyester shield with tinned copper drain wire	
Max Outer Diameter	6.5mm	
Temperature Range:	-20°C to +60°C	
Characteristics - Plug		
Operating Life: Minimum 750 insertion cycles	Min 750 Insertion cycles	
Contact Material: Copper Alloy	Copper Alloy	
Contact Plating: 1.25 micrometres Au/Ni	1.25 micrometres Au/Ni	
RJ45 Plug dimensions compliant with	ISO/IEC 60603-7 and FCC 47 Part 68	

Technical Specification		Compliance YES / NO
Standards	ISO / IEC 11801 2nd Ed Amd 1 Class EA, TIA-569-C.2 CAT6A, UL 1883; CSA C22.2	
Fire Propagation Tests	IEC 60332-1, IEC 61034-2	
Electrical Characteristics	Max Voltage: 150VAC (max)	
	Max Current: 1.5A @ 25°C	
Supports	High Speen 10G BASE-T Networks and backward compatible with 10/100/1000BASE-T Networks	
Single / Dual Face Plate		
Accommodates	Accommodates UTP, STP jacks	
Accommodates	Accommodates UTP, STP Data gate jacks Accommodates single bezel Fibre modules	
	Accommodates media configurable modules	
Material	VE10 ABS	
Web Site link	Enter global web site link for quoted model	
Fiber Backbone cabling Specification		
12/24 Core Multi mode OM4 Fiber cable		
Type of Fiber	12/24Core Multimode OM4 50/125-Micron Loose Tube outdoor armoured with ROHS Compliant	
Application	Outdoor/ Underground	
Jacket	UV Stabilized Polyethylene HDPE Sheath	
Armouring	Corrugated Steel Tape Armor (ECCS Tape), Thickness > 0.15mm	
Strength Member	Two Steel GI Wires	
Max. Crush Resistance	2000N	
Max. Tensile Strength	1500N	
Fiber Protection	Polybutylene Terephthalate (PBT)	
Core wrapping	Polyethylene Terephthalate	
Standard	ITU G652.D - LWP, Low water peak	

Technical Specification		Compliance YES / NO
Dimensions and Mass		
Mass (Nominal)	80 to 95 Kg/km	
Web Site link	Provide global web site line for quoted model	
24 / 48 Fiber Rack Mount Fiber Panel- LIU		
Rack Mount	19" rack mounted with 1U height, Sliding Drawer Type with 4 Cable entry/exit points with Lock and Key	
Material	Powder coated CRS / Robust Steel	
Accommodation and supports	Accommodation of multimode fibres	
	Capable of supporting 24 Fiber with SC and 48 Fiber LC interface	
Compatibility	Labelling for port identification, Fiber Management rings to accommodate excess fiber cordage behind the trough adapters and maintain fiber bend radius	
Optical Fiber Adapter Plates		
Features and Benefits	Adapter density ranges from 12 to 24 fibre per plate, allowing for 1U 96 fibre density. Available in a variety of connectors and performance levels, the Plates require no tools for installation	
	Snap Rivets – allows for easy installation and removal	
	100% Factory Tested – Guaranteed performance	
Commercial Standards	ISO/IC 11801, ANSI/TIA/EIA 568.B.3-2000, ANSI/TIA/EIA-492, TELECORDIA GR-409, ICEA-596	
24 Fiber Splice Holder		
Capable of supporting 45mm and 61mm Splice Protector		
Material	ABS - Halogen Free	
Base with Self-adhesive Pads of securing on a flat surface and a lid		
LC-LC Multi Mode OM4 OFC Patch Cords 50/125 Micron - 2 / 3 mtr		
Type of connectors	LC - LC LSOH - Low Smoke Zero Halogen	
Length	2 / 3 meters	

Technical Specification		Compliance YES / NO
Polishing	100% Factory polished and tested	
Insertion Loss	Less than 0.35dB per connector	
Attenuation	0.4dB/km over 1310nm to 1625nm	
Jacket colour	Industry Standard Colour - OS1/2 - Yellow, OM4-Aqua, OM2-Grey, OM1-Orange	
Temperature Range	-40 Degree C to +85 Degree C	
Buffer Diameter:	900µm	
Strength Member:	Aramid Yarn	
Jacket Material:	LS0H IEC 61034-1 & 2, IEC-60332-1, IEC-60754- 1 & 2	
Multi-Mode OM4 Pigtail		
Type of connectors	LC - LC LSOH - Low Smoke Zero Halogen	
Length	1.5 Mtrs	
Polishing	100% Factory polished, tested and Guaranteed Performance	

Modular Network Rack Specifications

42U Network Rack Server Room – 800*1000mm

- Rack 42U Height x 800mm Width x 1000mm Depth.
- Rack Frame should be robust and made of welded steel frame that offers strong and sturdy support for installation of 19"" equipment and accessories.
- Rack Frame made of Multi Folded Steel Profile and connected with Horizontal Profiles for Width and Depth.
- The 19” mounting angles should be provided 2 nos. on front and rear side of the Rack. It should be adjustable full depth.
- 19” Mounting Angles made up of Formed Steel 2mm Thickness with punched 10mm square holes and universal 12.7mm. 15.875. Alternating holes format offers for better mounting flexibility and maximizes usable mounting space.
- Depth support channel with adjustable mounting slots.
- Top and bottom Panel with ventilation and cable entry facility covered with rubber grommets.
- Top Panel with Fan housing fixing provision, zero U Space.
- Side Panel with Bottom Vented & Slam Latch
- Front Door Lockable Toughened Glass / Perforated
- Rear Door Lockable Vented / Perforated Single / Dual with 63% Perforation.
- CAM Lock & Key for Single Door & 3 Point Lock for Dual Door.
- Single Point Swing Handle Lock can be provided for both front & rear door.
- Castor wheels (2 wheels with brake and rear without brake) with levellers or Base Frame

- Static Load 750 kgs with castors & 1200 kgs with Base Frame / Plinth
- Rack shall be powder coated with 7 Tank pre-treatment process meeting ASTM standards. The Powder coating process shall be ROHS compliant.
- Powder coating thickness shall be 80 to 100 microns.
- The colour of the powder coat shall be RAL 7035 or Black.
- 100% assured compatibility with all equipment conforming to DIN 41494 / EIA 310-D standard. (General industrial standard for equipment)
- UL Certified & ISO 9001 & 14001.
- Equipment fixed Shelf 570mm or 470mm Depth.
- Modem Tray 19"/1U with 250mm Depth
- Keyboard Tray with Slides.
- Plinth Frame or Castor wheel set of 4 with Feet Brake.
- 4" Fan 90 CFM with Housing Unit on Top without Usable space of the Rack.
- Vertical Cable Manager with PVC Loops, 42U/100/100.
- The rack should be provided with front panel captive hardware set in a pack of 20 which helps in directly mounting the 19" equipment's.
- Horizontal Bar Earth, Cu, 16 x 3 x 485mm
- Earthing Strap
- Cable Manager 1U/19" Loop Type or Closed Type
- Power Distribution Box should be Single Phase with 1 x 12 nos. of Indian Round 5A Socket with 16Amp MCB and indicator with 3 Core Cable – 3 meters (terminated or unterminated 15A Plug Top).
- Power Distribution Box should be Single Phase with 1 x 12 nos. of Indian Round 5/15A Socket with 32Amp MCB and indicator with 3 Core Cable – 3 meters (terminated or unterminated IEC309 Plug Top).

42U Network Rack HUB Room & TSP / ISP Rooms – 800*800mm

- Rack 42U Height x 800mm Width x 800mm Depth.
- Rack Frame should be robust and made of welded steel frame that offers strong and sturdy support for installation of 19"" equipment and accessories.
- Rack Frame made of Multi Folded Steel Profile and connected with Horizontal Profiles for Width and Depth.
- Vertical Cable Reduce Channel for 19" Conversion with Loops for better cable routing.
- The 19" mounting angles should be provided 2 nos. on front and rear side of the Rack. It should be adjustable full depth.
- 19" Mounting Angles made up of Formed Steel 2mm Thickness with punched 10mm square holes and universal 12.7mm. 15.875. Alternating holes format offers for better mounting flexibility and maximizes usable mounting space.
- Depth support channel with adjustable mounting slots.
- Top and bottom Panel with ventilation and cable entry facility covered with rubber grommets.
- Top Panel with Fan housing fixing provision, zero U Space.

- Side Panel with Bottom Vented & Slam Latch
- Front Door Lockable Toughened Glass / Perforated
- Rear Door Lockable Vented / Perforated Single / Dual with 63% Perforation.
- CAM Lock & Key for Single Door & 3 Point Lock for Dual Door.
- Single Point Swing Handle Lock can be provided for both front & rear door.
- Castor wheels (2 wheels with brake and rear without brake) with levellers or Base Frame
- Static Load 750 kgs with castors & 1200 kgs with Base Frame / Plinth
- Rack shall be powder coated with 7 Tank pre-treatment process meeting ASTM standards. The Powder coating process shall be ROHS compliant.
- Powder coating thickness shall be 80 to 100 microns.
- The Color of the powder coat shall be RAL 7035 or Black.
- 100% assured compatibility with all equipment conforming to DIN 41494 / EIA 310-D standard. (General industrial standard for equipment)
- UL Certified & ISO 9001 & 14001.
- Equipment fixed Shelf 570mm or 470mm Depth.
- Modem Tray 19”/1U with 250mm Depth
- Keyboard Tray with Slides.
- Plinth Frame or Castor wheel set of 4 with Feet Brake.
- 4" Fan 90 CFM with Housing Unit on Top without Usable space of the Rack.
- Vertical Cable Manager with PVC Loops, 42U/100/100.
- The rack should be provided with front panel captive hardware set in a pack of 20 which helps in directly mounting the 19” equipment’s.
- Horizontal Bar Earth, Cu, 16 x 3 x 485mm
- Earthing Strap
- Cable Manager 1U/19” Loop Type or Closed Type
- Power Distribution Box should be Single Phase with 1 x 12 nos. of Indian Round 5A Socket with 16Amp MCB and indicator with 3 Core Cable – 3 meters (terminated or unterminated 15A Plug Top).
- Power Distribution Box should be Single Phase with 1 x 12 nos. of Indian Round 5/15A Socket with 32Amp MCB and indicator with 3 Core Cable – 3 meters (terminated or unterminated IEC309 Plug Top).

32U Network Rack HUB Room & TSP / ISP Rooms – 800*800mm

- Rack 32U Height x 800mm Width x 800mm Depth.
- Rack Frame should be robust and made of welded steel frame that offers strong and sturdy support for installation of 19"" equipment and accessories.
- Rack Frame made of Multi Folded Steel Profile and connected with Horizontal Profiles for Width and Depth.
- Vertical Cable Reduce Channel for 19” Conversion with Loops for better cable routing.
- The 19” mounting angles should be provided 2 nos. on front and rear side of the Rack. It should be adjustable full depth.

- 19” Mounting Angles made up of Formed Steel 2mm Thickness with punched 10mm square holes and universal 12.7mm. 15.875. Alternating holes format offers for better mounting flexibility and maximizes usable mounting space.
- Depth support channel with adjustable mounting slots.
- Top and bottom Panel with ventilation and cable entry facility covered with rubber grommets.
- Top Panel with Fan housing fixing provision, zero U Space.
- Side Panel with Bottom Vented & Slam Latch
- Front Door Lockable Toughened Glass / Perforated
- Rear Door Lockable Vented / Perforated Single / Dual with 63% Perforation.
- CAM Lock & Key for Single Door & 3 Point Lock for Dual Door.
- Single Point Swing Handle Lock can be provided for both front & rear door.
- Castor wheels (2 wheels with brake and rear without brake) with levellers or Base Frame
- Static Load 750 kgs with castors & 1200 kgs with Base Frame / Plinth
- Rack shall be powder coated with 7 Tank pre-treatment process meeting ASTM standards. The Powder coating process shall be ROHS compliant.
- Powder coating thickness shall be 80 to 100 microns.
- The Color of the powder coat shall be RAL 7035 or Black.
- 100% assured compatibility with all equipment conforming to DIN 41494 / EIA 310-D standard. (General industrial standard for equipment)
- UL Certified & ISO 9001 & 14001.
- Equipment fixed Shelf 570mm or 470mm Depth.
- Modem Tray 19”/1U with 250mm Depth
- Keyboard Tray with Slides.
- Plinth Frame or Castor wheel set of 4 with Feet Brake.
- 4" Fan 90 CFM with Housing Unit on Top without Usable space of the Rack.
- Vertical Cable Manager with PVC Loops, 42U/100/100.
- The rack should be provided with front panel captive hardware set in a pack of 20 which helps in directly mounting the 19” equipment’s.
- Horizontal Bar Earth, Cu, 16 x 3 x 485mm
- Earthing Strap
- Cable Manager 1U/19” Loop Type or Closed Type
- Power Distribution Box should be Single Phase with 1 x 12 nos. of Indian Round 5A Socket with 16Amp MCB and indicator with 3 Core Cable – 3 meters (terminated or unterminated 15A Plug Top).
- Power Distribution Box should be Single Phase with 1 x 12 nos. of Indian Round 5/15A Socket with 32Amp MCB and indicator with 3 Core Cable – 3 meters (terminated or unterminated IEC309 Plug Top).

1.9 Integrated Command and Control Centre

Scope of work

- Integrated Command and Control Centre (ICCC) helps the TIDEL Park, Madurai Operational Manager to manage complex infrastructure, Incidents, emergencies, and environments of entire plot that capture real time data from area wide sensors. It offers integrated data visualization with collaboration of different departments and collaborative data analytics.
- It is very difficult to get an accurate real time assessment of the situation on the ground. There is lot of data which needs to be obtained, analyzed, and shared among group of agencies or departments or individuals. Information and Communication Technology (ICT) can create, collect, integrate information, and provide the comprehensive dashboard for user. Individual monitoring and management systems such as utility, traffic, transportation, Video surveillance, Access control, Public Address system, Building Management System, External Lighting Control, etc. implies big real time sensing data.
- ICCC is a top-level application running on the top of all these systems and providing comprehensive dashboard based on Standard Operating Procedures (SOP). Near real time and historical data analysis helps agencies enhance the efficiency of operations, plan for growth and coordinate and manage response efforts. ICCC involves the collocation of operations staff, planning team, technical support specialists, maintenance, and management team at a custom designed collaborative monitoring environment. Collaborative monitoring environment provides data of different systems integrated on GIS (Geographical Information System) platform with interactive dashboards.
- ICCC provides operational data in customizable reports using multiple analytic algorithms, interactive standard operating procedures (SOPs) and other tools for better operations and response management. ICCC helps in taking informed decisions with visibility of entire plot operations.
- The robust communication network is required to communicate the collected field data to Central location. Communication network may be one communication technologies including but not limited to wired communication with copper or optical fiber cables.

Codes and Standard

- ISO 11064: Ergonomic design of control centers – Part 1 to 4
  - Part 1: Principles for the design of control centers
  - Part 2: Principles for the arrangement of control suites
  - Part 3: Control room layout
  - Part 4: Layout and dimensions of workstations
- Protocols for Application integration
  - Inter Control Centre Protocol (ICCP),
  - Open Platform Communication (OPC),
  - Open Database Connectivity (ODBC),
  - Common Alerting Protocol (CAP) and Common Information Model (CIM)

- Extensible Markup Language (XML) to external systems for analytics over System Oriented Architecture (SOA) / Enterprise Service Bus (ESB) for Integration with IT Systems.

General System Requirement

- The ICCC application shall provide operators and managers with a management dashboard that provides a regular status and is automatically updated when certain actions, incidents and resources have been assigned, pending, acknowledged, dispatched, implemented, and completed and shall have following capabilities.
- ICCC will integrate the different application and provide integrated dashboard on GIS platform. Monitoring team will monitor the consolidated integrated command control center operation on 24x7 and provide interactive actions based on alerts and corresponding Standard operating procedures. ICCC application shall be designed to incorporate the features mentioned below:

Scalability

- Important technical components of the ICCC architecture shall support scalability to provide continuous growth to meet the growing demand of the Plot. The system should also support vertical and horizontal scalability so that depending on changing requirements from time to time, the system may be scaled upwards. There must not be any system-imposed restrictions on the scalability.

Availability

- The ICCC architecture components should be redundant and ensure that are no single point of failures in the key solution components. Considering the high sensitivity of the system, design should be in such a way as to be resilient to technology sabotage. To take care of remote failure, the systems need to be configured to mask and recover with minimum outage.

Data security

- The ICCC architecture must adopt an end-to-end security model that protects data and the infrastructure from malicious attacks, theft, natural disasters etc. Using Firewalls and Intrusion Prevention Systems such attacks and theft should be controlled and well supported (and implemented) with the security policy. The virus and worm attacks should be well defended with gateway level Anti-virus system, along with workstation level Anti-virus mechanism.
- There should also be an endeavour to make use of the Secure Socket Layer (SSL)/ Virtual Private Network (VPN) technologies to have secured communication between Applications and its end users. Furthermore, all the system logs should be properly stored & archived for future analysis and forensics whenever desired. The security audit of the entire system shall be carried out at half yearly regular interval.
- The systems implemented for project should be highly secure, considering that it is intended to handle sensitive data relating to the plot and residents of the plot.

Manageability

- Ease of configuration, ongoing health monitoring, and failure detection are vital to the goals of scalability, availability, and security and must be able to match the

growth of the environment. Network should be auto/manual configurable for various future requirements for the ease of maintenance / debugging.

Interoperability

- The system should have capability to take feed from cameras installed by private / Govt. at public places, digitize (if required) & compress (if required) this feed & store as per requirements.
- Keeping in view the evolving needs of interoperability, especially the possibility that the solution shall become the focal point of delivery of services and may also involve cross-functionality with the e-Government projects of other departments / businesses in future, the solution should be built on Open Standards.

