MUNICIPAL CORPORATION OF GREATER MUMBAI

TENDER DOCUMENT

Proposed Construction of Multi-Specialty Hospital at land bearing C.T.S. No – 681A/8B, 681A/3, 681A/4 of village Nahur in S-Ward, Bhandup, Mumbai

VOLUME – II TECHNICAL SPECIFICATION M&E WORKS PART-1

M/S. SHASHI PRABHU & ASSOCIATES
Wankhede Stadium, North Stand, 'A2 & B1' Block,
'D' Road, Churchgate, Mumbai-400 020.
Email: - mail@spaaec.com
Tel: - 022-66199999 Fax:- 022-66199900

NAME OF PROJECT: - PROPOSED MULTI-SPECIALITY BHANDUP HOSPITAL AT LAND BEARING C.T.S.NO681A/88,681A/3,681A/4 OF VILLAGE NAHUR IN S-WARD, BHANDUP MUMBAI

TECHNICAL SPECIFICATIONS –ELECTRICAL WORKS FOR FAIR RATE ITEM

SHASHI PRABHU & ASSOCIATES

SHASHI PRABHU AND ASSOCIATES

MUNICIPAL CORPORATION OF GREATER MUMBAI

H T P A N E L

1 SCOPE

This specification covers the requirements of supplying of HT OUTDOOR metal clad cubicle switch gear having Vacuum Circuit Breakers. These are general requirements of switchgear panel.

Shop Drawings:

The contractor shall prepare and submit to the Construction Manager/Consultants for his approval six (6) sets of detailed layout drawings of all ELECTRICAL WORKS equipment's and piping layouts.

He shall prepare shop drawings incorporating the details given by manufacturers for the items included in his contract and also Client supplied items and any other items which need to be coordinated with other contractors for interfacing.

Before starting the work, the contractor shall submit to the Construction Manager/Consultants for his approval in the prescribed manner, the shop/execution drawings for the entire installation.

The Construction Manager/Consultants, reserves the right to alter or modify these drawings if they are found to be insufficient or not complying with the established technical standards or if they do not offer the most satisfactory performance or accessibility for maintenance. Contractor shall supply in eight (8) sets of all approved shop drawings for execution.

Shop drawings shall be submitted under the following conditions:

Large scale drawings showing fixing detail equipment and showing coordination with other services.

Showing any change in layout in the ELECTRICAL WORKS drawings.

Equipment layout, ducting, piping and wiring/control diagram.

Manufacturer's or Contractor's fabrication drawings for any materials or equipment supplied by him.

No work will be carried out without approval of shop drawings by the Consultants.

"AS BUILT" DRAWINGS:

At the completion of work and before issuance of certificate of completion the contractor shall submit eight (8) sets to the Construction Manager/Consultants, layout drawing drawn at appropriate scale indicating the complete ELECTRICAL WORKS system "as installed" and the same shall be approved by the Consultants before handing over to the Client.

Instruction/Maintenance Manual:

The Contractor shall prepare and produce instruction, operation and maintenance manuals in English for the use, operation and the maintenance of the supplied equipment and installations, and submit to the Construction Manager/Consultants in (8) copies at the time of handing over. The manual shall generally consist of the following:

Description of the project.

Operating instructions.

Maintenance instructions including procedures for preventive maintenance.

Manufacturers catalogues.

Spare parts list.

Trouble shooting charts.

Drawings.

Type and routine test certificates of major items.

One (1) set of reproducible `as built' drawings.

Completion Certificate:

On completion of the ELECTRICAL WORKS installation a certificate shall be furnished by the contractor countersigned by the licensed supervisor, under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form as required by the local supply authority. The contractor shall be responsible for getting the ELECTRICAL WORKS installation inspected and approved by the local concerned authorities and for obtaining the necessary clearance certificates from the authorities.

Guarantee:

At the close of the work and before issuance of final certificate of completion by the Construction Manager/ Consultants, the contractor shall furnish written guarantee Indemnifying the Client against defective materials and workmanship for a period of one year after completion. The contractor shall hold himself fully responsible for reinstallation or replacement, free of cost to Client, the following:

Any defective work or material supplied by the Contractor.

Any material or equipment supplied by the Client which is damaged or destroyed as a result of defective workmanship by the contractor.

Any material or equipment damaged or destroyed as a result of defective workmanship by the contractor.

Staff:

The contractor shall employ competent fully licensed qualified, full time ELECTRICAL WORKS engineers to direct the work of ELECTRICAL WORKS installation in accordance with the drawings and specifications.

The engineers shall be available at all times at site to receive instructions from the Construction Manager., in the day to day activities throughout the duration of contract. The engineer shall correlate the progress of the work in conjunction with all the relevant requirement of the supply authority.

Safety Barriers and Construction Safety:

The Contractor shall at his own cost provide for the protection and safety of the persons working in the area, safety barriers around all openings in every location and at the periphery and edges of all slabs, staircases and stairwells, lift shafts, ducts etc., all to the approval and satisfaction of the Construction Manager. However, contractor shall take appropriate safety precautions suitable for specific locations/ situations and as instructed by the Construction Managers.

The Contractor shall, in general, be fully responsible for all matters with regard to every form of safety during construction and in connection with the execution of the Works, and the Contractor shall take all necessary precautions and provide at his cost everything necessary to ensure such safety at all times. Should any accidents occur due to the Contractor's failure to comply with such safety requirements and to take all other safety measures necessary, the Contractor shall be fully responsible for all such accidents and he shall bear and pay for all costs and damages in connection therewith and as a consequence there of.

Disposal Of Rubbish From The Works And The Site And Provision Of Safety Netting/Screens By Contractor:

The Contractor shall at all times keep the Works and the site in clean, neat and tidy condition. All rubbish from the Works and the site shall be collected and deposited in large bins provided on the site for such purpose by the Contractor at his own cost. The rubbish from such bins shall be regularly carted away by the Contractor to rubbish tips and dump yards beyond the site.

At no time or stage shall any rubbish be thrown over the edges of slabs or through any openings or shafts or ducts or stairwells.

The Contractor shall, at his own cost and to the approval and satisfaction of the Construction Manager, provide safety netting/screens at the periphery of all slabs and at all openings, shafts, ducts and stairwells and/or canopies to prevent any rubbish or material falling over or into such areas and endangering the safety of the persons working below. Should the Contractor fail to provide such safety measures and to take other necessary precautions in accidents that may occur, he shall bear all costs and damages as decided by Construction Manager in connection therewith and as a consequence there of.

The Construction Manager shall have powers to withhold amounts from payment certificates in case of Contractor's persistent noncompliance with provisions of

this clause. Also the construction Manager is empowered to employ another agency at Contractor's cost after one week's notice to implement this Clause in case of Contractor's noncompliance with provisions of this Clause.

Space For Contractor's Construction Yard, Stores Etc.:

The Client shall provide adequate storage/office space to the contractor for his use. The space has to be maintained/constructed by the contractor as per his usage requirements.

All spaces allotted to the contractor, as described above shall be vacated and all structures removed from site at any time as and when required and directed by the relevant authorities or by the Client, unconditionally and without any reservation. The authorities or the Client will not be obliged to give any reason for such removal. Upon receiving instructions to vacate the space, the contractor shall immediately remove all his structures, materials, etc., from the spaces and clear and cleanup the site to the satisfaction of the Construction Manager.

It shall be the specific responsibility of the Contractor to safeguard the site and ensure that no illegal encroachments are made by outside elements within the area allotted to the Con tractor. Upon completion of the work or earlier as required by Client/Authorities, the Con tractor shall vacate the land totally without any reservations. Necessary Bond to this effect on a stamp paper shall be signed by the contractor in a prescribed form.

The Performance Bond and/or guarantees towards retention amount furnished by the Con tractor shall not be released until the spaces allotted to the contractor are fully vacated and handed over to the Client as per the instructions of the Client.

Carrying Out Work Beyond Normal Working Hours Or In Shifts

In order to achieve the milestone and completion dates and to keep pace with the approved construction programme, the Contractor shall be permitted to carry out his work beyond the normal working hours or in shifts. The Contractor shall be responsible for obtaining any necessary permission from the relevant authorities that may be required for him to carry out the work beyond the normal working hours or in shifts. Also, the Contractor shall give prior notice to and make arrangements with the Construction Manager for the supervision of work carried out beyond the normal working hours or in shifts. The Contractor shall make his own arrangements in respect of the provision of adequate lighting and any other facilities that may be required for carrying out the work beyond the normal working hours or in shifts. No extra payments shall be made to the Contractor for or in connection with any such overtime or shift work. The Contractor will not be required to bear the overtime expenses of the Construction Manager in respect of the supervision of such overtime or shift work of the Contractor.