Open standard

- Systems should use open standards and protocols to the extent possible. The ICCC should be able to interface over Inter Control Centre Protocol (ICCP), Open Platform Communication (OPC), Open Database Connectivity (ODBC), Common Alerting Protocol (CAP) and Common Information Model (CIM) /Extensible Markup Language (XML) to external systems for analytics over System Oriented Architecture (SOA) / Enterprise Service Bus (ESB) for Integration with IT Systems.

Technical Features

ICCC Application shall have following features to integrate different application and providing consolidated dashboard:

- The ICCC application shall provide the “day to day operation”, “Common Operating Picture” and situational awareness to the center and participating agencies during these modes of operation
- The platform shall have the ability to define all monitoring objects in a hierarchical fashion to segregate data. These objects give real time status of assets and update automatically in case of failure.
- The Platform shall have seamlessly integrated Asset Management System to have all relevant information of all assets in the Area to give real time status of assets & update automatically in case of failure. It should also be possible to have procurement data of similar product in past, check Inventory & issue work order accordingly
- The ICCC platform software shall consist of a human machine interface (HMI) system with support for supervisory and process control, real-time data acquisition, alarm and event management, historical data collection, report generation, local or remote telemetry communications to PLC's/RTU's and internet/intranet access
- Platform – The platform should provide a common data integration layer which can collect and contextualize information from disparate data sources regardless of protocol. The platform should support templates to allow build to once-deploy everywhere functionality.
- It shall improve scalability for large and geographically distributed environments
- It shall provide complete view of facilities, sensors, and alarms in an easy-to-use and intuitive GIS-enabled graphical interface with a powerful workflow and business logic engine.

- It shall provide a uniform, coherent, user-friendly, and standardized interface
- ICCC Application should have inbuilt Historian
- It shall provide possibility to connect to workstations to be displayed in one or more video wall with one or more module/application/solution being independently and/or simultaneously being displayed and functional.
- The dashboard content and layout shall be configurable, and information displayed on these dashboards shall be filtered by the role of the person viewing dashboard.
- ICCC application should allow creation of hierarchy of incidents and be able to present the same in the form of a tree structure for analysis purposes
- The system shall integrate with GIS and map information and be able to dynamically update information on the GIS maps to show status of resources.
- The ICCC application shall be available via a VPN as a web-based interface or a thin-client interface.
- It shall be possible to combine the different views onto a single screen or a multi-monitor workstation.
- ICCC application should maintain a comprehensive and easy to understand audit trail of read and write actions performed on the system
- ICCC shall be designed to integrate the following solutions and give consolidated dashboard with following different
  - Video Surveillance System
  - Building Management System
  - Access Control System
  - Fire Alarm System
  - Public Address System
  - Water SCADA
  - Energy Management System
  - Flood Management System
  - Solid waste management System
  - Smart Metering for Utilities (Water, Electricity, Gas)
  - Solid Waste Management System
  - Communication Network Management
- System should provide ability to extract data in desired formats for publishing and interfacing purposes.
- ICCC Applications should have mobility devices & applications for field staff to ensure fast restoration of services in case of alarms & issues. In case of non-attending of alarm, decision escalations will be done automatically. After closure of issue the workflow has to be closed with feedback from those devices.
- System should provide ability to attach documents and other facts to incidents from different application or other entities.
- ICCC application is required to issue, log, track, manage and report on all activities underway during these modes of operation such as anticipation of incident, incident or crisis, recovery, etc.

- The ICCC application software should provide a user-friendly interface to define the Standard Operating Procedures (SOPs) into the system. The SOPs defined in the system should be editable by an administrator
- ICCC application shall present the workflow and task information in a clear and logical manner on the incidents screen.
- ICCC application shall include a section that will contain the Policy and standard operation procedures with easy to search functions to support the Operators during a crisis.
- ICCC application should use analytics to create a view of hazards and prioritizes based on a severity and risk profile.
- ICCC application shall provide call center management with:
  - Incidents are reported by the end users to common board telephone numbers or through web portal
  - The operator responds and records the incident details on a form.
  - The system should be able to create, assign, track and report on the lifecycle of tasks during a particular incident.
  - The system should allow a particular task to be decomposed into sub-tasks.
  - The system should provide an easy to interpret management dashboard view of the progress of all tasks during an incident.
  - The platform shall have cross functional workflows with the ability to communicate between People, devices, and systems (such as Enterprise Resource Planning (ERP) / Computerized Maintenance Management System (CMMS) / Enterprise Asset Management System (EAM)).
- ICCC application shall have the facility to view and handle multiple alarms at one time, shall have the facility to view multiple video windows at one time. Operators shall be able to resize and move video windows. It shall have the facility to view windows in a single monitor or across multiple monitors
- ICCC application shall have the facility to access, display and manage incidents/alarms and related sensors data and information from subsystem based on priority and authority level and shall view and manage detailed response procedures and tasks
- ICCC shall enable a single operator or multiple operators to monitor and control commands from connected subsystems, including all operational capabilities for detection, assessment, notification, entry control, and communications and shall provide the rapid annunciation and display of alarms to facilitate evaluation and assessment.
- ICCC application shall integrate following systems with sizing defined in the table below and shall have provision to accommodate the capacity by minimum double the size of each solution on the date of implementation.

S.No.	Smart Solutions	Components of solution
1	*Video Surveillance System*	Total Number of Cameras
2	*Building Management System*	Buildings IO Count
3	*Access Control System*	Number of doors with ACS

S.No.	Smart Solutions	Components of solution
4	*Fire Alarm System*	Number of Fire panel with devices
5	*Public Address System*	Number of Amplifiers / Speakers
6	*Water SCADA*	Number of PLC / RTU / IO
7	*Energy Management System*	Number of Panels / Meters
8	*Solid waste management System*	Number of Collection bins / Transfer station / collection Vehicles
9	*Smart Metering for Utilities (Water, Electricity, Gas)*	Number of Tenants inside the Buildings
10	*Communication Network Mgmt.*	Number of nodes/ PoP/ Switch

Technical Specifications of Video Display Monitor Screen

Parameter	Minimum Specifications
Technology	LED Suitable for Video Display Panel
Screen Size	12 Nos of 42” 4K Resolution LED Monitor Display Panel. 4 x 3 = 12 Nos Matrix to be installed.
Panel Technology	Vertical Alignment (VA)
Native Resolution	4K resolution is 2,160 pixels tall and 3,840 pixels wide, for a total of nearly 8.3 million pixels.
Pixel Pitch	Direct LED Pixel pitch of 3 mm or less
Static Contrast Ratio (Minimum)	Min 5000:1 or more
Dynamic Contrast Ratio (Minimum)	Min 1000000:1 or more
Brightness calibrated	600 Cd/Sq
Brightness uniformity	>= 98%
Viewing angle	178 degree/178 degree (H/V)
Response time	8ms or less
Bezel Width	3 mm or less
Screen to Screen Gap	<= 1 mm
Input	HDMI, VGA, Digital DVI, Display Port, FHD Base T & other inputs as per Video Wall solution offered. 20 HDMI, 2 universal DVI, Streaming Inputs - Camera over network with almost zero latency
Operations	365 X 7 X 24
Accessories	All Included (AC Power Cord, Remote Control, Adjustable Wall Mount Bracket, Necessary Cables and Connectors etc.)
Monitoring of critical parameters to ensure stable operation of the system 24 x 7	Internal temperature, Ambient temperature, humidity, Brightness, Cooling, Light source status

Parameter	Minimum Specifications
Cube control & monitoring	Video wall should be equipped with a cube control & monitoring system, should be able to control & monitor individual cube, multiple cubes and multiple video walls, Provide video wall status including Source, light source, temperature, fan and power information, Should provide a virtual remote on the screen to control the video wall, System should have a quick monitor area to access critical functions of the video wall
Dust prevention	Should meet or exceed IP6X standard. Certificate to this effect to be furnished from 3rd party Laboratory
Control	IP based control to be provided
Remote	IR remote control should also be provided for quick access
Light Source Type	Individual cube should be equipped with multiple laser banks and each laser bank should have an array of diodes. Single or multiple diode failure should not impact image display on the screen.
Lifetime	1 lakhs hours Lifetime

Technical Specifications of Video Display Controller

Parameter	Minimum Specifications
LED Controller	LED Controller possesses powerful video signal receiving, splicing, and processing capacities, and supports multiple signal inputs
Input port	Supports various digital signal ports, including 1×HDMI 2.0, 4×DVI, 2×SDI
Input Resolution	4096 x 2160 @60Hz
Maximum loading capacity	8.88 million
Maximum Width	8192 pixels
Maximum Height	8192 pixels
Output	16 Gigabit Ethernet output
USB	Dual USB 2.0 for high-speed configuration and easy cascading
HDCP	Support HDCP 2.2
Transmission Distance	90 meters
Peripherals	Multifunctional Card, Optical fiber transceivers, gigabit switcher
Size	2U Standard Box
LAN	Network control (communication with PC, or

Parameter	Minimum Specifications
	access network)
USB IN	USB input, which connects with PC to configure parameters
USB OUT	USB output, cascading with the next controller
Genlock	Genlock signal input ensures synchronism of display image
Genlock Loop	Genlock synchronous signal loop output
Input Voltage	100-240 V AC
Rated Power Consumption	80 watts or less
Weight	6.8 Kg or less
Operation Environment	Operation Temp: +5 °C ~ +40 °C Store Temp: -20 °C ~ +70 °C Operation Humidity: <95%
Cable & Connections	Successful bidder should provide all the necessary cables and connectors, to connect Controller with LED Display units

Technical Specifications of Video Wall Management Software

- The configuration and operation of the software shall be web-based or dedicated windows application; however only be accessed through intranet. No internet access will be provided. Simple web-based interface or dedicated windows-based application to control and configure the Video Management software from any PC available on local area network.
- The software shall provide an API for support and control by third-party software. This must be accessible via the protocols TCP/IP or SSH.
- Software shall support for controlling central video split-controllers and distributed video controllers. Quick selection and switching of the display/the video wall to be operated. Adjustable grid for easy positioning when launching and changing source arrangements. Multiple selection of sources for simultaneous changing of position and /or size. Source arrangements in layouts shall be saved and possible to restore stored layouts. Real-time search for sources and layouts should be possible. Storage of preview images for each source and live preview of hardware sources should be possible.
- An integrated scheduler for launching and switching of layouts should be provided. Setting for displaying partial areas of a source (cropping) and Control of the sound volume per source.
- Integrated user management for assigning and restricting user authorization rights with multiple level of access should be possible.
- The software operation should be with mouse and keyboard and launching of available sources shall be possible via Click & Open.
- All features and functionality should be certified by the OEM. The Display Modules, Display Controller & Software should be from a single OEM.

Technical Specifications of ICCC Application Hardware & Softwares

ICCC Application shall have following technical requirement to integrate different application and providing consolidated dashboard: The below requirement shall be overseeded the details of integration shall be covered under the requirements of entire TIDEL Park Madurai utilities Services.

Parameters	Minimum Requirements
General requirements	The Command & Control solution should be implemented and Compliance to the industry open standards based Commercial-of-the-shelf (COTS) products.
	ICCC should support Role based access of application modules.
	System must provide a comprehensive API (Application Program Interface) or SDK (Software Development's Kit) to allow interfacing and integration with existing systems and future application and sensors which shall be deployed on the field.
	The platform should be able to normalize the data coming from different devices of same type and provide secure access to that data using data API(s) to application developers.
Command & Control	Proposed ICCC Application and Field User Mobile Application shall have Web Security Audit certificate from a Cert-In authorized Security Auditor as on date of publishing of the bid.
	Proposed ICCC Application and Field User Mobile Application shall have Web Security Audit certificate from a Cert-In authorized Security Auditor as on date of publishing of the bid.
	The platform must be able to normalize the data from various data sources such as IOT (Internet of things), IT (Informational Technology).
	ICCC Platform shall be developed utilising the latest Microsoft .NET architecture and the backbone of the systems database will be a Microsoft SQL server.
	The proposed ICCC platform should be deployable both on-prem or on cloud.
	The proposed ICCC platform must be published on at least one of the leading global CSP marketplace i.e., AWS/Azure/GCP.
	The platform must be able to integrate data from different sub-systems and provide a unified view of the sub-system data over visualization dashboards.
	The platform must have the capability to perform collection of data from the devices or sensors through the APIs provided by the sub-systems.
	The platform must be compatible to work on web browsers.
	ICCC and Video Management System should not be from same OEM.

Parameters	Minimum Requirements
	Must have capabilities to achieve load balancing and high availability using load balancer & must be self-certified by the OEM.
Integrations	The ICCC shall integrate with the following Systems/ Platforms through SDKs and APIs shared by their provider: • Video Surveillance System - 1000 Nos Cameras Points through OnVIF configurable • Building Management System - 25000 Points IO Points with inclusive of Hard wired & Soft integration • Security Access Control System - 200 Nos Doors in which inclusive of Gates Security Access to be integrated • Fire Detection & Alarm System - 10000 Nos Detectors & Modules to be integrated • Public Address System - 3000 Points of PA System related Components through IP Connection • Water PLC SCADA System - 1000 Points from various Water Station inclusive of Hard wired & Soft integration • Energy Management System - 3000 IO Points with inclusive of Hard wired & Soft integration • Solid waste management System - 500 IO Points with inclusive of Hard wired & Soft integration • Smart Metering for Utilities (Water, Electricity, Gas) - 1000 IO Points with inclusive of Hard wired & Soft integration • Communication Network Mgmt. - 2000 Nodes with inclusive of Hard wired & Soft integration through IP Configurable • Solar System Panel Integration - 100 IO Points with inclusive of Hard wired & Soft integration • EV charging point integration - 100 IO Points with inclusive of Hard wired & Soft integration • HSD Tank Flow Monitor Integration - 100 Points with inclusive of Hard wired & Soft integration • HSD Tank Consumption Meter Integration - 100 Points with inclusive of Hard wired & Soft integration Video Management System (CCTV Surveillance System) points are mentioned above shall inclusive of below analytics • Video Analytics (Loitering, People Count, Face Detection, Virtual line crossing, Baggage identifying, Tampering, Intrusion detection etc.,) • X-Ray with ETD • Physical security systems – Bollards, UVSS, Boom Barriers, Baggage Scanners, DFMD etc., • GIS platform

Parameters	Minimum Requirements
	• Email Gateway • SMS Gateway All the above proposed 3rd party system shall have a compatibility to connect with ICCC Platform. The platform of ICCC should be able to interface over Inter Control Centre Protocol (ICCP), Open Platform Communication (OPC), Open Database Connectivity (ODBC), Common Alerting Protocol (CAP) and Common Information Model (CIM) /Extensible Markup Language (XML) to external systems for analytics over System Oriented Architecture (SOA) / Enterprise Service Bus (ESB) for Integration with IT Systems.
Video Management System (CCTV Surveillance System) Integration	ICCC Platform Solution should have the capability to be integrated with Video Management System (VMS) through SDKs and APIs shared by their provider and shall have the following functionalities:
	View live video of Camera nearest to the Alert location in ICCC Application.
	User can take snapshot and allocated with alert created which can be utilized for future reference.
	All Cameras should be mapped on GIS platform (if integrated) with different information regarding their status, Location address.
	The camera visual should be directly accessed through the icon on the map.
	There should be a snapshot functionality when the operator accesses a live video camera.
	Zoom in/out camera functionality should be provided.
	Ability to perform below mentioned video controls (if applicable) from ICCC systems by Operator:
	Play, slide-forward, slide-backward, pause, and specify time to play recorded video.
	Take a video still image (snapshot) from live or recorded video.
	Move PTZ camera by clicking on camera controls to the chosen location.
	Provide screen control in video pane to control pan, tilt and zoom PTZ camera.
	Display in 2x2 and 3x3 window formats.
Video Analytics & Face Recognition System Integration	The ICCC solution should have the capability to be integrated with Video Analytics Platform through SDKs and APIs shared by their provider and shall have the following functionalities:
	Alerts will be generated in ICCC Platform in case of any information received from the Video Analytics & FRS platform.

Parameters	Minimum Requirements
	All the information received from integrated Video Analytics & FRS Platform will be visible on ICCC Platform.
GIS Map Integration	ICCC application should be integrated with GIS map.
	All alerts should be mapped in GIS map
	Integration application should support for receiving different types of alerts.
	GIS map should have all basic features of creating any point of interest point or affected area.
	GIS map should have plotted all Cameras/Sensors deployed across the city.
	GIS map should enable search on Map for any alert by type or subtype.
	Distance measuring tool should be part of GIS panel.
	On receiving alerts GIS map should zoom on alert location.
	Clicking on any alerts in GIS map should allow to acknowledge or close the alert. Same should be possible from alert panel.
	Alert Panel and GIS panel should be in sync and support multi-screen.
	Clicking on any Alert should show nearest Cameras, from where live viewing of Camera should support.
	Operator should be able to take Snapshot of Live streaming and save image.
	Operator should have capability to Create alerts when viewing something on Camera and attaching the snapshot taken.
	All alerts should be mapped to various SOP, where authorities should be informed through SMS or Email.
	Operator should be able to draw a free hand shape on GIS map and should be able to perform following functionalities: ➢ Alert list should be populated in a window which are generated in area within the drawn shape on GIS Map. ➢ Operator Should be able to perform certain action on listed Alerts like close the alert, assign nearest responder, and execute SOP. ➢ Responder list should be populated in a window which are available in area within the drawn shape on GIS Map. ➢ Operator should be able to Send the Message to selected Responders. ➢ Operator should be able to see health status of all sensors which are available in area within the drawn shape on GIS Map.
	Operator can assign to nearest field responder from drag and drop option from GIS Map as well as assigned from Alert panel.