Period And Time Limit For Completion Of Works:

The period and time limit for Completion of the Works shall be as per client’s requirement from the date of issue of Work Order to commence works or handing over of site in respect of the award of Contract. This time period shall be inclusive of the mobilization period and monsoon period.

Professional Integrity And Team Spirit:

It is the intent of the Client, Architect and Construction Manager that this project will be executed in a spirit of team and full professional integrity. Contractor is expected to cooperate with all the agencies involved in the project to fulfill this objective.

List Of Approved Makes:

Unless otherwise specified and expressly approved in writing by the Engineer in Charge/only material of makes and specifications as mentioned in the list of approved makes attached with the specification shall be used.

The contractor shall clearly indicate the list of materials proposed to be used by him & enclose the same with the tender.

On Instruction of Engineer in Charge the Contractor shall submit samples of materials proposed to be used in the works. Approved samples shall be kept in the office of the Engineer in Charge and returned to the Contractor at the appropriate time.

Before procurement, Contractor will discuss with Client for preferred makes.

Water and electricity shall be supplied at one point.

Reference Points:

Contractor shall provide permanent bench marks, flag tops and other reference points for the proper execution of works and these shall be preserved till the end of the work.

All such reference points shall be in relation to the levels and locations, given in the architectural and ELECTRICAL WORKS drawing.

Reference Drawings:

The Contractor shall maintain one set of all drawings issued to him as reference drawings. These shall not be used on Site. All important drawings shall be mounted on boards and placed in racks indexed, no drawings shall be rolled.

All correction, deviations and changes made on the site shall be shown on these reference drawings for final incorporation in the completion drawings. All changes to be made shall be initialed by Engineer in Charge or Architect.

Vendor shall prepare Shop Drawings with all details after checking the feasibility at Site which shall be approved by the Consultants before execution. No work will be carried out without approval of Shop drawing by the Consultant.

Handing Over:

Contractor will be responsible for following:

Entire System shall be commissioned and tested as per design parameter is coordination with Client & consultant.

Complete certificate has to be obtained from the consultant to certify the quality of work and performance of the system.

Contractor has to hand over 4 sets of as Built Drawings duly approved by consultants along with 2 soft copy in CD's.

Contractor has to handover operator manual of the system with catalogue and Technical Data of equipment supplied.

1.1 APPLICABLE STANDARDS :

The switch gear panel and components mounted shall confirm to the following latest revisions of relevant Indian or equivalent British or International standards. In case of any conflict between the following standards and this specification, the requirements of this specification shall prevail.

IS: 2516(Part1 sec.2)	Specifications for circuit breakers. General & Definitions(for voltages above 1000V A.C.).
IS: 2516(Part1 sec.3)	Specifications for Alternating (circuit breakers requirements (voltage above 11KV).
IS: 2516(Part 2 sec.2)	Circuit breaker tests voltage (range 1 KV to 11 KV).
IS: 4710	Switches and switch isolators (above 1 KV but not exceeding 11 KV.)
IS: 375	Marking and arrangement of switch gear bus bars.
IS: 2707 (Part 1 to 4)	Current Transformers.
IS: 3156	Voltage Transformers.
IS: 1248	Electrical Indicating Instruments.
IS: 3231	Electrical relays for power system protection.
IS: 6875h	Control switches and push buttons.
IS: 4483	Preferred panel cutout for relays.
IS: 9046	HT Vacuum contactors.
IS: 3427	Degree of protection provided for metal enclosed switch gear and control gear.

IS: 5578	Guide for marking of insulated conductors.
IS: 5082	Material for data for Aluminum conductors.
IS: 3618	Phosphate treatment of iron and steel for protection against corrosion.
IS: 6005	Code of practice of phosphating of iron and steel.
IS: 5	Painting.
IS: 722	Integrating meters.
IS: 2544	Specifications for HV post insulators.

1.2 CONSTRUCTION:

1.2.1 The switch gear panel shall be metal enclosed, rigid, free standing, floor mounted, draw out, dead front type and fabricated from standard prefabricated, cold rolled sheet steel units. The vertical units shall be assembled in such away that uniform height can be achieved while line up of each vertical units on floor.

1.2.2 The minimum thickness of the sheet steel shall not be less than 2.5 mm. Necessary stiffeners shall be provided.

1.2.3 The switchboard shall be totally enclosed, vermin -proof, except bus bar compartment. Degree of protection of enclosure shall be minimum IP56 as per IS: 3427. If necessary, openings for natural ventilation louvered with wire mesh shall be provided. For bus bar compartment wire mesh shall be such as to protect against object of 1.0 mm size and above.

1.2.4 All doors, removable covers, gland plates and other openings shall be gasket all round the perimeter with neoprene gaskets.

1.2.5 Switch gear shall be provided with an ISMC channel as a base frame. Minimum height of the base frame shall be of 100 mm.

1.2.6 All doors shall be supported by strong hinges of concealed type and braced in such a manner as to ensure freedom from sagging, bending and general distortion of panel or hinged parts.

1.2.7 Switchboards shall be suitable for site conditions as specified in the Technical Data Sheet.

1.2.8 Each unit of the switch gear shall be provided with necessary internal sheet metal barrier to form separate components for buses/Indicating instruments/protective relays/control and power cable connection etc. Compartment for cable connection shall allow adequate space for cable pulling, termination and connection work with energised switch gear. Suitable arc propagation barrier shall also be provided. Preferably independent pressure release valves shall be provided for different compartments. Terminal strips for outgoing control cable connection

should be accessible to facilitate working and testing with breaker in test/service condition with the energised switchboard.

1.2.9 After isolation of the power and control connection of a circuit, it shall be possible to safely carry out maintenance or a repair work in a compartment with the bus bars and adjacent circuits alive.

1.2.10 At a future date, it shall be possible to extend the switch gear in either direction. Ends of the bus bars shall be suitably drilled for this purpose. Panels at the extreme ends shall have openings which shall be covered with plate screw to the panel with necessary gaskets.

1.2.11 Switch gear shall be vertical isolation and horizontal draw out type.

1.2.12 All draw out circuit breaker trucks/trolley of the same rating for all outgoing breakers shall be identically wired/equipped for complete interchangeability at site. `Service', `Test', `Draw Out' positions of the draw out carriage of the switchboard shall be provided. Automatic safety shutters shall be provided to ensure the inaccessibility of all live parts after the breaker is drawn out.

1.2.13 Dummy panels required for rear extensions for cable terminations or to mount the components shall be included in the offer and details of each type of such panels shall be furnished along with offer.

1.3 SAFETY INTERLOCKS:

It shall not be possible to draw out the carriage with circuit breaker closed. The breaker feeder trolley shall remain inside the cubicle even in the `drawout' position. There shall be distinct overall door for the breaker compartment and it should be lockable. Suitable interlocks to prevent following faulty operations shall be provided.

1.3.1 `Plugging in' or `drawing out' of a closed breaker.

1.3.2 `Plugging in' a breaker with earthing isolator closed.

1.3.3 `Closing' of earthing isolator with breaker `Plugged in

1.3.4 Pulling out of auxiliary circuit plug with breaker in service position.

1.3.5 Pushing in breaker to service position with auxiliary circuit plug not in position.

1.3.6 Opening of compartment door with isolating switch in ON position and vice versa.

Necessary mechanical and electrical interlocks between H.T. and L.T. switch gears shall be provided in closing and tripping circuits of breakers which shall be a part of the specification. The total bill of material and scheme designed by the manufacturer will be subject to client/consultant's approval and any addition or deletion shall be binding to the manufacturer on the basis of unit rates available in the offer.

1.4 ACCESSIBILITY:

1.4.1 Checking and removal of components shall be possible without disturbing adjacent components. All components shall be easily accessible. It shall be possible to set all `measuring' and `protective' relays without de- energising the switchboard. All mounted equipment shall have painted identification labels at the front & rear also. In addition to that identification numbers shall be painted on the panel wall to give permanent identification mark. Mounting of the relays for a particular breaker panel shall be limited to that particular panel.

1.4.2 Unused CT secondary terminals must be short circuited and wired to the terminal block. All terminals shall be shrouded with plastic covers to prevent accidental contact.

1.5 BUS BAR ARRANGEMENT

1.5.1 The switchboard shall comprise 3 phase bus bars as indicated in the Technical Data Sheet or SLD which shall extended through all units of the switch gear. All phase bus bars shall be of uniform cross section throughout the switch gear and shall be sized to carry continuously the current specified in the Technical Data Sheet or SLD. Bus bars shall be housed in a separate air insulated chamber and shall be accessible for inspection only with special tools. Wire guards/mesh shall be provided inside the sheet steel enclosure to allow visual inspection of bus bars, CT's, PT's and cable terminations and to avoid accidental touch when rear cover is removed.

1.5.2 Bus bars shall be made of electrolytic aluminum/copper as indicated in the Technical Data Sheet or SLD and shall be sleeved and joints shall be shrouded. Fiber glass/metal sheet with cast resin bushing partitions shall be provided at every junction between two adjacent cubicles. All bus bar joints shall be shrouded with shrouds having sufficient insulation level suitable for nominal system voltage.

1.5.3 Bus bars shall be supported at regular intervals and both, bus bars and the supports shall be adequately sized and braced to withstand the specified short circuit level without permanent deformation. Dynamic stresses shall be calculated on the basis of the specified peak short circuit currents. All bus supports shall be of non carbonizing material resistant to acids and alkalis and shall have non hygroscopic characteristics such as SMC, DMC epoxy bonded fiber glass.

1.5.4 Thermal design of the bus bars shall be based on installation of the switch gear in ventilated conditions. The cooling air volume shall take into account only the bus enclosure.

1.5.5 The maximum operating temperature of the bus bars at the maximum design temperature inside the panel shall be as per IS: 1272 and IEC 298

1.5.6 Bus bars shall be sleeved with colour coded type sleeve having insulation level suitable for nominal system voltage. If the insulating sleeve is not coloured bus bar shall be colour coded with coloured bands at suitable intervals.

1.5.7 All bus bars joints and bus tap joints shall be of the bolted type and shall be shrouded. Spring washers shall be provided to ensure good contact at the joint locations and suitable contact grease shall be applied just before making a joint.

1.5.8 Positive/live terminal or bus bar shall be located at the top or on the left for vertical and horizontal layout respectively.

1.5.9 Sequence of Red, Yellow, Blue phases shall be left to right and top to bottom for horizontal and vertical layout respectively.

1.6 POWER CABLE CONNECTION:

1.6.1 The incoming and outgoing power cable connection shall be through PILC/XLPE/PVC cables of various sizes as indicated in the Technical Data Sheet or SLD. Ample space for connection for these cables shall be provided at the rear of the switchboard. In order to avoid accidental contact in the cable compartment while carrying out inspection by opening the back cover, a removable expanded metal barrier shall be provided in the cable compartment.

1.6.2 The cable entry of the switchboard shall be from the bottom.

1.6.3 Cable lugs and the requisite bushes for sealing power cable entries shall be supplied along with the switchboard.

1.6.4 `Cupal' washers shall be provided for copper busbar to aluminum cable terminations.

1.6.5 The switchboard shall be supplied complete with supports for clamping outgoing and incoming cables. Terminal blocks shall not be used to support cables. The distance available between cable gland plate and terminal lug shall not be less than 750 mm for switchgear upto 11 KV. cables.

1.6.6 In case, cable termination cannot be accommodated in side the panel, a suitable box for mounting at the rear side and at the bottom of panel shall be supplied. Earth strip shall also be brought to this box. In lieu of this a dummy panel may be provided.

1.6.7 The individual switchgear panel shall have adequate space and terminal busbar clearance for accommodating no. of cables as specified in Technical Data Sheet and SLD. The type of cable termination units to be considered shall be heat shrinkable type.

1.7 CONTROL WIRING AND TERMINALS:

1.7.1 Inside the cubicle the wiring for control, indication, signaling, protection and instrument circuits shall be done with PVC insulated stranded conductors. The insulation grade shall be 1.1 KV. The wiring shall preferably be enclosed in plastic channels or neatly bunched together.

1.7.2 10% spare terminals shall be provided on each terminal block. Conductors shall be terminated with adequately sized compression type copper lugs for connection to equipment terminal block. Terminal block shall be of Elemex/Connect well

make. All auxiliary equipments terminals shall be made with pressure type terminals. Sufficient terminals shall be provided on each terminal block to ensure that not more than one outgoing wire is connected per terminal. Terminal strips shall preferably be separated from power circuits by metal barriers or enclosures. All spares contacts of aux. relays, timers etc. shall be wired upto the terminals.

1.7.3 Each wire shall be identified at both the ends by, correctly sized PVC ferrules. Shorting links shall be provided for all CT terminals.

1.7.4 For CT circuits 2.5 sq. mm copper conductor shall be used. Other control wiring can be with 1.5 sq. mm copper conductors.

1.7.5 Control cables shall enter the switchgear from the bottom/ top. It shall be possible to have the control cable entry from both the left and right side corners at the front portion of the switchgear without cutting any standard part of for these cables are also included in the scope of supply of the switchboard. The cable glands shall be compression type, supporting facilities shall be provided for clamping the control cables. All control cables shall be with 2.5 sq. mm Cu stranded conductors.

1.7.6 All inter panel control wiring shall be done by the switchgear supplier. The inter panel wiring shall be taken through PVC sleeves or suitable grommets. Multi pin plug shall be provided and should have scraping earth terminal.

1.7.7 Control cable cutout and gland plate shall be provided preferably at the place where the power cable cutout will be provided. Gland plate for the control cables shall be separate from those provided for the power cables.

1.8 CONTROL AND INDICATION:

Breaker tripping and closing devices shall be operated on D.C. supply. The rated D.C. voltage shall be as specified in the Technical Data Sheet. The supply for breaker opening, closing and indication devices shall be provided as under:

a) One D.C. feeder shall be provided for each bus section. The Bus coupler panel may be fed from any of the two supplies.

b) One separate 240 V AC supply shall be provided for space heater etc.

Mechanical indication for breaker positions such as ON, OFF, spring charged, test position/Service position shall be provided. Various Electrical indications with colours are indicated below shall be provided.

a) Breaker `ON' - Green lamp

b) Breaker `OFF' - Red Lamp

c) Breaker `Auto Trip' - White lamp

d) Trip circuit healthy - White lamp

e) DC fail - Blue lamp.

f) Red phase ON - Red

g) Yellow phase ON - Yellow

h) Blue phase ON - Blue

1.9 EARTHING CONNECTIONS:

1.9.1 Continuous earth bus-bar running throughout the length of the switchboard shall be provided. All doors and movable parts shall be connected to the earth bus with flexible copper connections. Provision shall be made to connect the earthing busbar to the plant earthing grid at two ends. All non-current carrying metallic parts of the equipment shall be earthed . Earth bus shall be brought back to cable compartment and earthing bolts shall be provided to ground cable Armour. Mating surfaces of all bolted parts shall be specifically zinc passivated to ensure continuity between them.

1.9.2 The material of the earth bus shall be copper or equivalent size of aluminum. The earth bus size shall be minimum 180 mm2 copper upto short circuit withstand capacity of 31.5 KA and 300 mm2 above 31.5 KA.

1.9.3 All instruments, relays and other components shall be connected to earth busbar by means of 650 V grade, PVC insulated, stranded tinned copper conductor of 2.5 sq.mm.

1.10 LABELS AND NAMEPLATES:

1.10.1 A nameplate with the switchgear designation at the top of the central panel and separate nameplate giving feeder details shall be provided at front and rear side of each panel.

1.10.2 Name plates shall be provided for each equipment (Lamps, PBs, Switches, Relays, Auxiliary contactors etc.) mounted on the switchboard. Special warning plates shall be provided on all removable covers or doors giving access to high voltage cables, bus bars. Special warning label shall be provided inside the switchboard also, wherever considered necessary. Identification tags shall be provided inside the panels matching with those shown on the circuit diagram.

1.10.3 Engraved nameplates shall preferably be of 3-ply (Red-white- red or Black-white-Black lamicoid sheets or anodized aluminum or back engraved Perspex sheet nameplates shall be provided. Engraving shall be done with square groove cutters. Hard paper nameplates will not be acceptable. Name plates shall be fastened by Screws and not by adhesives.

1.11 SHEET STEEL TREATMENT AND PAINT:

1.11.1 All metal surfaces shall be thoroughly cleaned and digressed to remove mill scale, rust, grease and dirt. Fabricated structure shall be pickled and then rinsed to remove any trace of acid . The under surface shall be prepared by applying a coat of phosphate paint, and a coat of yellow zinc chromate's primer. The under

surface shall be made free from all imperfections before undertaking the finishing coat.

1.11.2 After preparation of the under surface, the switchboard shall be spray painted with two coats of final paint. Colour shade of final paint shall be smoke gray shade no. 631 as per IS: 5 unless otherwise specified. The finished panels shall be dried in stovings ovens in dust-free atmosphere. Panel finish shall be free from imperfections like pinholes, orange peels, runoff, paint etc. The supplier shall furnish painting procedure details along with the offer.

1.11.3 All unpainted steel parts shall be cadmium plated or suitable treated to prevent rust corrosion. If these parts are moving elements, then these shall be greased.

1.12 SPACE HEATERS:

1.12.1 Each vertical cubical shall be provided with space heater to prevent moisture condensation and maintain required temperature. The space heaters shall be located at the bottom of the switchboard and shall be controlled through a thermostat with an adjustable setting with single pole MCB with overload and short circuit release in the phase, link in the neutral. The thermostat shall preferably be located in the metering/ relay chamber.