Parameters	Minimum Requirements
	Platform shall have Map view widgets with support of different base maps and additional map layers imposed on the base map.
	Platform shall support open-source base map as well as should be able to support major map providers such as HERE, Tom-tom, Google Maps, ESRI etc.
	Platform shall be able to integrate and visualize map layers provided by Client for different layers such as administrative boundaries, Road Networks, Hospital/Fire Stations, Landmarks etc. These layers can be contextually enabled or disabled by the operator for situational awareness.
	Platform shall support the Map functionalities such as zoom-in, zoom-out, re-centre, search, filter, area selection, zoom to marker level, multi-select, selection of a specific element to see more details of the same, change of the base map, selection/deselection of layer maps for visualization.
	Platform shall visualize on the map different vehicles, IoT Devices & Sensors, CCTV Cameras, and other IoT Elements. These layers shall show contextual information on the icons when mouse-over and have different colour of icons for easy representation of the state of the IoT elements. A summary panel shall show the legends and the corresponding counts.
	Platform shall have capability to show heatmap as additional map layer on top of pre-selected map layers.
Alert Management	The Platform shall support the following Alert Management functionality:
	Operator can access complete information related with Alert.
	Operator should be able to be assigned nearest responder to an alert from the alert Panel itself
	Should support Geospatial rendering of Alert information. Platform must have the ability to show the alerts over the map view so that there is a sense of awareness amongst the platform users where the alert has occurred.
	Should provide facility to capture critical information such as location, name, status, time of the event and be modifiable in real time by multiple authors. Events should be captured in standard formats to facilitate event correlation and reporting.
	Operator should be able to print audit log of an alert from the alert panel which should contained all the activities performs against the alert.
	Application should provide visual indication for the severity of alert, like if severity of alert is high it should show upward-arrow,

Parameters	Minimum Requirements
	if low then downward-arrow should be visible against each alert in alert panel.
	Platform must have differentiated colour cues for multiple criticalities of the alert that are sourced from the sub-systems or generated in the platform.
	Application should provide visual indication in alert panel if alert crossed escalation time.
	Operators shall be able to perform the following actions: • Change the Alert state. • Edit the Alert. • Change the description • Change the priority level • Attach additional entities to the Alert. • Link related Alert. • Attach a document as a URL link to the Alert. It shall be possible to query the Alert history filtering by: • Alert type • Alert state • Location • Priority • Trigger time range • Alert owner
	Operator should be able to change the severity of an alert from the alert panel itself after analysing the alert.
	Platform must have the ability to change the severity of an alert and the ability to capture the comments when change in critically is performed by platform users.
	Platform users must have the capability to create manual events from the alert Management module by providing appropriate domain, alert type, description, location details and image/video for proof of alert.
	Operator should have clear visual indication that alert have an attachment or not.
	Platform users must have the ability to comment and collaborate on any event that is visible and provide more evidence, if necessary, in the form of image or video.
	Alert attachments should be accessible from the alert panel and user should not be required to open the complete alert to view the alert attachments.

Parameters	Minimum Requirements
	Operator should be able to short the alert based on severity, status, created time, assigned responder, alert type, alert sub type and source of alerts.
	Alert comments must also receive the image and video evidence submitted by the field responder, if field responder assigned for the alert.
	Operator should be able to clear an alert from the alert panel with mandatory remarks.
	Operator should be able to define up to ten escalation levels associated with the Type and Jurisdiction of an alert.
	Operator should be able to escalate the alert from alert panel and application should find appropriate escalation level automatically and a SMS and Email should be dispatched to qualified escalation level.
	Create and modify user-defined alert types. An unrestricted number of user-defined alert types shall be supported.
	Operator should be able to schedule the creation of alert.
	User should be able Set the priority level of an alert.
	User should be able to view the history / activity perform against the Alert.
	Provide the ability to group alerts by source and by type.
	The platform should generate Notification/ Alert messages as per the incidence / events that are received, that should be visible within the Dashboard and the Field Responder Mobile App or web portal if required.
	All system messages (notifications, alerts and alarms) should always be available from the Notifications View.
	ICCC platform should support to deliver message. The Notification service should support min two types of notification methods:
	1. Email notification
	2. Short Messaging Service (SMS) notification
Architecture and Data Connectors	Platform must have the ability to connect to different source systems using varied connection protocols and consume the data that can be either used for ingestion into the platform database or be directly pushed for the visualization layer to be consumed by visualization layer or be exposed as an API to be consumed by 3rd party.
	Platform shall be an IP enabled solution. All communication between the servers and other clients shall be based on standard TCP/IP protocol.
	ICCC API/SDK should be available for third party system to use.

Parameters	Minimum Requirements
	Platform must be able to consume the data from REST API.
Standard Operating Procedures (SOPs)	Platform must provide the ability to assign SOP to an alert type.
	Platform must provide the ability to approve or reject an SOP from getting executed for a created alert.
	Platform must provide an ability to trigger multiple tasks at the same time.
	Platform must provide an ability to trigger tasks to Field Responder mobile application through SOP.
Escalation Rules	Platform must provide the Escalation capability if the SOP is not completed within the pre-defined duration. Duration can be set by an operator and can be updated if required.
	Platform must provide the capability to create Escalation levels so that escalation hierarchy can be established when the SOPs are not executed within the pre-defined duration.
	Escalation rules must be region-based and can be assigned to an SOP if escalation is required.
	Escalation rules must trigger both notification and email to the users for which the escalation level is assigned so that appropriate action can be taken by the user on the alert instance that is escalated.
Visualization	Platform must have capability to create grid-based widget system to create different visualization elements and compose it over dashboards.
	Platform must be capable of providing different widgets like charts, data grids, KPI, map, timeline.
	Platform user must be able to change the themes that are allocated by the admin user for the tenant.
	Platform visualization must be intuitive that the two or more widgets should be able to communicate with each other wherein the change in one or more widgets should affect the other widgets in the dashboard.
	Platform should allow widget to drilldown from one level to next level and also allow other related widgets data to be automatically updated based on the selected drilldown level.
	Platform must be able to embed other websites/portals/standalone pages into the dashboard using iframes.
Notifications	Platform must be able to source the events from the sub-systems and be able to show in the form of notification so that the platform user can take necessary action on the alerts.
	Platform must be able to show the escalation on an SOP Instance to an escalated user in the notification section.

Parameters	Minimum Requirements
	Platform users must be able to navigate from the notification section to the alert management section by perform click action on the notification.
	Platform must have an ability to unmute or mute notification sound for the alerts.
	Notification section must have the ability to represent graphically from which domain/sub-system the event is received.
	Platform users must receive the notification based on the Data Access Control restriction that is set for the domain for the derived roles.
Reports	Platform must have an ability to schedule reports from the report section.
	Platform must have the ability to fetch reports based of selected parameters and can download it in Excel or PDF format.
	Platform must be able to preview the report before scheduling the report.
	Platform must be able to generate the report Daily, Weekly and Monthly.
	Platform must have the ability to pause the report schedule and resume it when required.
Role based Access Control (RBAC)	In-built default Roles should be available in the Platform.
	Admin must have the ability to derive new roles from the default roles.
	Default roles must have the default features access capabilities predefined and can't be changed at any time.
	Platform must have the ability to assign appropriate features access levels to the roles.
	Platform must have the ability to assign appropriate domains access to the roles.
	Platform must have the ability to assign appropriate region access to the roles.
	Platform must have the ability to assign appropriate roles to the Users, and the users created would be able to see the data and access the features basis the role that has been assigned.
Dashboards	Integration platform should have KPI dashboard along with various analytics for end user.
	GIS Analysis: Platform should be equipped with heat map analysis along with clustering of alerts to indicate the area affected.
	Comparative Analysis: User should have option to compare two-time intervals along with alert type and subtype to measure the effectiveness of applying some policy.

Parameters	Minimum Requirements
	Trend Analysis: User should have visibility of all trends in system i.e., month wise, day wise, alert wise, season wise, time interval based.
	Solution shall be enabled with word cloud and operator can easily identify maximum used key words.
	User should allow to extract event based on custom draw shape from GIS map irrespective of any boundary's limitations.
Intelligent Dispatch Centre	Identify & dispatch mobile resources available nearby the Alert location.
Intelligent Operator Console	Provide configurable intelligent operator console based on the jurisdiction, critical area or sensors to monitor as per situation demands for focused surveillance.
Remote User Module	Supervisors remotely can access the system and monitor the alerts received, action taken status, response etc.
Mass Notification System	Provide a single web-based dashboard to send notifications to target audiences using multiple communication methods including SMS, E-mail.
Workflow Engine	User should be able to create the dynamic workflows with Drag and Drop ease.
	Workflow can be created based on action / status change of an Alert.
	User should be able to attach multiple activities with single workflow with Drag and Drop.
	All the activities should execute in sequential order as they are created / attached with the workflow.
	User should be able to attach single workflow with the Alert generated from different sub systems.
	User should be able to de-attach the workflow from Alert Type.
	User should be able to create multiple workflows without restricting a user.
	User Should be able to detach the Workflow from Alert Type in case it is not required.
Scheduler	User Should be able to schedule an Alerts/Event for a period at specific time.
	User should be able to schedule to broadcast a message to individual or group users of ICCC application.
	User should be able to schedule to play a file on public address system for certain period with an option to send it to individual or group of PA System (if applicable).
	User should be able to remove any scheduled event.

Parameters	Minimum Requirements
	All scheduled events should be mapped to Calendar view in form of day, week, or month.
Custom Query Builder	ICCC Platform should provide user to search the system data based on the query designed by operator dynamically.
	User should be able to design the dynamic query using Boolean operator like AND & OR.
	User should be able to design dynamic query using conditional operator like IN, Greater Then, Less Then, Equal To, between and not between etc.
	User should be able to save these query templates for future use.
	Search data can be taken as Print report in form of Excel/CSV or PDF.
Alert Search	Operator should be able to search alerts created based on some predefined parameters. Like From and To Date, Alert type, Alert area, alert sub type and status of alerts.
	Operator should be able to do analysis on searched data.
	Pre - defined charts should be generated automatically based on search data in 2 x 2 blocks.
	Operator should be able to change the type of chart in any of the panel out of four.
	Operator should be able to Map any chart type to any panel in 2 x 2 blocks.
	Operator should be able to enable or disable the level and legends of any chart panel.
	Operator should be able to change the X - Axis data of any chart from the search results.
Correlated Alerts	Application should allow an admin operator to set the correlation parameters like correlation distance, Time etc.
	Application should provide correlation notification in case any newly generated alert qualifies the defined correlation criteria.
	Operator should be able to tag two correlated alerts manually after modifying the correlation criteria for a login session.
	After tagging two alerts child alert should close automatically to avoid the repetitive work for operator.
	Application should provide the count of alerts generated from same source in alert panel.
	Operator should be able to view summary of alerts generated from same source and analyzed the similarity by clicking on counts of similar alerts.
	Operator should be able to close all similar alerts with single close action to avoid the repetitive work.

Parameters	Minimum Requirements
Post Alert Analysis	Solution should be displaying all Alert related details by just entering the alert ID.
	Post Alert analysis should have complete information of Similar Alert generated within predefined time.
	Administrator should have the ability to change the predefined time for displaying the similar alert.
	Complete history of alert action should be visible under post alert analysis.
	System should rate the alert execution based on certain parameter such as, closing time, priority, Action performs etc.
	Supervisors remotely can access the system and monitor the alerts received, action taken status, response etc.
	Supervisor should be able to add remarks against alerts.
	Supervisor should be able to give star ratings to an alert after analysing the complete details on single page.
Command Line Action	• Application should support following command line functionality: • Enable the console to be launched through a pre-defined button. • Enable a video window in the console to be displayed through a command line. • Launch an alarm window and alarm details in the console to be displayed through a command line. • View the All Commands Defined for operator action. • Programmatic command to acknowledge the specific alert. • Operator should be able to close an alert. • Escalate an alert through a command line. • Assign nearest field resource to alert through a command line. • locate the alert on map using command line. • Operator should be able to Enable and Disable the escalation for specific alert. • Open sensor window for deployed sensors across the jurisdiction. • Operator should be able to mark any sensor operational or non-operational using command line. • Send message to be logged in application user using command line. • Broadcast the message to all logged in application user.
Field Responder	The ICCC shall support mobile apps for various off-the-shelf smartphones and tablets. The mobile apps shall communicate

Parameters	Minimum Requirements
Mobile App General Requirements:	with the Mobile Server of ICCC over any WIFI or mobile network connection.
	Integration platform should have Work force mobile app.
	Mobile app should receive alerts from integration platform.
	Mobile app should be used for GPS tracking of Resources.
	Mobile app should have the feature to update its status by acknowledge, enroute and arrive on the assigned alert.
	Mobile app user should submit the action taken report in form of text and should be able to attach audio, video files or images with the alert.
	Action taken report should be visible at integration platform.
	Users should be able to stream videos from their mobile App, which should be displayed live on ICCC Application.
	Users should be able to capture the live video from the field and can attach it with the assigned Alert as Action Taken Report.
	Mobile application should have the facility to create POIs on the map to update the new locations to keep the map updated.
	All the communication between the mobile apps and ICCC platform will be on HTTP and also on HTTPS by adding TLS encryption (if required).
SOS Mobile App General Requirements:	The application should provide functionalities enforcing User safety.
	User should be able to register themselves using SOS application with minimal information like Name, Phone number, gender, age and address.
	User should be able to create SOS alert in integrated command-and-control centre application.
	Application should capture two pictures from front mobile camera and two from back camera automatically and attached with Created SOS alert.
	Number of images can be configured in application without coding efforts involved.
	Application should capture 10 second video from mobile camera and attached with SOS alert created.
	User should be able to attach Image, additional textual information as remarks in case SOS alert is active and not closed.
	User real time location should be tracked from command-and-control center during active SOS alert.
	User should view all the alerts generated by him at least for a month time span.

Parameters	Minimum Requirements
	User should save up to five contacts number within the application. In case SOS button pressed by citizen one predefined SMS should be delivered to saved Contacts.
	User should be able to view neared Police Station from the current location in case he/she within the city jurisdiction.
	User should be able to get route from current location to the selected Police station.
	User should be able to view neared Hospital from the current location in case he/she within the city jurisdiction.
	User should be able to get route from current location to the selected Hospital.
	SOS Mobile App should be an integral part of ICCC Application and should not be a Third-party Application.
	User Application should be available for Both Android and IOS mobile users.
Application Server Performance	Operator should be able to monitor following parameter of ICCC application servers on real time bases with in the ICCC application without using any external Tools. • CUP performance counter of Application server deployed • RAM Performance counter of Application server deployed/sec disk transfer and free and used space of drive • Lan Adaptor uses configured in Server • System performance counter like running process, file write operations / sec, file control operations / sec etc. • IIS performance counters like Request /sec, Request Wait Time, Request Failed, Success Request etc. Above parameters can be customizes as per the requirements
Database Performance	Operator should be able to monitor following parameter of ICCC database server on real time bases with in the ICCC application without using any external Tools. • Total Active requests on database. • Lock Request / sec. • Transactions / sec on database. • Database file size. • Processor Queue length. • User Connections. • Static Performance counters.
ICCC OEM Criteria	• ICCC Platform OEM should have ISO 9000; ISO 20000/ISO27001. • ICCC Platform OEM should have office and development center in India for last 5 years.

Parameters	Minimum Requirements
	• OEM Should have at least 5 Workorders wrt municipal bodies/smart cities/ Emergency response systems in India. • ICCC Platform Application Software OEM must be CMMI Level 3 or above Certified • OEM Should have at least 5 Workorders wrt municipal bodies/smart cities/ Emergency response systems in India. • The ICCC OEM should have PO/ Work-order for implementation of a state-wide command and control center project. • ICCC platform should be "make in India"

Technical Specifications of SMS Gateway

- Bidder has to provide SMS Gateway of Telecom Service Provider which has ability to withstand for continued growth in A2P SMS and SVI SMSG.
- The SMS Gateway PULL SMS application must have security features to ensure confidentiality of sensitive customer data.
- The SMS Gateway PULL SMS application should be able to retrieve SMSs sent to one or more short codes / virtual numbers.
- The SMS Gateway PUSH SMS application should be able to send messages at different priority levels.
- The SMS Gateway PUSH SMS application must have ability to set working hours and days.
- The solution should offer configurable mechanism in terms of number of retries and time duration for each retry for messages that could not be sent / delivered immediately.
- Online mechanism in real time mode has to be provided for SLA enforcement with regard uptime of Push / Pull services & deliveries along with the flexibility to generate MIS on daily / weekly / fortnightly / monthly / between specified data range.
- Check should be properly imposed to avoid duplicate or multiple SMS delivery to stakeholders.