1.12.2 Space heater shall be of strip type rated for operation on a 240 V, single phase, 50 Hz., A.C. supply system.

1.13 BASE FRAME:

1.13.1 The switchboard shall be suitable to be installed on a base frame supplied in one piece along with foundation bolts. These base channels shall be dispatched two months in advance from the date of dispatch of switchboard so that they can be buried and grouted in the concrete floor. Ample dimensioned oblong holes shall be provided at the bottom of all the switchboards for their installation of base frame. In addition, the switchboard shall have an additional base channel at the bottom with smooth surface.

1.14 BREAKERS:

1.14.1 Vacuum circuit breaker shall be used in the switchboard. Exact type and rating shall be as indicated in the Technical Data Sheet.

1.14.2 10% spare VCB bottles of each ratings shall be supplied along with the switchboard.

1.14.3 Vacuum circuit breaker shall be designed with low switching over voltage level and long switching life. The interrupter shall be leak free with a target value of vacuum life as 25 years.

1.14.4 The breakers shall have at least 8 NO + 8 NC spare auxiliary contacts. If these are not available an auxiliary contactor shall be used to multiply the auxiliary contacts of the breakers. All auxiliary contacts shall be wired to the terminal block. Auxiliary contacts and limit switches shall be in dust tight enclosures.

1.14.5 The breaker shall have motor operated spring charged mechanism. In addition to this, it shall be possible to charge the springs manually, if required. In case the limit spring fails to cut out the spring charging motor when the springs are fully charged the motor shall be automatically decoupled and annunciation for this shall be provided. The control circuit shall be suitable for local as well as remote control. Breaker shall trip free and shall have an anti pumping device. Breaker operating duty shall be 0-3'-CO-3'-CO except for switchgear line up having motor feeders stage wise, receleration feature in which case the duty shall be 0-0.3"-CO-3'-CO. Whenever a PT is mounted on the breaker carriage all auxiliary wiring shall be done in PVC flexible conduits.

1.14.6 Adequate provision shall be made in Vacuum circuit breaker for motor switching to limit the over voltage.

1.14.7 Mechanical trip push buttons shall be provided for all the breakers. Mechanical closing device will not be acceptable for motor feeders. Complete motor assembly should have interchangeability with identical rating of the breaker. Each motor breaker feeder shall be provided with an operation counter.

1.14.8 All integral earthing system or separate earthing carriage be provided. After withdrawing the circuit breaker, this can be inserted to facilitate earthing of the cables. Unit rate in the panel shall be furnished.

1.15 SWITCHBOARD COMPONENTS:

1.15.1 CURRENT TRANSFORMER:

Current transformers shall generally conform to IS: 2075. and of cast resin type and shall be mounted on the switchgear stationary part. The C.T. ratings shall be as shown in the Technical Data Sheet or SLD. For general guidance, the protective current transformers shall have an accuracy class `5P' and an accuracy limit factor greater than `10'. Low reactance C.T.s shall be used for protection. Current transformers for instruments shall have an accuracy class 0.5 and an accuracy limit factor less than 5.0. If a metering load is fed from a protection C.T., suitable 1/1 or 5/5 ratio interposing C.T.s shall be used.

1.15.2 VOLTAGE TRANSFORMERS:

a. The voltage transformers shall be cast resin and draw out type and provided with primary and secondary fuses.

b. The draw-out mechanism shall disconnect the bus bars and V.T. primary and secondary terminals shall be earthed. The primary connection shall be disconnected before the V.T. or its primary fuses become accessible.

c. The voltage transformers shall have an accuracy class 1.0 from 10% to 120% of normal voltage.

d. Secondary and tertiary windings of voltage transformer shall be rated for a three phase line to line voltage of 110 V except as noted.

1.16 MEASURING INSTRUMENTS:

All measuring and recording instruments shall be of square pattern 144 mm x 144 mm flush mounted type. Instruments shall be provided wherever specified in the Technical Data Sheet or SLD. All auxiliary equipment such as shunts, transducers C.T.s, V.T.s that are required shall be included in the supply of switchboard.

1.16.1 AMMETERS, VOLTMETERS, KW METERS

These shall be of moving iron type. The accuracy class shall be 1.0 as per IS: 1248. The range shall be as indicated in the Technical Data Sheet or on the SLD. Ammeters for motor feeders shall have non linear compressed scale at the end to indicate motor starting current.

The KW meter shall be suitable to measure unbalanced loads on a 3 phase 3 wire system. The KW and the voltmeter shall operate of a V.T. secondary of 110 volts.

1.16.2 RECORDING INSTRUMENTS:

Unless stated otherwise these shall be of direct writing type with automatic chart by means of a synchronous motor. The minimum chart length shall be of 24 hours. The chart speed shall be 30 mm/hour.

1.16.3 TRIVECTO METERS: (DIGITAL)

The KWH meter shall be 144 mm x 144 mm square, flush mounted, preferably in a draw-out case. It shall be suitable for operation on 3 phase 3 wire system.

1.16.4 FREQUENCY METERS:

These shall be direct reading or digital type square pattern 144 mm x 144 mm size, suitable for flush mounting and shall operate off a V.T. secondary voltage of 110 volts. The standard range shall be 45-50-55 Hz.

1.16.5 POWER FACTOR METER:

The power factor meter shall also be square pattern 144 mm x 144 mm size, suitable for flush mounting and of digital type. The meter shall operate off 110 volts C.T. secondary voltage. The C.T. secondary current shall be as shown on the SLD or Technical Data Sheet. The standard range shall be 0.5-1.0-0.5.

1.17 AUXILIARY EQUIPMENTS:

1.17.1 AUXILIARY RELAYS/CONTACTORS:

Auxiliary relays/contactors shall generally be used for interlocking and multiplying contacts. Auxiliary contacts shall be capable of carrying the maximum estimated current. In any case their rating must not be less than 5A - for 230 volts A.C. at a power factor between 0.3 and 1, and 2A for 110 volts D.C.(inductive load).

1.17.2 TRIPPING RELAYS:

All tripping relays shall be lockout type with hand reset contacts and shall be suitable to operate off the specified d.c. voltage. These relays shall have self coil cut - off contacts and shall be provided with hand reset operation indicators. Tripping relays will be acceptable in non draw-out cases. The number of contacts shall be as shown on the approved schematic drawings.

1.17.3 PROTECTIVE RELAYS:

All protective relays shall be back connected, draw-out type, suitable for flush mounting and fitted with dust tight covers. Alternatively, `plug in' type of relays will also be acceptable. The relay cases shall have provision for insertion of test plug at the front for `testing' and calibration' using an external power supply, without disconnecting the permanent wiring. It shall be possible to short the C.T.'s through the test plugs. Non protection relays can be in fixed execution.

All relays shall preferably be mounted in front of the panel and shall be as specified in the Technical Data Sheet or SLD. The cur rent and voltage coils shall be rated as specified.

All measuring relays shall have `built in' flags to indicate relay operation. It shall be possible to reset the flag without opening the relay case. Anti fungus treatment shall be provided for all relays.

1.17.4 PUSH BUTTONS:

Push button colours shall be as follows:

Stop, Open, Emergency - Red

Start - Close - Green

Trip circuit `Healthy' check -Black

Red push buttons shall be on the left side and green push buttons on the right side. Push button ratings shall be 5A at 240 V AC or 2A at 110 V DC (inductive load). Emergency stop push buttons shall be lockable in the operated position.

The key shall be released from the push button in both `Released' and `Operated' positions and operation of the push button shall be possible in the key release position. Push button knobs for emergency stop push buttons shall be released to prevent accidental operation.

1.17.5 CONTROL SWITCHES:

All control switches shall be rotary, back connected type having a cam operated contact mechanism. Phosphor bronze contacts shall be used on the control switches. Unless otherwise stated, circuit breaker control switches shall be 3 position spring return to `neutral' from both `ON' and `OFF' positions. They shall have `pistol grip' handle. Number of ways, locking system, lost motion device if re-quired etc. Two spare ways shall be provided on these switched.

Ammeter and Voltmeter selector switches shall have ` make before break' feature on its contacts. The selector switch shall generally have four positions, three for reading three phase currents and phase to phase voltages respectively and the fourth as off position.

1.17.6 INDICATING LAMPS:

Switchboard type low consumption indicating lamps shall be used. Indicating lamps shall be suitable for the voltage indicated in the Technical Data Sheet. Lamps shall be supplied complete with the necessary current limiting resistor duly tested for its rating. Aging test for the resistors shall have been carried out. Lamps shall be provided with translucent lamp covers to diffuse light.

1.17.7 CUBICLE LIGHTING:

Each cubicle of switchgear shall be provided with interior lighting by means of a 20 W fluorescent tube lighting fixture with ON - OFF switch. The lighting fixture shall be suitable for operation from a 240 V, single phase, 50 Hz, A.C. supply. A 240 V, single phase, 15 A A.C. plug point shall be provided in the interior of each cubicle with an ON - OFF switch for connection of hand lamps.