Technical Specifications of Firewall System

- The minimum requirement of Firewalls with the following's major features and minimum essential specifications: -
  - Major supported features:
    - ✓ Anti-Virus
    - ✓ Intrusion Prevention System (IPS)
    - ✓ Web filtering
    - ✓ E-mail filtering, including protection against spam and grayware
    - ✓ Data Leak Prevention (DLP)
    - ✓ Application Control
    - ✓ Traffic inspection
    - ✓ Content inspection and filtering
    - ✓ Security Profiles components

- ✓ Security Profiles/lists/sensors
- ✓ Logging and reporting

➢ Minimum Specifications for Firewall

Description	Technical Compliance Parameter
Type	NGFW
Form Factor (RU)	1
Features	Layer 3 - Layer 4, NAT, VPN, Application Visibility and Control (AVC), User Identity, Next Generation Intrusion Prevention System (IPS), Zero Day Protection / Advance Malware protection, Web Security Essentials / URL Filtering
Traffic handled	TCP, UDP, HTTP/TCP, TCP/UDP
Hardware Architecture & Performance	1. The appliance hardware should be a multicore CPU architecture with a hardened 64-bit operating system with min. 32 GB memory. It should also have dedicated co-processor with min 8 GB RAM for hardware acceleration for network processing. 2. The appliance-based security platform should be capable of providing Next Gen Web Protection, Application Control, IPS, DOS, SSL/TLS Inspection & zero-day protection in a single appliance. 3. The quoted should have 8000 Mbps SSL/TLS inspection throughput or 4. The firewall Security Heartbeat policies can be able to limit access to network resources or completely isolate compromised systems until they are cleaned. Firewall should be IPv6, SD-WAN from day 1
NGFW Throughput (Measured with Firewall, IPS, Application Control enabled)	22000 Mbps or higher
Threat Protection throughput (Measured with Firewall, IPS, Application Control, and Malware Prevention enabled)	4500 Mbps or Higher
Concurrent Session / Concurrent Connection	350 K or higher
General Management	a. The firewall should support innovative technology for application acceleration. B. The quoted solution should be ready for extended Detection & Response (XDR) with endpoint, Server protection product from same

Description	Technical Compliance Parameter
	OEM. Should have single management console for Firewall, Endpoint, Server, email security and cloud security product. c. The firewall should include exploit prevention and Crypto guard Protection technology from endpoint security d. The firewall should have optional data centre selection and flexible user and group policy options on file type, exclusions, and actions on analysis e. The firewall should have fully transparent proxy for antimalware and web-filtering, Enhanced Advanced Threat Protection f. It Single client support for IPSec & SSL remote VPN with unlimited free mobile authenticator for android & IOS g. It should have minimum 1000 IPSec & 1000 SSL client license from day 1. The firewall should support TLS 1.3 inspection of encrypted traffic.
IPS Features	a. The firewall should have advance Threat Protection (detect and block network traffic attempting to contact command and control servers using multi-layered DNS, AFC, and firewall). The firewall should security heartbeat instantly identifies compromised endpoints including the host, user, process, incident count, and time of compromise. b. The firewall should have advanced web malware protection with JavaScript emulation, Live Protection real-time in-the-cloud lookups for the latest threat intelligence c. The firewall should have URL Filter database with millions of sites across 92 categories backed by OEM Labs
Type of Interface	GE Copper, SFP, SFP+
Number of 1 GbE Copper RJ 45 interface from day 1	8 or more
Number of 1/10G SFP+ interface from day 1 (Populated with 3 no. 1 GbE Single Mode LC Type Transceivers)	4 or more

Description	Technical Compliance Parameter
Number of GbE Small Form-Factor Pluggable (SFP) interface Slot / Module supported for future	6 or more
Number of 1/10 GbE SFP+ interface Slot/Module supported for future	2 or more
Number of IPsec VPN Peers supported (Site to Site)	4500 or higher
Number of IPsec VPN Peers supported (Client to Site)	4500 or higher
Number of SSL VPN Peers supported (Client to Site)	2000 or higher
Type of Storage Disk	SSD
Storage Capacity (TB)	1 or higher
Power Supplies from day 1	2 or more
Type of Processor	x86
High Availability Support	Yes
Interface Expansion slots supported	2 or more
Firewall Policies - License	Yes
Details of the Firewall Policies for the Firewall provided with the License	Web Security Essentials / URL Filtering, IPS License, Application Visibility License, APT (Advance Persistent Threat) License, Anti Malware Protection, C& C attacks, Geo IP Protection, Zero Day Threat Protection) and Web & Application Firewall (WAF) from day 1
NGIPS Signature supported	25000 or higher
Security Intelligence	IP, URL, Domain
Certification	The quoted firewall should have ICSA/EAL4+ certified. /NSS/NDPP Lab certified or equivalent certificate with minimum 93% security effectiveness as per last report. Certificates should be enclosed. The quoted firewall should have purpose-built, streamlined user interface and rule management for large rule sets with grouping with at-a-glance rule feature and

Description	Technical Compliance Parameter
	enforcement indicators. Proposed NGFW should be in Gartner Magic Quadrant in Network Firewall as per the latest report.
Installation and commissioning	The quoted firewall should be capable to restore the existing firewall policies and setting without using third party software. The bidder must configure the firewall as per the scope of work.
Documentation	All supporting documents such as datasheet, spec sheet, admin guide etc for the asked features must be enclosed.
On site OEM Warranty and License	a. The firewall should be quoted with 36 months License. b. All supporting documents such as datasheet, spec sheet, admin guide, certificates etc must be enclosed. All documents should be readily available online. Bidder must share the online links for all the submitted documents. c. License should include Web / URL / Content Filtering, Application Control and Visibility, IPS, Antimalware, WAF, Zero-Day Protection & 24 X 7 hardware & warranty support from the OEM.

Additional Notes for Contractor / Bidder:

- ✓ The Contractor / OEM must furnish the guidelines for installation / configuration planning of hardware and software before the start of the project.
- ✓ Complete installation and integration and customization will be taken place at TIDCO – Fintech Tower, no remote access will be provided for the same. The Bidder must migrate all the existing Firewall policies, settings etc. to the proposed Firewalls.
- ✓ No downtime shall be provided during the migration. Downtime shall be provided in later stage of physical migration. The Bidder shall also customize, add, edit rules/polices as per required by TIDCO – Fintech Tower.
- ✓ The solution shall be centralized controller-based deployment architecture that is required for granular control, simplified management, monitoring and for one click configuration. The Firewall shall be configured in Active-Active High Availability (HA) for Load Balancing and Failover.
- ✓ The solution shall be based on VLAN authentication, DHCP, MAC-IP based tight integration method by enabling all security as per guidelines. ‘
- ✓ To increase backbone bandwidth, Link Aggregation must be configured in Firewalls in LAN, DMZ and WAN Side.
- ✓ At the time of installation of the systems/sub-systems, if it is found that some additional HW/SW/Licenses or additional items are required to complete the configuration, which was not included in the Bidder’s original list of deliverables/BOM, then the vendor is required to supply such items to

ensure the completeness at no extra cost to TIDCO – Fintech Tower. The proposed solution shall be inclusive of installation / services / Accessories cost.

- ✓ Bidder must include installation, commissioning and integration, or any technical support cost for the period of 3 years. The bidder has to provide undertaking for the complete troubleshooting, day to day support, any hardware and software upgradation and technical support for the period 3 years. The OEM certified Engineer of the Bidder has to visit TIDCO – Fintech Tower for preventive maintenance on quarterly basis for the period of 3 years.
- ✓ The OEM must provide an undertaking that the quoted product shall not be end of life for minimum 5 years from the date of submission of quote.

Enterprise Management System

- To ensure that ICT systems are delivered at the performance level envisaged, it is important that an effective monitoring and management system be put in place. It is thus proposed that a proven Enterprise Management System (EMS) is proposed by the bidder for efficient management of the system, reporting, SLA monitoring and resolution of issues. Various key components of the EMS to be implemented as part of this engagement are –
  - ➢ Network Monitoring System
  - ➢ Server Monitoring System
  - ➢ Helpdesk System
- The solution should provide a unified web-based console which allows role-based access to the users.

  Network Management System
  - ➢ Solution should provide fault & performance management of the server-side infrastructure and should monitor IP\SNMP enabled devices like Routers, Switches, PA System, Emergency Call Boxes, Sensors, etc. Proposed Network Management shall also help monitor key KPI metrics like availability, in order to measure SLA's. Following are key functionalities that are required which will assist administrators to monitor network faults & performance degradations in order to reduce downtimes, increase availability and take proactive actions to remediate & restore network services.
  - ➢ Solutions should comply with The International Organization for Standardization (ISO) network management model defines five functional areas of network management
  - ➢ The ISO network management model's five functional areas are listed below.
    - ✓ Fault Management—Detect, isolate, notify, and correct faults encountered in the network.
    - ✓ Configuration Management—Configuration aspects of network devices such as configuration file management, inventory management, and software management.

- ✓ Performance Management—Monitor and measure various aspects of performance so that overall performance can be maintained at an acceptable level.
- ✓ Security Management—Provide access to network devices and corporate resources to authorized individuals.
- ✓ Accounting Management—Usage information of network resources

- The solution should have also capable of following features
  - ✓ The proposed solution must automatically discover manageable elements connected to the infrastructure and map the connectivity between them. Solution should provide centralized monitoring console displaying network topology map.
  - ✓ Proposed solution should provide customizable reporting interface to create custom reports for collected data.
  - ✓ The system must use advanced root-cause analysis techniques and policy-based condition correlation technology for comprehensive analysis of infrastructure faults.
  - ✓ The system should be able to clearly identify configuration changes and administrators should receive an alert in such cases.

Server Performance Monitoring System

- The proposed tool should integrate with network performance management system and support operating system monitoring for various platforms supplied as part of this Project.
- The proposed tool must provide information about availability and performance for target server nodes.
- The proposed tool should be able to monitor various operating system parameters such as processors, memory, files, processes, file systems, etc. where applicable.

Centralized Helpdesk System

- Helpdesk system should provide incident management, problem management templates along with helpdesk SLA system for tracking SLA's pertaining to incident resolution time for priority / non-priority incidents.
- System should also automatically create tickets based on alarm type
- The proposed helpdesk solution must provide flexibility of logging, viewing, updating, and closing incident via web interface for issues related to the project.
- The solutions should be capable of more proactive and preventing future incidents through visibility and analysis of experience
- The solutions should be completely complied with latest ITIL standard framework

I/O SUMMARY

BMS IO SUMMARY									
SL. No	**DESCRIPTION**	**QTY**	**AI**	**DI**	**AO**	**DO**	**Soft Points**	**Required Field Devices**	**Remarks**
A	**DDC TYPE ID - 01**								
	DDC Location - Basement 2 Fire Pump Room								
1	**Main Electric Hydrant Pump**	**1**							
	Pump ON / OFF Status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Pump Trip Status.			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Pump A/M Status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
2	**Main Electric Sprinkler Pump**	**1**							
	Pump ON / OFF Status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Pump Trip Status.			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Pump A/M Status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
3	**Main Electric Water Curtain Pump**	**1**							
	Pump ON / OFF Status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Pump Trip Status.			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Pump A/M Status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
4	**Electric Jockey Pump (3 Nos)**	**3**							
	Pump ON / OFF Status			3				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Pump Trip Status.			3				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Pump A/M Status			3				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
5	**Electric Booster Pump**	**1**							
	Pump ON / OFF Status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Pump Trip Status.			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Pump A/M Status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
6	**Diesel Generator Pump**	**1**							
	Pump ON / OFF Status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Pump Trip Status.			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Pump A/M Status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Fuel Tank Level Monitor		1					Signal shall be taken from Level Sensor	Contact terminals to be provided by Fire vendor
7	**Firefighting MCC Panel**								
	Incomer Breaker On / Off Status	**2**		2				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Incomer Breaker Trip Status	**2**		2				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker On / Off Status	**8**		8				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker Trip Status	**8**		8				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
8	**Pump Room Exhaust fan**	**1**							

BMS IO SUMMARY									
SL. No	**DESCRIPTION**	**QTY**	**AI**	**DI**	**AO**	**DO**	**Soft Points**	**Required Field Devices**	**Remarks**
	Fans On / Off Command					1		230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC / Electrical vendor
	Fans On / Off status			1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC / Electrical vendor
	Fans Auto / Manual status			1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC / Electrical vendor
	Fans Trip status			1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC / Electrical vendor
9	**Fresh Air Axial fan**	**1**							
	Fans On / Off Command					1		230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC / Electrical vendor
	Fans On / Off status			1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC / Electrical vendor
	Fans Auto / Manual status			1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC / Electrical vendor
	Fans Trip status			1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC / Electrical vendor
	Sub Total for Each Type of DDC TYPE ID - 01		**1**	**50**	**0**	**2**			
	Spare		1	10	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 01		**2**	**60**	**1**	**3**			
B	**DDC TYPE ID - 02**								
	DDC Location - Basement 2 PHE Pump Room								
1	**Fire water tank - 2 Nos**								
	Level sensor	**2**	2					Level Sensor	By PHE Vendor
2	**Rain water tank -1No**								
	Level sensor	**1**	1					Level Sensor	By PHE Vendor
3	**Flush water tank**								
	Level sensor	**1**	1					Level Sensor	By PHE Vendor
4	**Treated Domestic water tank -2Nos**								
	Level sensor	**2**	2					Level Sensor	By PHE Vendor
5	**HVAC Makeup water tank -2Nos**								
	Level sensor	**2**	2					Level Sensor	By PHE Vendor
6	**EV Charging Panel**								
	Incomer Breaker On / Off Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Incomer Breaker Trip Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
7	**Plumping MCC Panel**								
	Incomer Breaker On / Off Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Incomer Breaker Trip Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
8	**Pump Room Exhaust fan**	**1**							
	Fans On / Off Command					1		230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC / Electrical vendor
	Fans On / Off status			1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC / Electrical vendor
	Fans Auto / Manual status			1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC / Electrical vendor
	Fans Trip status			1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC / Electrical vendor

BMS IO SUMMARY									
SL. No	**DESCRIPTION**	**QTY**	**AI**	**DI**	**AO**	**DO**	**Soft Points**	**Required Field Devices**	**Remarks**
9	**Fresh Air Axial fan**	**1**							
	Fans On / Off Command					1		230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC / Electrical vendor
	Fans On / Off status			1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC / Electrical vendor
	Fans Auto / Manual status			1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC / Electrical vendor
	Fans Trip status			1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC / Electrical vendor
	Sub Total for Each Type of DDC TYPE ID - 02		**8**	**10**	**0**	**2**			
	Spare		2	2	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 02		**10**	**12**	**1**	**3**			
C	**DDC TYPE ID - 03**								
	DDC Location - Basement 1 HUB Room								
1	**EV Charging Panel**								
	Incomer Breaker On / Off Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Incomer Breaker Trip Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
2	**Basement Ventilation Panel**								
	Incomer Breaker On / Off Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Incomer Breaker Trip Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker On / Off Status	**5**		5				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker Trip Status	**5**		5				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
3	**HUB Room (B1 & B2)**	**2**							
	Room Temp & RH		4						
	Chilled water Valve modulation & Feed back		2		2				
	Chilled water inlet & outlet temperature		4					Immersion type temperature sensor	
	Sub Total for Each Type of DDC TYPE ID - 03		**10**	**14**	**2**	**0**			
	Spare		2	3	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 03		**12**	**17**	**3**	**1**			
D	**DDC TYPE ID - 04**								
	DDC Location - Podium 1 Chiller Plant Room								
1	**Water Cooled Chillers- Qty**	**3**							
1	Chiller Enable command					**3**		Command to chiller panel.	
2	Chiller On / Off status			**3**				signal from potential-free contact. Potential-free contact in Panel by Electrical Contractor	
3	Chiller Auto / Manual status			**3**				signal from potential-free contact. Potential-free contact in Panel by Electrical Contractor	
4	Chiller trip status			**3**				signal from potential-free contact. Potential-free contact in Panel by Electrical Contractor	
5	Set charge / Operating temperature				**3**			Command to chiller panel	HVAC Vendor. Via Software Integration.
6	Outlet and inlet temperature of Individual chillers		**6**					Immersion type temp sensor	BAS vendor. 2 Nos for each of the chiller
7	Common supply & return header temperature /each circuit		**2**					Immersion type temp sensor	BAS vendor.
8	Butterfly On / Off Chiller isolation valves command & status			**6**		**6**		Butterfly On / Off valve - open and close commands and feedbacks for valve nos. (1 No for each chiller)	Motorized Valve by HVAC Vendor. Cabling from Valve part of BAS Vendor

BMS IO SUMMARY									
SL. No	**DESCRIPTION**	**QTY**	**AI**	**DI**	**AO**	**DO**	**Soft Points**	**Required Field Devices**	**Remarks**
9	Butterfly On / Off Condenser Side isolation valves command & status			**6**		**6**		Butterfly On / Off valve - open and close commands and feedbacks for valve.	Motorized Valve by HVAC Vendor. Cabling from Valve part of BAS Vendor
10	Butterfly On / Off Cooling Tower Side isolation valves command & status			**6**		**6**		Butterfly On / Off valve - open and close commands and feedbacks for valve. (For 3 Cooling Towers, 3 Isolation Valves inlet side has been considered)	Motorized Valve by HVAC Vendor. Cabling from Valve part of BAS Vendor
11	Temperature at Condenser outlet side of chiller & Cooling tower outlet		**6**					Immersion type temp sensor	BAS vendor
12	Condensor Common supply & return header temperature /each circuit		**2**					Immersion type temp sensor	BAS vendor.
2	**Primary chilled Water Pumps - Qty**	**3**							
1	Pumps ON / OFF command					**3**		Command to chiller panel/ pumps panel	Potential free contact in panel by Electrical vendor. Control cable from DDC to Electrical panel by BAS Vendor
2	Pumps ON / OFF Status			**3**				signal from potential-free contact	Potential free contact in panel by Electrical vendor. Signal cable from DDC to Electrical panel by BAS Vendor
3	Pumps Auto / Manual status			**3**				signal from potential-free contact	Automanual Switch in panel by Electrical vendor. Signal cable from DDC to Electrical panel by BAS Vendor
4	Pumps trip status			**3**				signal from potential-free contact	Potential free contact in panel by Electrical vendor. Signal cable from DDC to Electrical panel by BAS Vendor
3	**Condenser Water Pumps - Qty**	**3**							
1	Pumps ON / OFF command					**3**		Command to chiller panel/ pumps panel	Potential free contact in panel by Electrical vendor. Control cable from DDC to Electrical panel by BAS Vendor
2	Pumps ON / OFF Status			**3**				signal from potential-free contact	Potential free contact in panel by Electrical vendor. Signal cable from DDC to Electrical panel by BAS Vendor
3	Pumps Auto / Manual status			**3**				signal from potential-free contact	Automanual Switch in panel by Electrical vendor. Signal cable from DDC to Electrical panel by BAS Vendor
4	Pumps trip status			**3**				signal from potential-free contact	Potential free contact in panel by Electrical vendor. Signal cable from DDC to Electrical panel by BAS Vendor
4	**Secondary Chilled Water Circulation Pumpsets**	**3**							
1	Pumps VFD healthy & run Status				**3**			signal from potential-free contact	ACMV Vendor. Cabling from BAS Vendor
2	Pumps VFD trip status				**3**			signal from potential-free contact	ACMV Vendor. Cabling from BAS Vendor
3	Outside Air RH & Temperature.		**2**					RH & Temperature sensors	BAS vendor
5	**Cooling towers**	**3**							
1	Cooling tower fan ON / OFF command					**3**		Command to fan panel	Potential free contact in panel by Electrical vendor. Control cable from DDC to Electrical panel by BAS Vendor
2	Cooling tower fan ON / OFF Status			**3**				signal from potential-free contact	Potential free contact in panel by Electrical vendor. Signal cable from DDC to Electrical panel by BAS Vendor
3	Cooling tower fan Auto / Manual status			**3**				signal from potential-free contact	Automanual Switch in panel by Electrical vendor. Signal cable from DDC to Electrical panel by BAS Vendor
4	Cooling tower fan trip status			**3**				signal from potential-free contact	Automanual Switch in panel by Electrical vendor. Signal cable from DDC to Electrical panel by BAS Vendor
5	Cooling tower basin level low		**3**					Level Switch	By BAS Vendor
6	Cooling tower basin level high		**3**					Level Switch	By BAS Vendor
6	**Chiller plant Exhaust air fan**	**1**							
1	Fan On Off Command					1		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
2	Fan 'ON'/'OFF' status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor

BMS IO SUMMARY									
SL. No	**DESCRIPTION**	**QTY**	**AI**	**DI**	**AO**	**DO**	**Soft Points**	**Required Field Devices**	**Remarks**
3	Fan Auto/Manual status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
4	Fan 'Trip' status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Sub Total for Each Type of DDC TYPE ID - 04		**24**	**57**	**9**	**31**			
	Spare		5	12	2	7			
	Total including Spares for Each Type of DDC TYPE ID - 04		**29**	**69**	**11**	**38**			
E	**DDC TYPE ID - 05**								
	DDC Location - Podium 1 Main Electrical Room								
1	**Electrical Room Exhaust air fan**	**1**							
	Fan On Off Command					1		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fan 'ON'/'OFF' status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fan Auto/Manual status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fan 'Trip' status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
2	**Main LT Panel**								
	Incomer Breaker On / Off Status	**5**		5				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Incomer Breaker Trip Status	**5**		5				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Bus Coupler On / Off Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Bus Coupler Trip Status	**1**		1					
	Outgoing Breaker On / Off Status	**15**		15				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker Trip Status	**15**		15				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
6	**APFC Panel**								
	Incomer Breaker On / Off Status	**2**		2				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Electrical Panel vendor
	Incomer Breaker Trip Status	**2**		2				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Electrical Panel vendor
7	**DG Sync Panel**								
	Incomer Breaker On / Off Status	**3**		3				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Incomer Breaker Trip Status	**3**		3				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Bus Coupler On / Off Status	**2**		2				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Bus Coupler Trip Status	**2**		2					
	Outgoing Breaker On / Off Status	**5**		5				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker Trip Status	**5**		5				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
8	**Fire Emergency Panel**								
	Incomer Breaker On / Off Status	**2**		2				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor

BMS IO SUMMARY									
SL. No	**DESCRIPTION**	**QTY**	**AI**	**DI**	**AO**	**DO**	**Soft Points**	**Required Field Devices**	**Remarks**
	Incomer Breaker Trip Status	**2**		2				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker On / Off Status	**8**		8				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker Trip Status	**8**		8				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
9	**Elevator Panel**								
	Incomer Breaker On / Off Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Incomer Breaker Trip Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker On / Off Status	**10**		10				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker Trip Status	**10**		10				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Sub Total for Each Type of DDC TYPE ID - 05		**0**	**111**	**0**	**1**			
	Spare		1	23	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 05		**1**	**134**	**1**	**2**			
F	**DDC TYPE ID - 06**								
	DDC Location - Podium 1 HUB Room								
1	**Transformer Room Exhaust Fan**	**1**							
	Fan On Off Command					1		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fan 'ON'/'OFF' status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fan Auto/Manual status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fan 'Trip' status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
2	**Lift Lobby CSU's**	**1**							
	CSU On / Off command					1		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	CSU On / Off status			1				Air Flow Switch	BMS Vendor Scope
	CSU Auto/Manual status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Potential Free Contact to be provided by HVAC/electrical vendor
	CSU Trip status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Potential Free Contact to be provided by HVAC/electrical vendor
	Supply Air Temparature		1					Supply air temperature sensor - Duct Type	BMS Vendor Scope
	PIBCV Valve control & status		1		1			2 Way PIBCV valve	BMS Vendor Scope
	Fire Damper common status			1					
	Filter Status			1					
	Chilled water inlet & outlet temperature		2					Immersion type temperature sensor	
3	**Basement Ventilation Panel**								
	Incomer Breaker On / Off Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Incomer Breaker Trip Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker On / Off Status	**5**		5				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker Trip Status	**5**		5				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
4	**Main HVAC Pump Panel**								

BMS IO SUMMARY									
SL. No	**DESCRIPTION**	**QTY**	**AI**	**DI**	**AO**	**DO**	**Soft Points**	**Required Field Devices**	**Remarks**
	Incomer Breaker On / Off Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Incomer Breaker Trip Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker On / Off Status	**14**		14				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker Trip Status	**14**		14				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
5	**EV Charging Panel**								
	Incomer Breaker On / Off Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Incomer Breaker Trip Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
6	**Main HVAC Panel**								
	Incomer Breaker On / Off Status	**2**		2				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Incomer Breaker Trip Status	**2**		2				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker On / Off Status	**7**		7				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker Trip Status	**7**		7				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
7	**Utility Panel**								
	Incomer Breaker On / Off Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Incomer Breaker Trip Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker On / Off Status	**12**		12				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker Trip Status	**12**		12				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
8	**Common Area Lighting Panel**								
	Incomer Breaker On / Off Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Incomer Breaker Trip Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
9	**Common Area Power Panel**								
	Incomer Breaker On / Off Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Incomer Breaker Trip Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
10	**HUB Room (P1)**	**1**							
	Room Temp & RH		2						
	Chilled water Valve modulation & Feed back		1		1				
	Chilled water inlet & outlet temperature		2					Immersion type temperature sensor	
	Sub Total for Each Type of DDC TYPE ID - 06		**9**	**100**	**2**	**2**			
	Spare		2	20	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 06		**11**	**120**	**3**	**3**			
G	**DDC TYPE ID - 07**								
	DDC Location - Podium 2 HUB Room								
1	**Battery Room Exhaust Fan**	**1**							

BMS IO SUMMARY									
SL. No	**DESCRIPTION**	**QTY**	**AI**	**DI**	**AO**	**DO**	**Soft Points**	**Required Field Devices**	**Remarks**
	Fan On Off Command					1		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fan 'ON'/'OFF' status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fan Auto/Manual status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fan 'Trip' status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Hydrogen level		1					Hydrogen Sensor	BMS vendor
2	**UPS Input Panel**								
	Incomer Breaker On / Off Status	**2**		2				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Incomer Breaker Trip Status	**2**		2				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker On / Off Status	**7**		7				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker Trip Status	**7**		7				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
3	**UPS Output Panel**								
	Incomer Breaker On / Off Status	**3**		3				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Incomer Breaker Trip Status	**3**		3				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
4	**HUB Room (Podium 02)**	**1**							
	Room Temp & RH		2						
	Chilled water Valve modulation & Feed back		1		1				
	Chilled water inlet & outlet temperature		2					Immersion type temperature sensor	
5	**UPS & Battery room CHW CSU's**	**2**							
	CSU On / Off command					2		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	CSU On / Off status			2				Air Flow Switch	BMS Vendor Scope
	CSU Auto/Manual status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Potential Free Contact to be provided by HVAC/electrical vendor
	CSU Trip status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Potential Free Contact to be provided by HVAC/electrical vendor
	Supply Air Temparature		2					Supply air temperature sensor - Duct Type	BMS Vendor Scope
	Room Temp & RH		2						
	PIBCV Valve control & status		2		2			2 Way PIBCV valve	BMS Vendor Scope
	Fire Damper common status			2					
	Filter status			2					
	Chilled water inlet & outlet temperature		4					Immersion type temperature sensor	
	Sub Total for Each Type of DDC TYPE ID - 07		**16**	**37**	**3**	**3**			
	Spare		4	8	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 07		**20**	**45**	**4**	**4**			
H	**DDC TYPE ID - 08**								
	DDC Location - Podium 3 ICCC Operator Room								
1	**ICCC Room Toilet & Pantry Exhaust Fan**	**2**							
	Fan On Off Command					2		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fan 'ON'/'OFF' status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fan Auto/Manual status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fan 'Trip' status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor

BMS IO SUMMARY									
SL. No	**DESCRIPTION**	**QTY**	**AI**	**DI**	**AO**	**DO**	**Soft Points**	**Required Field Devices**	**Remarks**
2	**ICCC Room Fresh Air fan**	**1**							
	Fan On Off Command					1		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fan 'ON'/'OFF' status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fan Auto/Manual status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fan 'Trip' status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Filter status			1					
3	**Operator Room**	**1**							
	Chilled water inlet & outlet temperature		2					Immersion type temperature sensor	
4	**UPS & Server Room CSU's**	**1**							
	CSU On / Off command					1		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	CSU On / Off status			1				Air Flow Switch	BMS Vendor Scope
	CSU Auto/Manual status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Potential Free Contact to be provided by HVAC/electrical vendor
	CSU Trip status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Potential Free Contact to be provided by HVAC/electrical vendor
	Supply Air Temparature		1					Supply air temperature sensor - Duct Type	BMS Vendor Scope
	Room Temp & RH		2						
	PIBCV Valve control & status		1		1			2 Way PIBCV valve	BMS Vendor Scope
	Fire Damper common status			1					
	Filter status			1					
	Chilled water inlet & outlet temperature		2					Immersion type temperature sensor	
5	**HUB Room (Podium 03 - 2 Nos)**	**2**							
	Room Temp & RH		4						
	Chilled water Valve modulation & Feed back		2		2				
	Chilled water inlet & outlet temperature		4					Immersion type temperature sensor	
	Sub Total for Each Type of DDC TYPE ID - 08		**18**	**15**	**3**	**4**			
	Spare		4	3	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 08		**22**	**18**	**4**	**5**			
I	**DDC TYPE ID - 09 (01 Nos of AHU's in Each DDC)**								
	DDC Location - Commercial Floor 01 - Each AHU's Room	**1**							
1	AHU On / Off command					0			Via soft integration
2	AHU On / Off status			0					Via soft integration
3	AHU Auto/Manual status			0					Via soft integration
4	AHU Trip status			0					Via soft integration
5	Return air Temperature & RH		2					Duct type Temperature and duct type Rh sensors	BMS Vendor Scope
6	Supply Air Temparature		1					Supply air temperature sensor - Duct Type	BMS Vendor Scope
7	PIBCV Valve control & status		1		1			2 Way PIBCV valve	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
8	Fire Damper common status			1					Potential Free Contact to be provided by HVAC/electrical vendor
9	Filter status			2				DP Switch	BMS Vendor Scope
10	Chilled water inlet & outlet temperature		2					Immersion type temperature sensor	BMS Vendor Scope
11	Return air CO2 Level		1					Duct CO2 sensor	BMS Vendor Scope
12	FA Modulating Damper control & Status		1		1			Modulating type damper actuator	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
13	Duct static pressure feedback		1					Static pressure sensor - Duct Type	BMS Vendor Scope
14	Air velocity Sensor		1					Velocity Sensor	BMS Vendor Scope
	Sub Total for Each Type of DDC TYPE ID - 09		**10**	**3**	**2**	**0**			
	Spare		2	1	1	1			

BMS IO SUMMARY									
SL. No	**DESCRIPTION**	**QTY**	**AI**	**DI**	**AO**	**DO**	**Soft Points**	**Required Field Devices**	**Remarks**
	Total including Spares for Each Type of DDC TYPE ID - 09		**12**	**4**	**3**	**1**			
	DDC TYPE ID - 09 Total 07 Sets		**84**	**28**	**21**	**7**			
J	**DDC TYPE ID - 10**								
	DDC Location - Commercial Floor 01 - HUB Room	**1**							
1	**Lift Lobby CSU units**	**3**							
	CSU On / Off command					3		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	CSU On / Off status			3				Air Flow Switch	BMS Vendor Scope
	CSU Auto/Manual status			3				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Potential Free Contact to be provided by HVAC/electrical vendor
	CSU Trip status			3				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Potential Free Contact to be provided by HVAC/electrical vendor
	Supply Air Temparature		3					Supply air temperature sensor - Duct Type	BMS Vendor Scope
	PIBCV Valve control & status		3		3			2 Way PIBCV valve	BMS Vendor Scope
	Filter status			3					
	Chilled water inlet & outlet temperature		6					Immersion type temperature sensor	
	Return air CO2 Level		3					Duct CO2 sensor	BMS Vendor Scope
	FA Modulating Damper control & Status		3		3			Modulating type damper actuator	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
	Air velocity Sensor		3					Velocity Sensor	BMS Vendor Scope
2	**TIDCO Office**	**1**							
	Chilled water inlet & outlet temperature		2					Immersion type temperature sensor	
3	**HUB Room (C1)**	**1**							
	Room Temp & RH		2						
	Chilled water Valve modulation & Feed back		1		1				
	Chilled water inlet & outlet temperature		2					Immersion type temperature sensor	
4	**Floor Electrical Panel**								
	Incomer Breaker On / Off Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Incomer Breaker Trip Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker On / Off Status	**20**		20				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker Trip Status	**20**		20				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Sub Total for Each Type of DDC TYPE ID - 10		**28**	**54**	**7**	**3**			
	Spare		6	11	2	1			
	Total including Spares for Each Type of DDC TYPE ID - 10		**34**	**65**	**9**	**4**			
K	**DDC TYPE ID - 11 (01 Nos of AHU's in Each DDC)**								
	DDC Location - Commercial Floor 02 - Each AHU's Room	**1**							
1	AHU On / Off command					0			Via soft integration
2	AHU On / Off status			0					Via soft integration
3	AHU Auto/Manual status			0					Via soft integration
4	AHU Trip status			0					Via soft integration
5	Return air Temperature & RH		2					Duct type Temperature and duct type Rh sensors	BMS Vendor Scope
6	Supply Air Temparature		1					Supply air temperature sensor - Duct Type	BMS Vendor Scope
7	PIBCV Valve control & status		1		1			2 Way PIBCV valve	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
8	Fire Damper common status			1					Potential Free Contact to be provided by HVAC/electrical vendor
9	Filter status			2				DP Switch	BMS Vendor Scope
10	Chilled water inlet & outlet temperature		2					Immersion type temperature sensor	BMS Vendor Scope

BMS IO SUMMARY									
SL. No	**DESCRIPTION**	**QTY**	**AI**	**DI**	**AO**	**DO**	**Soft Points**	**Required Field Devices**	**Remarks**
11	Return air CO2 Level		1					Duct CO2 sensor	BMS Vendor Scope
12	FA Modulating Damper control & Status		1		1			Modulating type damper actuator	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
13	Duct static pressure feedback		1					Static pressure sensor - Duct Type	BMS Vendor Scope
14	Air velocity Sensor		1					Velocity Sensor	BMS Vendor Scope
	Sub Total for Each Type of DDC TYPE ID - 11		**10**	**3**	**2**	**0**			
	Spare		2	1	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 11		**12**	**4**	**3**	**1**			
	DDC TYPE ID - 11 - Total 09 Sets		**108**	**36**	**27**	**9**			
L	**DDC TYPE ID - 12**								
	DDC Location - Commercial Floor 02 - HUB Room	**1**							
1	**Lift Lobby CSU units**	**2**							
	CSU On / Off command					2		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	CSU On / Off status			2				Air Flow Switch	BMS Vendor Scope
	CSU Auto/Manual status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Potential Free Contact to be provided by HVAC/electrical vendor
	CSU Trip status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Potential Free Contact to be provided by HVAC/electrical vendor
	Supply Air Temparature		2					Supply air temperature sensor - Duct Type	BMS Vendor Scope
	PIBCV Valve control & status		2		2			2 Way PIBCV valve	BMS Vendor Scope
	Filter status			2					
	Chilled water inlet & outlet temperature		4					Immersion type temperature sensor	
	Return air CO2 Level		2					Duct CO2 sensor	BMS Vendor Scope
	FA Modulating Damper control & Status		2		2			Modulating type damper actuator	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
	Air velocity Sensor		2					Velocity Sensor	BMS Vendor Scope
2	**Floor Electrical Panel**								
	Incomer Breaker On / Off Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Incomer Breaker Trip Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker On / Off Status	**20**		20				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker Trip Status	**20**		20				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
3	**HUB Room (C2)**	**1**							
	Room Temp & RH		2						
	Chilled water Valve modulation & Feed back		1		1				
	Chilled water inlet & outlet temperature		2					Immersion type temperature sensor	
	Sub Total for Each Type of DDC TYPE ID - 12		**19**	**50**	**5**	**2**			
	Spare		4	10	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 12		**23**	**60**	**6**	**3**			
M	**DDC TYPE ID - 13 (01 Nos of AHU's in Each DDC)**								
	DDC Location - Commercial Floor 03 - Each AHU's Room	**1**							
1	AHU On / Off command					0			Via soft integration
2	AHU On / Off status			0					Via soft integration
3	AHU Auto/Manual status			0					Via soft integration
4	AHU Trip status			0					Via soft integration
5	Return air Temperature & RH		2					Duct type Temperature and duct type Rh sensors	BMS Vendor Scope
6	Supply Air Temparature		1					Supply air temperature sensor - Duct Type	BMS Vendor Scope