1.18 TESTS AND INSPECTION:

1.18.1 During fabrication, switchgear shall be subject to inspection by Owner/Consultant or by an agency authorized by the Owner. Manufacturer shall furnish all necessary information concerning the supply to inspectors.
The client/ Contractor has right to witness the test carried out on all the equipment.

1.18.2 Tests shall be carried out at the manufacturers' works under his care and expense.

1.18.3 All routine tests as specified by the applicable standard code shall be conducted. Type test certificates for the switchgear panel and CB from a recognized testing organization shall be furnished with the offer. If client / consultant wishes type test shall be carried out at laboratory in the suppliers region in clients / consultants presence. The supplier shall also submit a list of guaranteed technical particulars with the offer.

1.25 In addition specific tests shall be conducted to check mechanical and electrical operation and switchboard wiring to this specification and approved schematic drawings.

1.18.5 These tests shall be provisionally conducted at manufacturer's works by providing temporary connection to switchgear units in order to simulate the actual conditions.

1.18.6 Shop tests shall be witnessed by an inspector of Owner / Consultant or of an agency authorized by owner.

Acceptance tests shall be as follows:

a) A general visual check. This shall cover measurement of overall dimensions, location, number and type of devices, terminal boxes, location and connection of terminals etc.

b) Manual and electrical operation of CB/Relays shall be checked under the worst conditions of auxiliary supply voltage.

c) Dry insulation test with power frequency voltage shall be conducted for the main and auxiliary circuits.

d) Insulation resistance of the main and auxiliary circuits shall be checked.

e) Operation check shall be carried out for every control function as per the approved schematic diagrams by manually stimulating the fault conditions and operation of control switches/relays etc.

f) Preferably, relays shall be tested with secondary injection test equipment.

For equipment bought from other sub - suppliers certified test reports of tests carried out at the manufacturer's works shall be submitted. Normally, all routine tests as specified in the relevant standards shall be conducted by the sub - supplier at his works.

List of tests shall be as follows :

Routine tests : power frequency tests, manual operating mechanism tests, functional tests of L.V. auxiliaries and relays, making and breaking capacity for switches and breaker, short time withstand current tests, making and breaking capacities for earth switch.

Type tests : impulse dielectric tests, power frequency dielectric tests, temperature rise tests, mechanical operating tests, verification of degree of protection, verification of electromagnetic compatibility.

1.19 DRAWINGS:

1.19.1 The manufacturer shall develop his own general arrangement and schematic drawing adding necessary auxiliary devices, accessories, components particular to supplied equipments etc. which are required for safe, convenient, efficient and proper operation of the HT switchgear.

1.19.2 Manufacturer shall submit for owner/consultant's approval the single line diagrams, general arrangement drawings, flooring and mounting detail drawings and schematic diagrams.

1.19.3 Owner's/consultant's approval of GA drawings is required before the fabrication of the cubicle is started. Approval of the schematic drawings is required before the manufacturer proceeds with the cubicle wiring. The owner/consultant's approval as the manufacturer's drawings shall not relieve the manufacturer of his responsibility for supplying equipment conforming with the relevant specifications and standards or for any other mistakes, errors or omissions in drawings.

1.19.4 Once manufacturer's schematic diagrams have been finally approved by owner/consultant, the manufacturer shall prepare wiring connection diagrams for each cubicle. These diagrams shall show any wiring inside the cubicle starting from the cubicle terminal strips. These diagrams shall be used by the owner for troubleshooting and shall show any device, terminal and wire number.

1.19.4 The manufacturer shall submit all the drawings in four copies for owner/consultant's approval.

1.19.5 Manufacturer shall submit four prints and reproducible of schematic, GA and wiring diagrams in final.

1.20 GUARANTEE:

The switchboard shall be guaranteed for trouble free operation for a period of 12 months from the date of commissioning or 30 months from the date of arrival at site, whichever is earlier. Any defects discovered during this period shall be rectified free of charge.

7.0 TECHNICAL DATA FOR EQUIPMENTS :

Sr. No.	Item Description	Data Designed by Consultant	Data Furnished by Supplier
1.0	Ambient Temperature	45°	
2.0	Maximum Ambient Temperature	45°	
3.0	Design Ambient Temperature	45°	
4.0	Rated Voltage, Phase and Frequency	22KV, 3pH, 50 Hz.	
5.0	Maximum system voltage	12/22 KV	
6.0	One minute power frequency withstand voltage	28 KV (rms)	
7.0	1.2 / 50 / usec. Impulse withstand voltage	75 KV (peak)	
8.0	Short circuit withstand		
8.1	Rated symmetrical breaking capacity	350 MVA	
8.2	Short time (1 sec) at rated voltage	250 KA (rms)	
8.3	Dynamic rating	46.84 KA (rms)	
9.0	Continuous rating of busbars under site reference ambient temp. of 45° C	630 A	
10.0	One minute dry withstand power frequency voltage	35 KA	
11.0	Impulse withstand voltage	75 KV	
12.0	Auxiliary supply for using shunt trip at power pack	30 V DC through	
13.0	Auxiliary supply for motor	240 VAC, 50 Hz.	
14.	Maximum temperature of	85°C	

	busbars, droppers, connectors and contact at continuous current rating under site reference temperature		
15	Busbar material	Copper (tinned Electolytic)	
16	Cable entry	Side	
17	Thickness of sheet in mm		
a.	cold rolled	Frame : 3	
b.	frame enclosure	2.5	
c.	Doors / Covers / Partitions	2.5	
18	Colour finish shade	2.5	
a.	Interior	Glossy white	
b.	Exterior	Light gray semi grade glossy shade, epoxy type 631, IS : 5	
19	Earthing Bus		
19.1	Material	Copper	
19.2	Size	Suitable for 25 KA for 1 sec.	
20	Earthing conductor		
21.1	Material	Copper	
21.2	Size	30 x 6 mm	
22	Bus bar insulation	Air insulated, PVC heat shrinkable type sleeved	
23	Circuit Breakers		
23.1	Type	Vacuum	
23.2	Voltage, frequency and no. of phases	11 kv, 50 Hz., 3 ph	
23.3	Rated Operating duty	0-3'-CO-3'-CO	
23.4	Rated current at site (reference ambient temp)	400A	
23.5	Rated breaking capacity	350 MVA, 250 KA (rms)	
23.6	Rated making current	47 KA (peak)	
23.7	Short time current withstand 4 for 1 sec. duration	250 KA (rms)	
23.8	Total break time	Less than 5 cycles	
23.9	Type of operating suitable for manual	Manually and motor mechanism charged spring and remote trip and close operations	

23.10	Minimum no. of auxiliary	8 NP, 8 NC on fixed contacts part of breaker for owner's use.	
23.11	Withstand test voltage One minute power	28	
23.12	Frequency KV(rms) 1.2/50 u sec impulse KV (peak)	75	
24	Auxiliary control voltage		
24.1	For closing coil for tripping coil 30 V DC through power pack	240V, pph, 50 Hz.	
24.2	For space heaters and lighting AC with MCB and thermostat unit	240V, 1 Ph, 50 Hz.	
24.3	Motor type	Universal	
24.4	Anti Pumping feature	Both electrical and mechanical shall be provided	
24.5	Circuit breaker operation	Local control switch for trip and close. Remote electrical trip and close for testing manual	
24.6	Protection required panel	As per single line diagram / Requirement of breaker	
25	Current Transformers		
25.1	Type	Cast resin, bar primary	
25.2	System voltage and frequency	22 KV, 50 Hz.	
25.3	Class of insulations	Class "E" or better	
25.4	Rated primary current ratio	300/5/5 – for both incomer & 120/5/5 for all outgoing	
25.5	Short time 1 sec. current rating	25 KA (rms)	
25.6	Dynamic rating	47 KA (peak)	
26	Voltage Transformers		
26.1	Type	Cast resin	
26.2	Rated voltage – primary	22000 / 3 volts	
	Rated voltage – secondary	110 / 3 volts	
26.3	Method of connection		
	Primary	Star	
	Secondary	Star	
26.4	Rated Voltage factor	1.1 constant	

		1.5 for 30 sec.	
26.5	Class of insulation	Class “E” or better	
26.6	VA burden and accuracy	As per the single line dia / specs requirement of breaker panel	
26.7	Withstand test voltage one minute power frequency	28	
	1.2 / 50 / u impulse KV (peak)	75 KV (peak)	
27	Make of material		
27.1	HRC Fuse	Siemens, L&T, Schneider, Havells Or As per MCGM SOR	
27.2	Fuse base	Siemens, L&T, Schneider, Havells As per MCGM SOR	
27.3	Voltmeter	AE As per MCGM SOR	
27.4	Ammeter	AE As per MCGM SOR	
27.5	Indication lamps	Teknic As per MCGM SOR	
27.6	Relays	Siemens, L&T, Schneider, Havells As per MCGM SOR	
27.7	Power factor meter (Electronic type)	AE As per MCGM SOR	
27.8	Frequency meter (Electronic type)	AE As per MCGM SOR	
27.9	Selector switch	Kaycee As per MCGM SOR	
27.10	Breaker control switch	GEC Alsthom As per MCGM SOR	
27.11	L – R Swithc	Kaycee As per MCGM SOR	
27.12	Terminal Block	Elmex / Connect well / As per MCGM SOR Technoplast	
27.13	Wires	Finolex or approved or equivalent As per MCGM SOR	
27.14	Trivector	Secure, Enercon As per MCGM SOR	

27.15	Digital KWH meter	Enercon As per MCGM SOR	
27.16	CT / PT	AE . Indcoil / Kappa As per MCGM SOR	
27.17	Push Buttons	Teknic As per MCGM SOR	
28	Cable Box arrangement		
	Incomer	2 Nos. 22 KV 3c x 240 mm² XLPE Armoured Al. cable	
	Outgoing	4 Nos. 22 KV 3c x 185 mm² XLPE Armoured Al. cable	
29	Requirements of Breaker Panel		
29.1	Panel description	3 x 1600 KVA transformer	
29.2	Quantity	1 No.	
29.3	Basic rating of breaker	800 Amps.	
29.4	Type of Breaker	VCB	
29.5	Red, Amber, Green indicating lamps	1 set	
30	Potential transformer, three phase, Epoxy cast resin type, 1100 volts / root 3/110 volts / root 3, 100 VA burden, Accuracy class 0.5h	1 set	
31	A44 mm² 0- 15 KV voltmeter	1 No.	
32	Voltmeter selector switch	1 No.	
33	144 mm² 0 – 100 A ammeter	1 No.	
34	Ammeter selector switch	1 No.	
35	Electronic type power factor meter	1 No.	
36	Trivector meter (digital) with KVA / KVARH / KVAH with maximum demand indication in KVA	1 No.	
37	Electronic type frequency meter	1 No.	
38	Epoxy cast resin type current transformer having details as under		
38.1	60/5/5 ratio of Class 1 and burden of 15 VA.	60 / 1 Amp.	
38.2	Accuracy class of metering	0.5	

	core – 1		
38.3	Accuracy class of protection core – 24	5 P 10	
39	Relays		
39.1	T.P. IDMTL relay with 2 O/C + 1E/F Element type equivalent to CDG-61 of EE make	1 No.	
39.2	D.C. fail alarm relay equivalent to VAA-21 of EE	1 No.	
39.3	High speed tripping relay equivalent to VAJH -13 of Eeh	1 No.	
39.4	Antipumping relay equivalent to VAA-11 of EE 4	1 No	
39.5	Auxiliary relay for buccholtz alarm and trip relay equivalent to VAA -21 of EE make	1 No.	
39.6	Auxiliary relay for winding temperature alarm and trip relay equivalent to VAA-21 of EE make	1 No.	
40	30 Volts DC shunt trip coil	1 No.	
41	D.C. fail indication lamp with ACCEPT and RESET push buttons	1 set	
42	Emergency trip lockable push button with keys P	1 No.	
43	Trip circuit healthy indication lamp with push button	1 set	
44	Auto trip indication	1 No.	
45	Spring charged indication	1 No.	
46	Common alarm trip and non trip scheme with ACCEPT, RESET push buttons, relays and hotter for audio indication	1 No.	
47	Space heater with ON-OFF MCB, HRC fuses and thermostat	1 set	
48	Power pack unit for 30 volts D C Output	1 set	
49	Adopter / Dummy panel	Quantity & unit rate shall be furnished by the bidder	
50	Prices for spares required for 2 years maintenance	Quantity & Unit	

	free operation rate shall be furnished by the bidder		
51	Cubicle illumination with 20 W tube & ON-OFF switch	1 set	
52	15 A plugs / socket with ON-OFF switch	1 set	
53	Unit prices for all relays and meters for addition by the bidder	Shall be furnished	

1.0 DRY TYPE TRANSFORMER

2.1 SCOPE

This specification covers performance, design, material, construction, manufacture, inspection, testing, packing forwarding, delivery at site, testing and commissioning of resin cast Dry Type Distribution Transformer with all accessories complete in all respects as described in this specification.

2.2 CODES AND STANDAPDS

A design, manufacture and performance of equipment shall comply with all currently applicable statutory regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall be constructed to relieve the vendor of his responsibility.

B Unless otherwise specified equipment shall conform to the following latest applicable I.S.

Sr. No.	Code No.	Title
1.	IS-5	Colours of ready mixed paints and enamels
2.	IS-694	PVC insulated cables for working voltages upto and including 1100V.
3.	IS-1271	Thermal evaluation arid classification of electrical insulation.
4.	IS-1893	Criteria for earthquake resistant design of structures.
5.	IS-2026	Power Transformers
6.	IS-2062	Steel for general structural purposes.
7.	IS-2099	Bushings for alternating voltages above l000 V
8.	IS-2147	Degrees of protection provided by enclosures for low voltage switchgear and control gear.
9.	IS-2707	Current transformers
10.	IS-2848	Industrial platinum resistance thermometer sensors.
11.	IS-3043	Code of practice for earthing
12.	IS-3144	Mineral wool thermal insulation method of test.
13.	IS-3639	Fittings and accessories for power transformers
14.	IS-3716	Application guide for insulation co ordination.
15.	IS-6005	Code of practice for phosphating of iron and steel
16.	IS-6160	Rectangular conductors for electrical machines.
1 7.	IS-7421	Porcelain bushings for alternating voltage upto and including 1000V.
18.	IS-8183	Bonded mineral wool
19.	IS-10028	Code of practice for selection, installation and maintenance of transformers.
20.	IS-I 1171	Dry type power transformers.
21.	IS-14000	Quality Systems — Guidelines for selection and use of standards on Quality Systems.

22.	IEC-270	Partial discharge measurements.
23.	IEC-5511	Determination of transformer and reactor sound levels
24.	IEC-616	Terminal and tapping markings for power transformers.
25.	IEEE-344	IEEE recommended practice for seismic qualification of class-IE equipment for nuclear power generating stations.

a) IS: 2026 Power transformer (Part 1 to 5).

2.3 RATING

The rating, voltage ratio, vector group and type of cooling of transformer, tap changing gear shall be as specified in the enclosed data sheet.

2.4 OPERATION UNDER OVERLOAD CONDITION

It shall be possible to operate all transformers as per loading guide IS: 6600 up to overload of 150% and there shall be no limitations imposed by bushing, tap changes, auxiliary equipment etc. to meet this requirement.

2.5 CONSTRUCTIONAL FEATURES

A General:

a) Similar parts, particularly removable ones, shall be interchangeable.
b) Exposed parts shall not leave pockets where water can collect.
c) Internal design of transformer shall ensure that air is not trapped in any location.

B Core:

The magnetic circuit shall be constructed from high grade cold-rolled, non-ageing grain oriented low loss high permeable silicon steel laminations and shall be of 'Core' type. The core shall be painted with suitable resin to protect it against corrosion and other parts shall be hot dip galvanized. The lamination shall be free of all burrs and sharp projections. The lamination Grade shall be indicated in the Technical Data and shall be subject to the Engineer's approval.

The joints of limbs and yokes shall be designed and constructed to keep the no load losses and the hot spot temperature in the magnetic core as well as the noise level as low as possible.

The insulation structure for the core to bolts and core to clamp plates shall be such

All steel sections used for supporting the core shall be non-magnetic. They shall be thoroughly shot or sand blasted, after cutting, drilling and welding.

The design of the magnetic circuit shall be such as to avoid static discharges development of short circuit paths within itself or to the earthed clamping structure and production of flux component at right angles to the plane of lamination's which may cause local heating.

The finally assembled core with all the clamping structures shall be free from deformation and shall not vibrate during operation.

The core clamping structure shall be designed to minimize eddy current loss and bolts shall not pass through the lamination for any purpose whatsoever. Fiber glass or equivalent tapes of adequate strength shall be used for clamping the core through and approved procedure.

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

Max permissible flux density shall be 1.6 Tesla.

C Internal Earthing:

All internal metal plates of the transformer shall be earthed at one point only. The magnetic circuit shall be connected to the clamping structure at one point only. The frame work and clamping arrangements of core and coil shall be securely earthed by copper strip connection to the main frame and enclosure. Two earthing terminals shall be provided on the frame for external earthing. The terminals shall be suitable for the earthing conductor of size indicated in the Data Sheets.