BMS IO SUMMARY									
SL. No	**DESCRIPTION**	**QTY**	**AI**	**DI**	**AO**	**DO**	**Soft Points**	**Required Field Devices**	**Remarks**
7	PIBCV Valve control & status		1		1			2 Way PIBCV valve	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
8	Fire Damper common status			1					Potential Free Contact to be provided by HVAC/electrical vendor
9	Filter status			2				DP Switch	BMS Vendor Scope
10	Chilled water inlet & outlet temperature		2					Immersion type temperature sensor	BMS Vendor Scope
11	Return air CO2 Level		1					Duct CO2 sensor	BMS Vendor Scope
12	FA Modulating Damper control & Status		1		1			Modulating type damper actuator	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
13	Duct static pressure feedback		1					Static pressure sensor - Duct Type	BMS Vendor Scope
14	Air velocity Sensor		1					Velocity Sensor	BMS Vendor Scope
	Sub Total for Each Type of DDC TYPE ID - 13		**10**	**3**	**2**	**0**			
	Spare		2	1	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 13		**12**	**4**	**3**	**1**			
	DDC TYPE ID - 13 - Total 09 Sets		**108**	**36**	**27**	**9**			
N	**DDC TYPE ID - 14**								
	DDC Location - Commercial Floor 03 - HUB Room								
1	**Lift Lobby CSU units**	**2**							
	CSU On / Off command					2		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	CSU On / Off status			2				Air Flow Switch	BMS Vendor Scope
	CSU Auto/Manual status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Potential Free Contact to be provided by HVAC/electrical vendor
	CSU Trip status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Potential Free Contact to be provided by HVAC/electrical vendor
	Supply Air Temparature		2					Supply air temperature sensor - Duct Type	BMS Vendor Scope
	PIBCV Valve control & status		2		2			2 Way PIBCV valve	BMS Vendor Scope
	Filter status			2					
	Chilled water inlet & outlet temperature		4					Immersion type temperature sensor	
	Return air CO2 Level		2					Duct CO2 sensor	BMS Vendor Scope
	FA Modulating Damper control & Status		2		2			Modulating type damper actuator	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
	Air velocity Sensor		2					Velocity Sensor	BMS Vendor Scope
2	**Floor Electrical Panel**								
	Incomer Breaker On / Off Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Incomer Breaker Trip Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker On / Off Status	**20**		20				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker Trip Status	**20**		20				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
3	**HUB Room (C3)**	**1**							
	Room Temp & RH		2						
	Chilled water Valve modulation & Feed back		1		1				
	Chilled water inlet & outlet temperature		2					Immersion type temperature sensor	
	Sub Total for Each Type of DDC TYPE ID - 14		**19**	**50**	**5**	**2**			
	Spare		4	10	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 14		**23**	**60**	**6**	**3**			
O	**DDC TYPE ID - 15 (01 Nos of AHU's in Each DDC)**								
	DDC Location - Commercial Floor 04 - Each AHU's Room	**1**							
1	AHU On / Off command					0			Via soft integration

BMS IO SUMMARY									
SL. No	**DESCRIPTION**	**QTY**	**AI**	**DI**	**AO**	**DO**	**Soft Points**	**Required Field Devices**	**Remarks**
2	AHU On / Off status			0					Via soft integration
3	AHU Auto/Manual status			0					Via soft integration
4	AHU Trip status			0					Via soft integration
5	Return air Temperature & RH		2					Duct type Temperature and duct type Rh sensors	BMS Vendor Scope
6	Supply Air Temparature		1					Supply air temperature sensor - Duct Type	BMS Vendor Scope
7	PIBCV Valve control & status		1		1			2 Way PIBCV valve	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
8	Fire Damper common status			1					Potential Free Contact to be provided by HVAC/electrical vendor
9	Filter status			2				DP Switch	BMS Vendor Scope
10	Chilled water inlet & outlet temperature		2					Immersion type temperature sensor	BMS Vendor Scope
11	Return air CO2 Level		1					Duct CO2 sensor	BMS Vendor Scope
12	FA Modulating Damper control & Status		1		1			Modulating type damper actuator	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
13	Duct static pressure feedback		1					Static pressure sensor - Duct Type	BMS Vendor Scope
14	Air velocity Sensor		1					Velocity Sensor	BMS Vendor Scope
	Sub Total for Each Type of DDC TYPE ID - 15		**10**	**3**	**2**	**0**			
	Spare		2	1	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 15		**12**	**4**	**3**	**1**			
	DDC TYPE ID - 15 - Total 08 Sets		**96**	**32**	**24**	**8**			
P	**DDC TYPE ID - 16**								
	DDC Location - Commercial Floor 04 - HUB Room								
1	**Lift Lobby CSU units**	**2**							
	CSU On / Off command					2		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	CSU On / Off status			2				Air Flow Switch	BMS Vendor Scope
	CSU Auto/Manual status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Potential Free Contact to be provided by HVAC/electrical vendor
	CSU Trip status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Potential Free Contact to be provided by HVAC/electrical vendor
	Supply Air Temparature		2					Supply air temperature sensor - Duct Type	BMS Vendor Scope
	PIBCV Valve control & status		2		2			2 Way PIBCV valve	BMS Vendor Scope
	Filter status			2					
	Chilled water inlet & outlet temperature		4					Immersion type temperature sensor	
	Return air CO2 Level		2					Duct CO2 sensor	BMS Vendor Scope
	FA Modulating Damper control & Status		2		2			Modulating type damper actuator	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
	Air velocity Sensor		2					Velocity Sensor	BMS Vendor Scope
2	**Floor Electrical Panel**								
	Incomer Breaker On / Off Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Incomer Breaker Trip Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker On / Off Status	**20**		20				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker Trip Status	**20**		20				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
3	**HUB Room (C4)**	**1**							
	Room Temp & RH		2						
	Chilled water Valve modulation & Feed back		1		1				
	Chilled water inlet & outlet temperature		2					Immersion type temperature sensor	
	Sub Total for Each Type of DDC TYPE ID - 16		**19**	**50**	**5**	**2**			

BMS IO SUMMARY									
SL. No	**DESCRIPTION**	**QTY**	**AI**	**DI**	**AO**	**DO**	**Soft Points**	**Required Field Devices**	**Remarks**
	Spare		4	4	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 16		**23**	**54**	**6**	**3**			
Q	**DDC TYPE ID - 17 (01 Nos of AHU's in Each DDC)**								
	DDC Location - Commercial Floor 05 - Each AHU's Room	**1**							
1	AHU On / Off command					0			Via soft integration
2	AHU On / Off status			0					Via soft integration
3	AHU Auto/Manual status			0					Via soft integration
4	AHU Trip status			0					Via soft integration
5	Return air Temperature & RH		2					Duct type Temperature and duct type Rh sensors	BMS Vendor Scope
6	Supply Air Temparature		1					Supply air temperature sensor - Duct Type	BMS Vendor Scope
7	PIBCV Valve control & status		1		1			2 Way PIBCV valve	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
8	Fire Damper common status			1					Potential Free Contact to be provided by HVAC/electrical vendor
9	Filter status			2				DP Switch	BMS Vendor Scope
10	Chilled water inlet & outlet temperature		2					Immersion type temperature sensor	BMS Vendor Scope
11	Return air CO2 Level		1					Duct CO2 sensor	BMS Vendor Scope
12	FA Modulating Damper control & Status		1		1			Modulating type damper actuator	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
13	Duct static pressure feedback		1					Static pressure sensor - Duct Type	BMS Vendor Scope
14	Air velocity Sensor		1					Velocity Sensor	BMS Vendor Scope
	Sub Total for Each Type of DDC TYPE ID - 17		**10**	**3**	**2**	**0**			
	Spare		2	1	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 17		**12**	**4**	**3**	**1**			
	DDC TYPE ID - 17 - Total 08 Sets		**96**	**32**	**24**	**8**			
R	**DDC TYPE ID - 18**								
	DDC Location - Commercial Floor 05 - HUB Room								
1	**Lift Lobby CSU units**	**2**							
	CSU On / Off command					2		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	CSU On / Off status			2				Air Flow Switch	BMS Vendor Scope
	CSU Auto/Manual status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Potential Free Contact to be provided by HVAC/electrical vendor
	CSU Trip status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Potential Free Contact to be provided by HVAC/electrical vendor
	Supply Air Temparature		2					Supply air temperature sensor - Duct Type	BMS Vendor Scope
	PIBCV Valve control & status		2		2			2 Way PIBCV valve	BMS Vendor Scope
	Filter status			2					
	Chilled water inlet & outlet temperature		4					Immersion type temperature sensor	
	Return air CO2 Level		2					Duct CO2 sensor	BMS Vendor Scope
	FA Modulating Damper control & Status		2		2			Modulating type damper actuator	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
	Air velocity Sensor		2					Velocity Sensor	BMS Vendor Scope
2	**Floor Electrical Panel**								
	Incomer Breaker On / Off Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Incomer Breaker Trip Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker On / Off Status	**20**		20				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor

BMS IO SUMMARY									
SL. No	**DESCRIPTION**	**QTY**	**AI**	**DI**	**AO**	**DO**	**Soft Points**	**Required Field Devices**	**Remarks**
	Outgoing Breaker Trip Status	**20**		20				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
3	**HUB Room (C5)**	**1**							
	Room Temp & RH		2						
	Chilled water Valve modulation & Feed back		1		1				
	Chilled water inlet & outlet temperature		2					Immersion type temperature sensor	
	Sub Total for Each Type of DDC TYPE ID - 18		**19**	**50**	**5**	**2**			
	Spare		4	10	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 18		**23**	**60**	**6**	**3**			
S	**DDC TYPE ID - 19 for Cafeteria CSU's**								
	DDC Location - Commercial Floor 06 - HUB Room	**2**							
1	CSU On / Off command					2		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
2	CSU On / Off status			2				Air Flow Switch	BMS Vendor Scope
3	CSU Auto/Manual status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Potential Free Contact to be provided by HVAC/electrical vendor
4	CSU Trip status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Potential Free Contact to be provided by HVAC/electrical vendor
5	Supply Air Temparature		2					Supply air temperature sensor - Duct Type	BMS Vendor Scope
6	PIBCV Valve control & status		2		2			2 Way PIBCV valve	BMS Vendor Scope
7	Filter status			2					
8	Chilled water inlet & outlet temperature		4					Immersion type temperature sensor	
9	Return air CO2 Level		2					Duct CO2 sensor	BMS Vendor Scope
10	FA Modulating Damper control & Status		2		2			Modulating type damper actuator	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
11	Air velocity Sensor		2					Velocity Sensor	BMS Vendor Scope
	Sub Total for Each Type of DDC TYPE ID - 19		**14**	**8**	**4**	**2**			
	Spare		3	2	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 19		**17**	**10**	**5**	**3**			
T	**DDC TYPE ID - 20 (01 Nos of AHU's in Each DDC)**								
	DDC Location - Commercial Floor 06 - Each AHU's Room	**1**							
1	AHU On / Off command					0			Via soft integration
2	AHU On / Off status			0					Via soft integration
3	AHU Auto/Manual status			0					Via soft integration
4	AHU Trip status			0					Via soft integration
5	Return air Temperature & RH		2					Duct type Temperature and duct type Rh sensors	BMS Vendor Scope
6	Supply Air Temparature		1					Supply air temperature sensor - Duct Type	BMS Vendor Scope
7	PIBCV Valve control & status		1		1			2 Way PIBCV valve	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
8	Fire Damper common status			1					Potential Free Contact to be provided by HVAC/electrical vendor
9	Filter status			2				DP Switch	BMS Vendor Scope
10	Chilled water inlet & outlet temperature		2					Immersion type temperature sensor	BMS Vendor Scope
11	Return air CO2 Level		1					Duct CO2 sensor	BMS Vendor Scope
12	FA Modulating Damper control & Status		1		1			Modulating type damper actuator	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
13	Duct static pressure feedback		1					Static pressure sensor - Duct Type	BMS Vendor Scope
14	Air velocity Sensor		1					Velocity Sensor	BMS Vendor Scope
	Sub Total for Each Type of DDC TYPE ID - 20		**10**	**3**	**2**	**0**			
	Spare		2	1	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 20		**12**	**4**	**3**	**1**			
	DDC TYPE ID - 20 - Total 05 Sets		**60**	**20**	**15**	**5**			

BMS IO SUMMARY									
SL. No	**DESCRIPTION**	**QTY**	**AI**	**DI**	**AO**	**DO**	**Soft Points**	**Required Field Devices**	**Remarks**
U	**DDC TYPE ID - 21**								
	DDC Location - Commercial Floor 06 - HUB Room								
1	**Lift Lobby CSU units**	**2**							
	CSU On / Off command					2		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	CSU On / Off status			2				Air Flow Switch	BMS Vendor Scope
	CSU Auto/Manual status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Potential Free Contact to be provided by HVAC/electrical vendor
	CSU Trip status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Potential Free Contact to be provided by HVAC/electrical vendor
	Supply Air Temparature		2					Supply air temperature sensor - Duct Type	BMS Vendor Scope
	PIBCV Valve control & status		2		2			2 Way PIBCV valve	BMS Vendor Scope
	Filter status			2					
	Chilled water inlet & outlet temperature		4					Immersion type temperature sensor	
	Return air CO2 Level		2					Duct CO2 sensor	BMS Vendor Scope
	FA Modulating Damper control & Status		2		2			Modulating type damper actuator	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
	Air velocity Sensor		2					Velocity Sensor	BMS Vendor Scope
2	**Floor Electrical Panel**								
	Incomer Breaker On / Off Status	**2**		2				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Incomer Breaker Trip Status	**2**		2				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker On / Off Status	**35**		35				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker Trip Status	**35**		35				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
3	**HUB Room (C6)**	**1**							
	Room Temp & RH		2						
	Chilled water Valve modulation & Feed back		1		1				
	Chilled water inlet & outlet temperature		2					Immersion type temperature sensor	
	Sub Total for Each Type of DDC TYPE ID - 21		**19**	**82**	**5**	**2**			
	Spare		4	17	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 21		**23**	**99**	**6**	**3**			
V	**DDC TYPE ID - 22 (01 Nos of AHU's in Each DDC)**								
	DDC Location - Commercial Floor 07 - Each AHU's Room	**1**							
1	AHU On / Off command					0			Via soft integration
2	AHU On / Off status			0					Via soft integration
3	AHU Auto/Manual status			0					Via soft integration
4	AHU Trip status			0					Via soft integration
5	Return air Temperature & RH		2					Duct type Temperature and duct type Rh sensors	BMS Vendor Scope
6	Supply Air Temparature		1					Supply air temperature sensor - Duct Type	BMS Vendor Scope
7	PIBCV Valve control & status		1		1			2 Way PIBCV valve	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
8	Fire Damper common status			1					Potential Free Contact to be provided by HVAC/electrical vendor
9	Filter status			2				DP Switch	BMS Vendor Scope
10	Chilled water inlet & outlet temperature		2					Immersion type temperature sensor	BMS Vendor Scope
11	Return air CO2 Level		1					Duct CO2 sensor	BMS Vendor Scope
12	FA Modulating Damper control & Status		1		1			Modulating type damper actuator	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor

BMS IO SUMMARY									
SL. No	**DESCRIPTION**	**QTY**	**AI**	**DI**	**AO**	**DO**	**Soft Points**	**Required Field Devices**	**Remarks**
13	Duct static pressure feedback		1					Static pressure sensor - Duct Type	BMS Vendor Scope
14	Air velocity Sensor		1					Velocity Sensor	BMS Vendor Scope
	Sub Total for Each Type of DDC TYPE ID - 22		**10**	**3**	**2**	**0**			
	Spare		2	1	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 22		**12**	**4**	**3**	**1**			
	DDC TYPE ID - 22 - Total 08 Sets		**96**	**32**	**24**	**8**			
W	**DDC TYPE ID - 23**								
	DDC Location - Commercial Floor 07 - HUB Room								
1	**Lift Lobby CSU units**	**2**							
	CSU On / Off command					2		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	CSU On / Off status			2				Air Flow Switch	BMS Vendor Scope
	CSU Auto/Manual status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Potential Free Contact to be provided by HVAC/electrical vendor
	CSU Trip status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Potential Free Contact to be provided by HVAC/electrical vendor
	Supply Air Temparature		2					Supply air temperature sensor - Duct Type	BMS Vendor Scope
	PIBCV Valve control & status		2		2			2 Way PIBCV valve	BMS Vendor Scope
	Filter status			2					
	Chilled water inlet & outlet temperature		4					Immersion type temperature sensor	
	Return air CO2 Level		2					Duct CO2 sensor	BMS Vendor Scope
	FA Modulating Damper control & Status		2		2			Modulating type damper actuator	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
	Air velocity Sensor		2					Velocity Sensor	BMS Vendor Scope
2	**Floor Electrical Panel**								
	Incomer Breaker On / Off Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Incomer Breaker Trip Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker On / Off Status	**20**		20				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker Trip Status	**20**		20				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
3	**HUB Room (C7)**	**1**							
	Room Temp & RH		2						
	Chilled water Valve modulation & Feed back		1		1				
	Chilled water inlet & outlet temperature		2					Immersion type temperature sensor	
	Sub Total for Each Type of DDC TYPE ID - 23		**19**	**50**	**5**	**2**			
	Spare		4	10	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 23		**23**	**60**	**6**	**3**			
X	**DDC TYPE ID - 24 (01 Nos of AHU's in Each DDC)**								
	DDC Location - Commercial Floor 08 - Each AHU's Room	**1**							
1	AHU On / Off command					0			Via soft integration
2	AHU On / Off status			0					Via soft integration
3	AHU Auto/Manual status			0					Via soft integration
4	AHU Trip status			0					Via soft integration
5	Return air Temperature & RH		2					Duct type Temperature and duct type Rh sensors	BMS Vendor Scope
6	Supply Air Temparature		1					Supply air temperature sensor - Duct Type	BMS Vendor Scope
7	PIBCV Valve control & status		1		1			2 Way PIBCV valve	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
8	Fire Damper common status			1					Potential Free Contact to be provided by HVAC/electrical vendor