D WINDING

i Winding shall be of high conductivity annealed copper conforming to IS-6160. The conductors shall be transposed at intervals in order to minimize eddy currents and equalize the distribution of currents and temperatures along the windings. The insulation class for the windings shall be at least Class-F having high tensile and dielectric strength and temp. rise of 90oc. Low voltage windings are two layer helical type of spiral type employing number of strips in parallel. High voltage windings can be cross over coils or disc type coils separated from each other by keyed radial spacers. Max current density in any part of the winding shall be 2 Amp / mm2.

ii Both HV and LV windings of one phase shall be separately cast on one rigid tubular coil co-axially arranged with no mechanical connection in between. The complete coil assembly shall be cast under vacuum Into moulds, which forms the insulation system. The coil shall be casted in epoxy resin with fiber glass covering on the conductor to form a compact tubular spool for achieving high mechanical strength.

iii The resin used for winding insulation shall be non-hygroscopic to prevent the penetration of moisture into windings. It should be possible to energize the

transformer without predrying even after a long period of service interruption. The resin used shall be self-extinguishing and void free and shall be suitable for temperate climate and 100% air humidity.

iv The transformer shall free of partial discharges atleast upto 1 .2 times of the rated voltage and shall be able to withstand short circuits as well as switching and atmospheric impulse as specified.

Adequate barriers shall be provided between windings and core as well as between HV and LV windings.

E TANK

i Tank shall be made from good commercial grade low carbon steel and shall be of welded construction.

ii Tank shall be designed to permit lifting, by crane of jacks, of the complete transformer assembly filled . Radiators shall be detachable type connected to the tank through butterfly valves.

iii The material used for gasket shall be cork neoprene or approved equivalent.

iv Tank shall be provided with lifting lugs a minimum of four jacking lugs and suitable haulage holes.

v The tank cover shall be fitted with pockets for a thermometer and for the bulbs of oil and winding temperature indicators. Protection shall be provided, where necessary, for each capillary tube.

vi All wheels should be detachable and shall be made of cast iron or steel as required.

vii Inspection cover on the top shall be provided (for small transformer of 500 KVA and above). Tank cover shall be suitably sloped to prevent accumulation of rainwater.

F Conservator:

Two nos. sensing elements (RTDs) shall be provided in each phase. The RTDs shall be embedded at the hottest spot. The type of RTD shall be simplex and the material shall be platinum

G Core and Coil Assembly:

The cast coils are inserted on to the core limbs. The resin cast spacer blocks, end blocks and separators are used as required. The end frames are then assembled.

H Terminals:

The HV side termination facility to be provided on the transformer shall be designed for connecting 11KV XLPE (E) (240 sq.mm. 3 core Al. cable) insulated cables terminated with crimping type lugs. The cable entry shall be from the bottom. HV bushing terminals shall be extended upto the cable terminals by means of busbars. These busbars shall be located in the upper side of the transformer at a convenient height. Busbars shall be supported by supporting insulators from the top frame of the enclosure, clearing the ventilation hood. HV line end busbar terminals shall facilitate termination of cables with heat shrinkable sleeves. Formation of delta on the HV side is in the scope of transformer manufacturer. Only cable termination shall be at site. No modification / formation of and windings shall be done on site.

Phase to phase and phase to ground clearances shall be as specified in data sheets.

The LT side terminals for the transformer shall be connected directly to switchgear bus by direct bus bars. Horizontal/Vertical connections to busbars shall be straight and without unnecessary joints. For bus connection the LV terminals shall be extended upto the switchgear by bus bars. These bus bars will be connected to the switchgear bus bars through copper flexible suitable for 100% rating. Formation of star on the LV side is in the scope of transformers manufacture. The LV terminals shall be located in such a manner to suit the level of LT switchgear bus bars (top entry).

Tap changing links provided on a separate mounting plate than on cast resin MV windings so as to avoid any burnings of the links and resin arising out of loose connections due to frequent changing of the links or due to human error.

The transformer shall have terminals designed to suite any special requirements for BESCOM over & above IS. The HT/LT cable boxes shall be detachable type. Flange for bus bar termination shall be provided at LT box as per the busbar used from transformer to LT switchgear.

The neutral of the star connected winding shall be in two branches and shall be brought out to two separate bushing terminals. One neutral bushing shall be provided to facilitate leading the earth conductor down to the ground level. The terminal shall be suitable for connecting to two separate earthing pads. Suitable lugs shall be supplied by the Contractor for connecting the earthing conductors. The second bushing shall be provided by side of the phase terminals for connecting neutral to neutral bus bar in the switchgear buses. Location of the CTs for the earth fault protection shall be in the common portion of the neutral i.e. before bifurcation of the neutral in two branches

I Two earthing terminal of required size shall be provided.

J Rating and diagram plates shall be provided as per IS: 2026.

2.7 VOLTAGE CONTROL

A type of control and No. of taps shall be as specified in data sheet.

B **ON LOAD TAP Changer:** OLTC with AVR and RTCC panel shall be provided if required. **REQUIRED FOR THIS APPLICATION**.

2.8 BUSHING INSULATORS AND CABLE BOXES

A Transformer shall be fitted either with bushing insulators or with cable boxes, as specified. Cable box should be air insulated type.

B Cable box shall have sufficient space to facilitate termination if more than one cable terminations are specified, and to accommodate all cable joint fittings or sealing ends including stress/cones etc. Links shall be provided of suitable length for easy termination of cables. Necessary glands and cable sockets shall be provided. Box shall have a drain plug to enable the filling medium removal quickly. Armor earthing pads(2 nos.) shall be provided along-with cable termination kit support.

C Non-magnetic cable gland plate shall be provided in the cable box, whenever single core cables are specified.

2.9 BUSDUCT TERMINATION

When bus-duct termination is specified a flanged throat or equivalent connection shall be provided to suit purchaser's bus-ducts. The LV winding termination shall be on outdoor type of bushings.

2.10 TEMPERATURE INDICATING DEVICES AND ALARM

A device for measuring the hot spot temperature of the winding shall be provided winding temperature indicators consisting of:

Temperature sensing elements. The no. of sensing elements shall be provided as indicated in 1.7.

Local indicating instrument with four adjustable electrically independent ungrounded contacts brought out to separate terminals for winding temperature high alarm and trip. One indicating instrument shall be provided for each phase.

The tripping contact of winding temperature indicators shall be adjustable to close between 60°C and 120°C and alarm contacts to close between 50°C and 100°C and both shall reopen when the temperature falls by about 10°C.

Connections shall be brought from the device to marshaling box.

Separate MCBs shall be provided for control supply (alarm and trip circuits). Control supply shall not be taken from secondary side of the transformer

2.11 Marshalling Box :

The contractor shall provide a marshalling box and shall mount the winding temperature indicators in the marshalling box and shall marshalling to it all the contacts/terminals of CT secondary and winding temperature indicators required

for the transformer. The contractor shall provide the interconnection cabling between the above equipment and the marshalling box. The winding temperature indicator shall be flush mounted on the marshalling box door. This interconnection shall be through wires in GI conduits or through armoured cables. The insulation for the wires/cables shall be consistent with the ambient temperature in the housing. Compression type brass cable glands required for these interconnections shall be supplied by the contractor.

The marshalling box shall be mounted on the transformer housing. All doors, covers and plates shall be provided with neoprene gaskets. Bottom of the marshalling box shall be at least 600mm above floor level and provided with removable bolted, un-drilled gland plate.

All contacts for alarm, trip and indication circuits shall be electrically free, wired for auxiliary supply as specified and brought out to separate terminals at the terminal block in the marshalling box. Terminal blocks shall be preferably of GE power controls/Elmex. Terminals shall be rated for 10A. Wiring shall be with PVC insulated, stranded, copper, conductor of sizes not smaller than 1.5 Sq mm for control and 2.5 Sq mm of CT circuits. CT terminals shall be provided with shorting facility. Engraved identification ferrules, marked to correspond with the approved wiring diagrams shall be fitted to each wire. Ferrules shall be of yellow colour with black lettering.

2.12 PAINTING

The inside of the enclosure shall be treated with matt paint of semi-glossy white. Steel surfaces exposed to the weather shall be thoroughly cleaned and applied first coat of zinc chromate, second coat of oil and weather resistant paint and final coat of glossy oil and weather resistant non fading paint of shade no 632 of IS :5 (epoxy paint)

2.13 TESTS

A **Routine tests :** Routine test such as ratio test, open circuit test, short circuit test, no load test, induced high voltage test, insulation resistant test, measurement of winding resistance etc. shall be conducted as per IS : 2026. Including CT polarity test, earth continuity test, OLTC operation test, oil dielectric test.

Type tests : Type tests if required by client / consultant shall be carried out at certified laboratory of the suppliers area shall be carried out. If not required by client certificates for type test carried out for similar rating of transformer shall be submitted by the supplier. Type tests shall be carried out for temp. Rise, impulse voltage and short circuit analysis.