BMS IO SUMMARY									
SL. No	**DESCRIPTION**	**QTY**	**AI**	**DI**	**AO**	**DO**	**Soft Points**	**Required Field Devices**	**Remarks**
9	Filter status			2				DP Switch	BMS Vendor Scope
10	Chilled water inlet & outlet temperature		2					Immersion type temperature sensor	BMS Vendor Scope
11	Return air CO2 Level		1					Duct CO2 sensor	BMS Vendor Scope
12	FA Modulating Damper control & Status		1		1			Modulating type damper actuator	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
13	Duct static pressure feedback		1					Static pressure sensor - Duct Type	BMS Vendor Scope
14	Air velocity Sensor		1					Velocity Sensor	BMS Vendor Scope
	Sub Total for Each Type of DDC TYPE ID - 24		**10**	**3**	**2**	**0**			
	Spare		2	1	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 24		**12**	**4**	**3**	**1**			
	DDC TYPE ID - 24 - Total 07 Sets		**84**	**28**	**21**	**7**			
Y	**DDC TYPE ID - 25**								
	DDC Location - Commercial Floor 08 - HUB Room								
1	**Lift Lobby CSU units**	**2**							
	CSU On / Off command					2		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	CSU On / Off status			2				Air Flow Switch	BMS Vendor Scope
	CSU Auto/Manual status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Potential Free Contact to be provided by HVAC/electrical vendor
	CSU Trip status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Potential Free Contact to be provided by HVAC/electrical vendor
	Supply Air Temparature		2					Supply air temperature sensor - Duct Type	BMS Vendor Scope
	PIBCV Valve control & status		2		2			2 Way PIBCV valve	BMS Vendor Scope
	Filter status			2					
	Chilled water inlet & outlet temperature		4					Immersion type temperature sensor	
	Return air CO2 Level		2					Duct CO2 sensor	BMS Vendor Scope
	FA Modulating Damper control & Status		2		2			Modulating type damper actuator	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
	Air velocity Sensor		2					Velocity Sensor	BMS Vendor Scope
2	**Floor Electrical Panel**								
	Incomer Breaker On / Off Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Incomer Breaker Trip Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker On / Off Status	**20**		20				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker Trip Status	**20**		20				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
3	**HUB Room (C8)**	**1**							
	Room Temp & RH		2						
	Chilled water Valve modulation & Feed back		1		1				
	Chilled water inlet & outlet temperature		2					Immersion type temperature sensor	
	Sub Total for Each Type of DDC TYPE ID - 25		**19**	**50**	**5**	**2**			
	Spare		4	10	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 25		**23**	**60**	**6**	**3**			
Z	**DDC TYPE ID - 26 (01 Nos of AHU's in Each DDC)**								
	DDC Location - Commercial Floor 09 - Each AHU's Room	**1**							
1	AHU On / Off command					0			Via soft integration
2	AHU On / Off status			0					Via soft integration
3	AHU Auto/Manual status			0					Via soft integration
4	AHU Trip status			0					Via soft integration
5	Return air Temperature & RH		2					Duct type Temperature and duct type Rh sensors	BMS Vendor Scope

BMS IO SUMMARY									
SL. No	**DESCRIPTION**	**QTY**	**AI**	**DI**	**AO**	**DO**	**Soft Points**	**Required Field Devices**	**Remarks**
6	Supply Air Temparature		1					Supply air temperature sensor - Duct Type	BMS Vendor Scope
7	PIBCV Valve control & status		1		1			2 Way PIBCV valve	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
8	Fire Damper common status			1					Potential Free Contact to be provided by HVAC/electrical vendor
9	Filter status			2				DP Switch	BMS Vendor Scope
10	Chilled water inlet & outlet temperature		2					Immersion type temperature sensor	BMS Vendor Scope
11	Return air CO2 Level		1					Duct CO2 sensor	BMS Vendor Scope
12	FA Modulating Damper control & Status		1		1			Modulating type damper actuator	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
13	Duct static pressure feedback		1					Static pressure sensor - Duct Type	BMS Vendor Scope
14	Air velocity Sensor		1					Velocity Sensor	BMS Vendor Scope
	Sub Total for Each Type of DDC TYPE ID - 26		**10**	**3**	**2**	**0**			
	Spare		2	1	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 26		**12**	**4**	**3**	**1**			
	DDC TYPE ID - 26 - Total 07 Sets		**84**	**28**	**21**	**7**			
AA	**DDC TYPE ID - 27**								
	DDC Location - Commercial Floor 09 - HUB Room								
1	**Lift Lobby CSU units**	**2**							
	CSU On / Off command					2		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	CSU On / Off status			2				Air Flow Switch	BMS Vendor Scope
	CSU Auto/Manual status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Potential Free Contact to be provided by HVAC/electrical vendor
	CSU Trip status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Potential Free Contact to be provided by HVAC/electrical vendor
	Supply Air Temparature		2					Supply air temperature sensor - Duct Type	BMS Vendor Scope
	PIBCV Valve control & status		2		2			2 Way PIBCV valve	BMS Vendor Scope
	Filter status			2					
	Chilled water inlet & outlet temperature		4					Immersion type temperature sensor	
	Return air CO2 Level		2					Duct CO2 sensor	BMS Vendor Scope
	FA Modulating Damper control & Status		2		2			Modulating type damper actuator	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
	Air velocity Sensor		2					Velocity Sensor	BMS Vendor Scope
2	**Floor Electrical Panel**								
	Incomer Breaker On / Off Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Incomer Breaker Trip Status	**1**		1				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker On / Off Status	**20**		20				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
	Outgoing Breaker Trip Status	**20**		20				230 V, 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Fire vendor
3	**HUB Room (C9)**	**1**							
	Room Temp & RH		2						
	Chilled water Valve modulation & Feed back		1		1				
	Chilled water inlet & outlet temperature		2					Immersion type temperature sensor	
	Sub Total for Each Type of DDC TYPE ID - 27		**19**	**50**	**5**	**2**			
	Spare		4	10	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 27		**23**	**60**	**6**	**3**			
AB	**DDC TYPE ID - 28**								
	DDC Location - Commercial Floor 09 - AHU 01 Room								

BMS IO SUMMARY									
SL. No	**DESCRIPTION**	**QTY**	**AI**	**DI**	**AO**	**DO**	**Soft Points**	**Required Field Devices**	**Remarks**
1	**AHU Treated Fresh Air Unit**	**3**							
	Fans On Off Command					3		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans 'ON'/'OFF' status			3				DP Switch	BMS Vendor Scope
	Fans Auto/Manual status			3				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans 'Trip' status			3				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	VFD speed control				3			230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	VFD speed feedback		3					230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Duct static pressure feedback		3					Static pressure sensor - Duct Type	BMS Vendor Scope
	Chilled water inlet & outlet temperature		6					Immersion type temperature sensor	BMS Vendor Scope
	Supply Air Temparature		3					Duct Temperature in the outlet	BMS Vendor Scope
	PIBCV Valve control & status		3		3			2 Way PIBCV valve	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
	Filter status			6				Outdoor DP Switch	BMS Vendor Scope
	Sub Total for Each Type of DDC TYPE ID - 28		**18**	**15**	**6**	**3**			
	Spare		4	3	2	1			
	Total including Spares for Each Type of DDC TYPE ID - 28		**22**	**18**	**8**	**4**			
AC	**DDC TYPE ID - 29**								
	DDC Location - Commercial Floor 09 - AHU 04 Room								
1	**AHU Treated Fresh Air Unit**	**3**							
	Fans On Off Command					3		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans 'ON'/'OFF' status			3				DP Switch	BMS Vendor Scope
	Fans Auto/Manual status			3				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans 'Trip' status			3				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	VFD speed control				3			230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	VFD speed feedback		3					230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Duct static pressure feedback		3					Static pressure sensor - Duct Type	BMS Vendor Scope
	Chilled water inlet & outlet temperature		6					Immersion type temperature sensor	BMS Vendor Scope
	Supply Air Temparature		3					Duct Temperature in the outlet	BMS Vendor Scope
	PIBCV Valve control & status		3		3			2 Way PIBCV valve	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
	Filter status			6				OD DP Switch	BMS Vendor Scope
	Sub Total for Each Type of DDC TYPE ID - 29		**18**	**15**	**6**	**3**			
	Spare		4	3	2	1			
	Total including Spares for Each Type of DDC TYPE ID - 29		**22**	**18**	**8**	**4**			
AD	**DDC TYPE ID - 30**								
	DDC Location - Commercial Floor 09 - AHU 07 Room								
1	**AHU Treated Fresh Air Unit**	**3**							
	Fans On Off Command					3		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans 'ON'/'OFF' status			3				DP Switch	BMS Vendor Scope
	Fans Auto/Manual status			3				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans 'Trip' status			3				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor

BMS IO SUMMARY									
SL. No	**DESCRIPTION**	**QTY**	**AI**	**DI**	**AO**	**DO**	**Soft Points**	**Required Field Devices**	**Remarks**
	VFD speed control				3			230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	VFD speed feedback		3					230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Duct static pressure feedback		3					Static pressure sensor - Duct Type	BMS Vendor Scope
	Chilled water inlet & outlet temperature		6					Immersion type temperature sensor	BMS Vendor Scope
	Supply Air Temparature		3					Duct Temperature in the outlet	BMS Vendor Scope
	PIBCV Valve control & status		3		3			2 Way PIBCV valve	HVAC Vendor will provide Valve suitable for BMS Operation. Necessary cabling from DDC Panel to Valve shall be in scope of BAS Vendor
	Filter status			6				OD DP Switch	BMS Vendor Scope
	Sub Total for Each Type of DDC TYPE ID - 30		**18**	**15**	**6**	**3**			
	Spare		4	3	2	1			
	Total including Spares for Each Type of DDC TYPE ID - 30		**22**	**18**	**8**	**4**			
AE	**DDC TYPE ID - 31 - For Toilet Exhaust & Cafeteria Exhaust Fan**								
	DDC Location - Commercial Floor 09 - AHU 07 Room								
1	**Toilet Exhaust fan**	**2**							
	Fans On Off Command					2		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans 'ON'/'OFF' status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans Auto/Manual status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans 'Trip' status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
2	**Caféteria Exhaust fan**	**3**							
	Fans On Off Command					3		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans 'ON'/'OFF' status			3				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans Auto/Manual status			3				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans 'Trip' status			3				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Sub Total for Each Type of DDC TYPE ID - 31		**0**	**15**	**0**	**5**			
	Spare		1	3	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 31		**1**	**18**	**1**	**6**			
AF	**DDC TYPE ID - 32 - For Toilet Exhaust & Electrical Room Exhaust Fan**								
	DDC Location - Commercial Floor 09 - AHU 04 Room								
1	**Toilet Exhaust fan**	**2**							
	Fans On Off Command					2		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans 'ON'/'OFF' status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans Auto/Manual status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans 'Trip' status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
2	**Electrical Exhaust fan**	**2**							
	Fans On Off Command					2		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans 'ON'/'OFF' status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans Auto/Manual status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor

BMS IO SUMMARY									
SL. No	**DESCRIPTION**	**QTY**	**AI**	**DI**	**AO**	**DO**	**Soft Points**	**Required Field Devices**	**Remarks**
	Fans 'Trip' status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
3	**Smoke Exhaust Axial fan**	**4**							
	Fans On Off Command					4		230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans 'ON'/'OFF' status			4				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans Auto/Manual status			4				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans 'Trip' status			4				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Sub Total for Each Type of DDC TYPE ID - 32		**0**	**24**	**0**	**8**			
	Spare		1	5	1	2			
	Total including Spares for Each Type of DDC TYPE ID - 32		**1**	**29**	**1**	**10**			
AG	**DDC TYPE ID - 33**								
	DDC Location - Commercial Floor 09 - AHU 04 Room								
1	**Service Lift Lobby Pressurization Fan**	**1**							
	Fans 'ON'/'OFF' status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans Auto/Manual status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans 'Trip' status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
2	**Staircase Pressurization Fan**	**2**							
	Fans 'ON'/'OFF' status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans Auto/Manual status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans 'Trip' status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
3	**Main Liftwell Pressurization Fan**	**5**							
	Fans 'ON'/'OFF' status			5				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans Auto/Manual status			5				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans 'Trip' status			5				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
4	**Service Liftwell Pressurization Fan**	**1**							
	Fans 'ON'/'OFF' status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans Auto/Manual status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Fans 'Trip' status			1				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by HVAC/electrical vendor
	Sub Total for Each Type of DDC TYPE ID - 33		**0**	**27**	**0**	**0**			
	Spare		1	6	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 33		**1**	**33**	**1**	**1**			
AH	**DDC TYPE ID - 34**								
	DDC Location - Terrace Floor Chiller Plant (Outdoor Type)								
1	**Air Cooled Chillers- Qty**	**2**							
	Chiller Enable command					**2**		Command to chiller panel.	
	Chiller On / Off status			**2**				signal from potential-free contact. Potential-free contact in Panel by Electrical Contractor	
	Chiller Auto / Manual status			**2**				signal from potential-free contact. Potential-free contact in Panel by Electrical Contractor	

BMS IO SUMMARY									
SL. No	**DESCRIPTION**	**QTY**	**AI**	**DI**	**AO**	**DO**	**Soft Points**	**Required Field Devices**	**Remarks**
	Chiller trip status			**2**				signal from potential-free contact. Potential-free contact in Panel by Electrical Contractor	
	Set charge / Operating temperature				**2**			Command to chiller panel	HVAC Vendor. Via Software Integration.
	Outlet and inlet temperature of Individual chillers		**4**					Immersion type temp sensor	BAS vendor. 2 Nos for each of the chiller
	Common supply & return header temperature /each circuit		**2**					Immersion type temp sensor	BAS vendor.
	Butterfly On / Off Chiller isolation valves command & status			**2**		**2**		Butterfly On / Off valve - open and close commands and feedbacks for valve nos. (1 No for each chiller)	Motorized Valve by HVAC Vendor. Cabling from Valve part of BAS Vendor
2	**Primary chilled Water Pumps - Qty**	**2**							
	Pumps ON / OFF command					**2**		Command to chiller panel/ pumps panel	Potential free contact in panel by Electrical vendor. Control cable from DDC to Electrical panel by BAS Vendor
	Pumps ON / OFF Status			**2**				signal from potential-free contact	Potential free contact in panel by Electrical vendor. Signal cable from DDC to Electrical panel by BAS Vendor
	Pumps Auto / Manual status			**2**				signal from potential-free contact	Automanual Switch in panel by Electrical vendor. Signal cable from DDC to Electrical panel by BAS Vendor
	Pumps trip status			**2**				signal from potential-free contact	Potential free contact in panel by Electrical vendor. Signal cable from DDC to Electrical panel by BAS Vendor
3	**Secondary Chilled Water Circulation Pumpsets**	**2**							
	Pumps VFD healthy & run Status				**2**			signal from potential-free contact	ACMV Vendor. Cabling from BAS Vendor
	Pumps VFD trip status				**2**			signal from potential-free contact	ACMV Vendor. Cabling from BAS Vendor
	Sub Total for Each Type of DDC TYPE ID - 34		**6**	**14**	**6**	**6**			
	Spare		2	3	2	2			
	Total including Spares for Each Type of DDC TYPE ID - 34		**8**	**17**	**8**	**8**			
AI	**DDC TYPE ID - 35**								
	DDC Location - Terrace Floor Pump Area (Outdoor Type)								
1	**Terrace Booster Pump**	**2**							
	Pump ON / OFF Status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Plumbing vendor
	Pump Trip Status.			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Plumbing vendor
	Pump MCC Power Status			2				230 V , 6A Relay. Termination to the MCC panel upto NO Contact.	Contact terminals to be provided by Plumbing vendor
2	**Terrace Sump Details**								
	Fire water tank Level Monitoring	**1**	1					Level Sensor	By PHE Vendor
	Domestic water tank Level Monitoring	**1**	1					Level Sensor	By PHE Vendor
	Makeup water tank Level Monitoring	**1**	1					Level Sensor	By PHE Vendor
	Flush water tank Level Monitoring	**1**	1					Level Sensor	By PHE Vendor
	Sub Total for Each Type of DDC TYPE ID - 35		**4**	**6**	**0**	**0**			
	Spare		1	2	1	1			
	Total including Spares for Each Type of DDC TYPE ID - 35		**5**	**8**	**1**	**1**			
96	**THIRD PARTY INTEGRATIONS**								
1	Energy Meters	180					1260		Modbus over RS 485. Considered 7 points per meter
2	Tenent Billing System	200					1000		Modbus over RS 485 / BACnet over MSTP. Considered 10 points per meter
3	DG / Transformer Syn panel PLC integration	1					200		Modbus over RS 485
4	UPS	5					50		Modbus or BACnet. Considered 20 points per UPS
5	Secondary Pump PLC panel	2					100		Modbus or BACnet. Considered 50 points
6	EC Fan	120					1200		Modbus or BACnet. Considered 11 points per EC fan

BMS IO SUMMARY									
SL. No	**DESCRIPTION**	**QTY**	**AI**	**DI**	**AO**	**DO**	**Soft Points**	**Required Field Devices**	**Remarks**
7	VFD	15					150		Modbus over RS 485. Considered 10 points per VFD
8	Basement Ventilation Panel	4					200		Modbus or BACnet. Considered 50 points per panel
9	Fire Alarm Panels	1					5500		Modbus or BACnet.
10	Water meter integration	10					50		Modbus or BACnet. Considered 5 points per meter
11	CHW Cassette / CHW Hi wall units integration	30					150		Modbus over RS 485. Considered 5 points per unit
12	Elevator monitoring system(Lifts)	10					100		Modbus or BACnet. Considered 5 points per lift
13	Chillers	5					100		Modbus or BACnet. Considered 20 points per chiller
14	PHE PUMP PLC panel integration	1					100		Modbus or BACnet.
15	Solar System Panel Integration	1					25		Modbus over RS 485
16	EV charging point integration	40					200		Modbus or BACnet.
17	HSD Tank Flow Monitor Integration	10					50		Modbus over RS 485
18	HSD Tank Consumption Meter Integration	1					5		Modbus over RS 485
TOTAL IO POINTS 3rd PARTY INTEGRATION							**10160**		
			1240	**1494**	**330**	**196**	**10160**		

THIRD PARTY INTEGRATION PARAMETERS		
Sl No.	**Description**	**Parameters**
1	Chillers	Chiller ON / OFF command
		Chiller ON / OFF status
		Chiller Auto/Manual Status
		Chiller Trip Status
		Chilled Water Setpoint
		Compressor 1 CND. Pressure
		Compressor 1 CND. Temaparature
		Compressor 1 Enter. oil Temparature
		Compressor 1 EVP. Pressure
		Compressor 1 EVP. Temaparature
		Compressor 1 Suction. oil Temparature
		Compressor 2 CND. Pressure
		Compressor 2 CND. Temaparature
		Compressor 2 Enter. oil Temparature
		Compressor 2 EVP. Pressure
		Compressor 2 EVP. Temaparature
		Compressor 2 Suction. oil Temparature
		Current Drawn
		Enetering Water temparature
		Leaving Water temparature
2	Energy Meter	Line Voltage R-Y- B
		Phase Voltage, R-Y, Y-B, R-B
		Current , R, Y, B phases
		KVA
		Power Factor
		KVAH
		EB / DG Source
3	UPS	Line Voltage R-Y- B
		Phase Voltage, R-Y, Y-B, R-B
		Current , R, Y, B phases
		KVA
		Freequency
		Power Factor
		Over Load
		Short Circuit
		Earth Fault
		Earth Leakage
		Other fault indication
4	DG	DG Run Status
		Line Voltage (each phase)
		current (each phase)
		Active Power (each phase)

Sl No.	Description	Parameters
		Power factor (each phase)
		Neutral Voltage (each phase)
		Line to Line Average Voltage
		Active Power - Average
		Average Current
		Forward Active Energy
		Line to Neutral Average Voltage
		DG Fault Status
		DG Overload status
		Engine Parameters
5	BTU Meters	Supply side temparature
		Return side temparature
		Flow monitoring
		AC consumption in KWH
6	Basement Ventilation Fans - PLC	CO level
		Fan run status
		Fan trip status
		Fan Auto/Manual Status
7	VFD's	Motor Speed
		Output Current
		Output Frequency
		Run status
		Output Voltage
		Trip Status
		Torque
		Energy Consumption
		Auto/Manual status
		Output Power
8	EC fan	Motor Speed
		Output Current
		Output Frequency
		Run status
		Output Voltage
		Trip Status
		Torque
		Energy Consumption
		Auto/Manual status
		Output Power
		Command
9	CHW cassette / hi wall	On/off command

Sl No.	Description	Parameters
		On/off status
		Set temperature
		trip status
10	Elevators	normal mode
		maintenance mode
		fire mode
		alarm bell status
		Floor Status
11	Water meters	Volume (litres) or (gallons)
		Flow rate (l/s) or (gpm)
		Meter <ref.> Communication Status
		Total water flow
12	Fire alarm panel	Detector / Module Normal Status
		Detector / Module Alarm Status
13	Secondary pump PLC	VFD speed feedback
		Pressure setpoint
		Run status
		Trip status
		Alarm status
		Panel of/off status
		Health status

TECHNICAL SPECIFICATIONS-
LIFT WORKS

Scope

The scope of work covers design, manufacture, Supply to site, unloading and storage at site, installation, testing and commissioning, handing over of Lifts as detailed in this specification. The details of Passenger and Service Lifts are clearly defined in the below chapters.

General

i. Items shall be executed as per BOQ, detailed specifications below and TN PWD specifications & CPWD General Specifications for Electrical works Part-III (Lift & Escalators) & NBC-2016 as amended up to date.

ii. Contractor shall demonstrate testing of lifts as per standard practice of manufacture and as per TN PWD / C.P.W.D. specifications which is stringent.

iii. Contractor shall obtain necessary license from Tamilnadu Government for operation of lifts (necessary fee for the same shall be paid by the Department).

iv. Final finishing selection shall be as per instructions of Project officer In-charge.

v. The lifts shall have brail button in each car as well as each landing, at each floor suitable audio and video signal shall be provided at lifts car arrival.

vi. Lifts are to centrally monitored and switch on / off also necessary provision on BACnet / MODBUS may be provided on controller.

Detailed Specific Requirements for Lifts, please refer following:

(a) 20 Passenger Lift

SL. NO.	DESCRIPTION		REQUIRED TECHNICAL PARTICULARS
1	Type of lift	:	Passenger, Gearless & Machine room less
2	No. of lift required	:	5 Nos
3	Load, No. of persons	:	1360kg, 20 passengers
4	Rated speed	:	1.75mps
5	Travel in meter	:	As per Arch Drawing (41.85 Mtrs)
6	Nos. of floor served	:	10 (Podium1 (P1) & Commercial Floor 1 (C1) to Commercial Floor 9 (C9))
7	a) Inside size of lift well	:	2700mm W x 2500mm D
	b) Pit depth	:	As per Arch Drawing (2200MM)
	c) Head room	:	As per Arch Drawing (4900MM)
8	a) Clear inside size of lift car	:	“Max. Car sizes shall be as per NBC 2016”
	b) Landing door	:	1300mm W x 2300mm H, centre opening
	c) Location of landing entrance in different floors	:	All floors on the same side

SL. NO.	DESCRIPTION		REQUIRED TECHNICAL PARTICULARS
9	Dimension of lift machine room	:	MRL
10	Operation	:	5 Car group passenger lifts with DCS.
11	Lift car finishes	:	As per BOQ
13	False ceiling	:	As per BOQ
14	Flooring	:	As per BOQ
16	DCS- Operating Panel	:	Full DOAS system with 2 keypads in GF and 2 keypads in all other floors with voice announcement and braille with disabled friendly feature.

(b) 15 Passenger Lift (Jump Lift)

SL. NO.	DESCRIPTION		REQUIRED TECHNICAL PARTICULARS
1	Type of lift	:	Passenger, Gearless & Machine room less
2	No. of lift required	:	2 Nos
3	Load, No. of persons	:	1020kg, 15 passengers
4	Rated speed	:	1.0mps
5	Travel in meter	:	As per Arch Drawing (13.45 mtr)
6	Nos. of floor served	:	05 (B2, B1& Podium1 (P1) TO Podium3 (P3))
7	a) Inside size of lift well	:	2300mm W x 2300mm D
	b) Pit depth	:	As per Arch Drawing (1700MM)
	c) Head room	:	As per Arch Drawing (4400MM)
8	a) Clear inside size of lift car	:	"Max. Car sizes shall be as per NBC 2016"
	b) Landing door	:	1200mm W x 2300mm H, centre opening
	c) Location of landing entrance in different floors	:	All floors on the same side
9	Dimension of lift machine room	:	MRL
10	Operation	:	Duplex Full Collective

SL. NO.	DESCRIPTION		REQUIRED TECHNICAL PARTICULARS
11	Lift car finishes	:	As per BOQ
12	False ceiling	:	As per BOQ
13	Flooring	:	As per BOQ
14	Car operating panel along with braille feature	:	Flushed COP with SS brush finish as per side walls .1 nos. COP shall be provided at left side of entrance door.
15	Hall Operating Panel & Lanterns		Stainless Steel Brushed Finished & with TFT LCD Display

(c) Service Lift (Fire cum Service Lift)

SL. NO.	DESCRIPTION		REQUIRED TECHNICAL PARTICULARS
1	Type of lift	:	Passenger, Gearless & Machine room less
2	No. of lift required	:	1 Nos
3	Load, No. of persons	:	1360kg, 20 passengers
4	Rated speed	:	1.5mps
5	Travel in meter	:	As per Arch Drawing (48.65 mtr)
6	Nos. of floor served	:	14 (B2, B1, Podium1 (P1) to Podium3 (P3) & Commercial Floor 1 (C1) to Commercial Floor 9 (C9)) Terrace
7	Inside size of lift well	:	2300mm W x 2800mm D
	Pit depth	:	As per Arch Drawing (1700mm)
	Head room	:	As per Arch Drawing (4400mm)
8	a) Clear inside size of lift car	:	"Max. Car sizes shall be as per NBC 2016"
	b) Landing door	:	1300mm W x 2300mm HT, centre opening
	c) Location of landing entrance in different floors	:	All floors on the same side
9	Dimension of lift machine room	:	MRL
10	Operation	:	Simplex full collective
11	Lift car finishes	:	As per BOQ
12	False ceiling	:	As per BOQ
13	Flooring	:	As per BOQ
14	Car operating panel along with braille feature	:	Flushed COP with SS brush finish as per side walls .1 nos. COP shall be provided at left side of entrance door.
15	Hall Operating Panel & Lanterns		Stainless Steel Brushed Finished & with TFT LCD Display

Common Specification for All Lifts:			
1	Machine & Drive system	:	All machines shall be energy efficient permanent magnet gearless traction machines with ACVVVF drives and shall be full control closed loop. Every machine shall have the provision of manual rescue operation in addition to any electrical / battery back-up arrangement. Alternatively, the battery back-up device shall have a battery monitor that gives adequate audio / visual warning in case of inadequate charge. Drive system shall be ACVVVF with converter / inverter drives. Design unit to limit current, suppress noise and vibration transmission. The units shall be provided with internal heat sink cooling fans for the power drive portion of the converter panels.
2	Reduction channels	:	Vendor to include for reduction channels to resize shaft sizes
3	Car & Counterweight buffers	:	Car and counterweight buffers shall be of hydraulic type (Oil buffers) with necessary supporting channels and struts. The buffers shall be capable of with-standing twice the fully loaded car and two times the counterweight at contract speed + 15% and the fully compressed buffer top shall be not less than 1.2 meter from the bottom.
4	Handrails	:	All lifts shall be "disabled friendly" and shall comply with IS15330:2003 or the latest available amendment. The minimum requirements shall ensure braille (engraved) buttons, gong / chime, car annunciators, handrails etc.
5	Door operation	:	An VVVF electric door operator for opening and closing the door and the Hoist way door shall be provided which shall consist of a machine on the elevator car operating the car door when the car is stopping at a landing. The car door and hoist way door shall be mechanically connected and shall move simultaneously in opening and closing. The opening of car and hoist way doors shall be such that door shall start open just before the elevator approaches the landing meant for, so that by the time the elevator stops completely the car and hoist way doors be fully open with advance door operation (ADO) feature.

6	Hall button panel with braille feature	:	As per manufacturers standard options to choose from or as per Project Officer`s in-charge instruction.
7	Hall position and direction indicator	:	As per manufacturers standard options to choose from or as per Project Officer`s in-charge instruction
8	Hall button panel height (position)	:	At disabled friendly height
9	Battery Operated Emergency alarm	:	There shall be provided an alarm (solid state – siren type) unit operated by 7.2 Volts power pack consisting of rechargeable nickel – cadmium pencil cells which are trickle charged by a specified charging circuit. The unit gives a waxing and waning siren when alarm button in the car is pressed momentarily. The unit has a faceplate to match with the other car fixtures.
10	Battery Operated Emergency light	:	There shall be provided an emergency light unit using 7.2 volts power pack consisting of rechargeable nickel – cadmium pencil cells which are trickle charged by a special charger unit batter and miniature with a rectifier lamp. It will operate automatically in case of power failure. The unit is mounted in a metal box located above the car operating panel and will have a stainless-steel faceplate. A toggle switch is provided to put off the emergency light when main switch is put off preventing discharge of cells. Also, the charger circuit is so designed that after one hour of discharge, the discharge rate is drastically reduced to prevent complete discharge of the cells.
11	Voice annunciation system with floor announcing system	:	Required in Hindi and English language.
12	PA/music system interface	:	Required
13	Full length infra-red door protection	:	Doors shall have full length infra-red door sensors.

14	Fireman switch	:	All lifts shall be provided with fire man's switch. In case of fire, only fireman shall operate 'Fire Elevator'. In normal course, it may be used by other persons. There shall be provided a switch with glass cover at the ground floor which shall permit a fireman to break the glass cover and call the Elevator to ground floor by cancelling all can and landing calls. The Elevator shall then stop at the ground floor with the doors open to permit the fireman to have exclusive use of the Elevator without any interference from the landing calls.
15	3-way intercom (cabling in bidder's scope)	:	Intercoms shall always be provided for every unit. The intercoms shall be hands free 3-way communicator capable of connecting to building emergency room (Fire command centre at ground floor), Lift cabin and top floor control panel. Communication system for lift shall be connected to BMS Control Room, top floor control panel& Security Control for the building. All wiring within hoist way shall be by the Bidder.
16	Fire rating (for landing doors)	:	Landing doors in lift enclosures shall have a fire resistance of not less than two hours. Contractor to provide 2h fire rating certificate for lift doors.
17	Overload device	:	All lifts shall be provided with overload detector, warning indicator and buzzer. In case an overload is detected the car shall remain rest with the doors open. The elevator operation shall resume only upon removal of overload.
18	Home landing	:	Car shall automatically return to the designated home landing after answering the last pending call.
19	Automatic rescue device	:	Each lift shall be provided with its own battery-operated automatic rescue device. The automatic rescue device shall facilitate rescue on power failure. The equipment shall be so designed to execute at least 3 rescue operations between the floors with the maximum travel in a 60-minute period without recharging irrespective of load condition. The automatic rescue device shall execute a rescue operation if one, two or all phases of supply fail.

20	Provision for secure access control system interface	:	Secure access can be card readers, keypad readers or biometric fingerprint readers and shall be confirmed by employer/ Engineer in charge. The supplier shall readily interface with the Access Control Bidder at no extra cost.
21	BMS interface	:	BACNET/IP or MOD-BUS protocol in lift control panel to be integrated with BMS room 1. Status - Normal / Maintenance / Fireman operation 2. Direction of travel 3. Status of door - open / close 4. Car position 5. Passenger trapped alarm / intercom status and more requirements shall be notified later
22	Auto light and fan 'ON-OFF'	:	If the car is not used for a predetermined time, the light and fan inside the car shall automatically switch off. They shall be 'on' automatically when someone calls car from any landing.
23	Door nudging feature	:	Required
24	Car chime	:	All lifts shall be provided with arrival chimes notifying passengers visually and audibly of the arrival of an elevator in advance. The international norms shall be adhered to.
25	CCTV cabling interface	:	Required with CAT-6A cable.
26	Levelling accuracy +5mm	:	A micro-levelling feature shall be incorporated. Micro levelling shall correct for over-travel, under travel and rope stretch, within its zone independently of the operating device. Car levelling at each landing shall not exceed +/- 5 mm with or without load and down or upward travel.

(d) Dumb Lift

SL. NO.	DESCRIPTION	REQUIRED TECHNICAL PARTICULARS
1.0	GENERAL	
1.1	Designation	Dumb Lift
1.2	No. of Elevators	1
1.3	Home landing	Basement-1
1.4	Alternate Landing	Commercial Floor-6
1.4	No. of landings	5
1.6	Floors Serving	(B1, P1, C1, C6 & C8)
1.7	Travel (approx.)	As per Arch.drgs (45.5 Mtrs)
2.0	CAPACITY	
2.1	No. of passengers	-
2	Weight (Kg)	100
2.3	Speed (mps)	0.75
3.0	HOISTWAY	
3.1	Dimensions W x D	1400 X 1100 mm
3.2	Available Pit Depth (mm)	As per Arch drawing
3	Available Overhead Height (mm)	As per Arch drawing
4.0	Cage	
4.1	Size Internal (WxDxH)	900 x 750 x 900 mm (or) As per Manufacturer Standards
4.2	Cage & Entrance door 'W x H	Telescopic - 750 x 900mm (or) As per Manufacturer Standards
4.4	Car interior finishing loads	
	i) Floor	Aluminium Chequered Plate
	ii) False ceiling & other fitments	75 Kg
4.5	Illumination	LED
4.6	Car Operating Panels	1
4.7	Cage shelf board	2
5.0	MACHINE ROOM	NO
6.0	POWER SUPPLY	415V ± 10% , 50HZ
7.0	TRACTION & CONTROLS	
7.1	Traction	Gearless Induction Motor
7.2	Speed Control	AC
7.3	Operation	Simplex
7.4	Alarm Bell	Yes
7.5	Buffers	Spring
7.6	Battery - operated Emergency Landing Facility	Yes

7.7	Car and Landing sills	Polished hard aluminium extrusion with non-slip grooves
8.0	HALL BUTTONS	
8.1	Hall Buttons	NA
8.2	Car Position Indicators on all Floors	Part of car operating panel
8.3	Fireman's Switch	No
8.4	Elevator Management System	NA
8.5	Automatic rescue device with no correction mode	No
8.6	Counterweight Safety	No
9.0	OTHER FEATURES	
	a) Emergency car lighting shall be through a maintenance - free battery forming part of Elevator suppliers scope of work complete with rectifier / charger.	
	b) Emergency Alarm	

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.

i) Tender Drawings

The drawings appended with the tender documents are intended to show the areas to be conditioned, space allotted for various equipment, tentative cable and pipe routes. The equipment offered shall be suitable for installation in the spaces shown in these drawings.

ii) Drawings for approval on award of the work

The contractor shall prepare & submit required sets of relevant drawings and get them approved from the Engineer-in-charge before the start of the work. The approval of drawings however does not absolve the contractor not to supply the equipment/ materials as per agreement, if there is any contradiction between the approved drawings and agreement.

Three sets of the relevant laminated drawings shall be submitted by the contractor while handing over the installation to the Department.

Documents to be furnished along with submission of tender document
i) Quality assurance plan for equipment to be submitted by the contractor.

Data to be furnished by the contractor after the award of contract and before installation

i)Schedule of drawings and documents to be submitted for review, approval and information with submission dates.
ii)Quality Assurance Plan (QAP).
iii)The drawing or documents shall include all design data and information furnished in data sheets.
iii)Procedure for performance testing.
iv)Test Certificates.
v)Erection, Start-up, Operation and maintenance manual with schedule, list of routine maintenance checks to be carried out, etc.

Documents to be furnished on completion of installation:

Required sets of the following documents shall be furnished to the department by the contractor on completion of work:
i) Completion drawings as mentioned above
ii) 3 sets of manufacturer's technical catalogues of all equipments and accessories.
iii) Operation and maintenance manual of all major equipments, detailing all Adjustments, operation and maintenance procedure, Mandatory & Recommended spares list for each equipment for 5 years.