B **Test certificates :** Five copies of the routine test and type test certificates shall be submitted for purchaser's record before dispatch of transformer, including test certificates of bought out items.

2.14 INSPECTION

A Inspection including witnessing routine tests will be carried out by purchaser or his authorized representative.

B Vendor shall notify purchaser or his authorized representative in writing atleast fifteen days prior to vendor's scheduled inspection tests.

2.15 GUARANTEE

Vendor shall guarantee design, materials workmanship and performance for a period of 12 months from the date of commissioning or 30 months after delivery at job site, for all goods to be supplied under order, till whichever date shall occur first.

2.16 TECHNICAL DATA FOR EQUIPMENTS : Supply, Installation testing and Commissioning of Indoor type Dry type CRT Transformer with Enclosure having 22 KV/0.415 KV voltage levels low loss type with rating of 1600 KVA with OLTC & RTCC Taps on Primary Winding for+ 10% to – 10% in steps of 2.5%, Primary Voltage Variation On Load Tap Changer, No. of switch positions : 9, IS – 11171 – 1985 & IS: 2026 -2011 With Latest standard and Energy efficiency Level, Losses At 50% Loading : 6320 W (Max.), At 100% Loading : 16800 W (Max.) Scope includes Supply transportation, loading, unloading, shifting to final location, checking of foundation level, welding of stoppers on foundation channels, including all labour and materials. Inteconnection between accssories mounted on the transformer & marshalling box along with mounting of loose accessories supplied by vendor.Losses as per latest IS&ECBC norms.

Sr. No.	Item Description	Data Designed by Consultant	Data Furnished by Supplier
1.	General		
1.1	Application	Power Distribution	
1.2	Quantity	Three (3)	
1.3	Installation	INDOOR/Outdoo r	
1.4	Type of winding	Double wound	
1.5	Rating	1600 KVA	
1.6	Cooling	AN	
2.0	Rating		
2.1	No load voltages		
a.	HV winding	22 KV	
b.	LV winding	0.415/0.433 KV	
c.	Impulse voltage withstand	95KVp – HV testing 28 KV	
d.	Fault level withstand	18.4 KA rms for 1 sec / 350 MVA	
2.2	Frequency	50 Hz.	
2.3	% age Impedance	App. 5%	
3.0	Losses	App 1 % of rating	
3.1	Full load losses – suggested	As per ECBC norms	
3.2	No load losses - suggested		
3.3	Efficiency at		
	100% load at UPF	To be provided by	

	75% load at UPF	vendor	
	100% load at 0.8 PF		
	75% load at 0.8PF		
4.0	Winding		
4.1	Material of winding	Copper	
4.2	Winding connection	HV Side - Delta LV Side - Star	
4.3	Vector group	DYn11	
4.4	Temp at full load - winding	55oC above ambient	
5.0	Terminal connection		
5.1	HV winding end	H. V Cable box suitable for 185 mm² x 3 core H.T. XLPE cable – top entry	
5.2	LV winding end	8nos x 400 sq mm x 3.5 C Cu XLPE cables – top entry	
5.3	LV winding end Neutral	To be brought out separately	
5.4	Earthing	Solidly earthed	
6.0	Tapping		
6.1	Total tapping range	+10% TO -12.5%	
6.2	Steps	1.5%	
6.3	Tap changer	On load with RTCC	
8.0	Dimensions / Weight		
8.1	Dimensions L X W X H	To be specified by vendors	
8.2	Weight of core		
8.3	Total weight of transformer		

Any other information, if not specified above, but necessary for the evaluation of offer shall be furnished by the supplier.

3.0 DIESEL GENERATOR SET WITH ACOUSTIC CANOPY

1.0 GENERAL :

1.1 **SCOPE :**

This general specification together with the equipment sheets and attachments defines the minimum requirements the design, performance, inspection, testing and supply diesel engines for general industrial purposes.

1.2 The construction, design and rating of the diesel engine shall meet fully, the requirements of the specified driven machine and the Vendor shall select and provide the requisite ancillaries and controls with the diesel engine for its safe and satisfactory operation.

1.3 No deviations or exceptions from this specification shall be permitted without the written approval of the purchaser. Intended deviations supported by reasons there of shall be separately listed by the vendor and submitted with the bid for the consideration of the Purchaser.

1.4 Compliance with this specification shall not relieve the vendor of the responsibility of furnishing equipment and accessories of proper design, materials and workmanship to meet the specified operating conditions.

1.5 This general specification supplements the specific requirements contained in the attached equipment data sheets. In the event of any contradiction between the two, the information contained in the latter shall govern.

1.6 Other attachments of the Material Requisition from a apart of this specification.

1.7 **TERMS AND DEFINITIONS:**

1.7.1 The Net Calorific value of fuel is defined as the heat resulting from the complete combustion of a unit quantity of fuel oil and air, without condensation of the water vapor. A net calorific value of 9,720 Kcal/Kg (As per IS : 1460 Rev.2) shall be considered while declaring the fuel consumption and for testing purposes.

1.7.2 The unit of horse power as defined in this specification is the metric horse power equivalent to 4,500 n-Kg/Min. The horse power in F.P.S. system is equal to 1.014 metric horse powers.

1.7.3 Other terms used in this specification or in the equipment data sheets are as defined in the latest edition of British Standard-5514.

2.0 STANDARD OPERATING CONDITIONS:

2.1 The standard operating conditions shall be defined in the latest edition of B.S.-5514 unless otherwise mentioned specifically in the equipment data sheet.

3.0 RATED POWER OUTPUT AND SPEED:

3.1 The diesel engine rating shall be the net output in brake horse power, which the engine is capable of delivering continuously at the stated crank shaft speed under the conditions specified under Clause 2.0 above, provided the engine is maintained in good operating condition and is serviced / overhauled regularly as per the schedules laid down by the Manufacturer.

3.2 No negative tolerance shall be allowed on the diesel engine rating specified by the Vendor in the equipment data sheets.

3.3 The engine shall be capable of satisfactorily providing an output 10 percent in excess of the continuous rating defined above, at the same speed for one hour in any period of 12 hours consecutive running.

3.4 The normal power requirement of the engine driven radiator fan or the coolant pump and the battery charging dynamo shall be clearly stated for the engine which is so equipped.

3.5 Unless otherwise specified in the equipment data sheets, the site rating of the engine shall be worked out considering the duration's specified under the latest edition of B.S.-5514 and the power absorb by all the engine driven ancillaries shall also be deducted.

4.0 DESIGN & CONSTRUCTION:

4.1 GENERAL:

4.1.1 The Diesel engine offered shall be of the regular production models of the manufacturer for industrial applications and already type tested either at the manufacturer's works or outside. The type test report shall be furnished to the purchaser for his review if so desired.

In case the proposed engine model has not been type tested, vendor shall furnish with the offer, a reference list of its existing industrial installation and at least three of these engines, should have completed, 5,000 houses of running at site.

4.1.2 Unless otherwise specified in the equipment data sheets, the diesel engine shall be provided with class A2 governing as per the latest edition of B.S. 5514.

4.1.3 The "Cyclic irregularity" of the diesel engine for direct coupling to an electric generator, "angular deviation of p73 A.C. generators " driven by diesel engine for parallel operation, and the "engine governor speed droop characteristics ", shall be restricted to the values specified under the latest edition of B.S.-5514.

4.1.4 In case diesel engines are required to drive generators in parallel, the governor fuel injection pumps provided should have identical characteristics and the speed-load curves shall be made available to the purchaser's inspector for his scrutiny and approval prior to load testing. The vendor shall maintain proper record for such curves to ensure additional diesel engines if required in future with identical characteristics, could be made available to the purchaser. A set of the said curves shall also be furnished to the purchaser.

4.1.5 The vendor shall be responsible for carrying out torsion analysis of the dynamic system as specified in the latest edition of British Standard-5514. The results in the

fork of a report shall be submitted to the purchaser for scrutiny and reference, if desired.

4.1.6 Vendor shall provide the flexible exhaust connection /s to connect the engine exhaust to the exhaust piping. The required size of the exhaust piping should be clearly specified by the Vendor.

4.1.7 If specified, the common base plate for mounting the diesel engine and the driven equipment as well as the flexible coupling, shall be supplied by the vendor.

4.1.8 Vendor shall indicate in the bid, the ISO Noise Level rating of the diesel engine with the offered exhaust silencer/s.

4.2 **ENGINE STARTING :**

4.2.1 Diesel engines shall be capable of starting without the use of cold starting aids so long the ambient temperature at the site is not below 4 ^{o}C. The vendor shall provide suitable cold starting aids with diesel engine for quick starting below 4^{o}C of ambient and such aids shall be clearly detailed out along with the offer.

4.2.2 Where the diesel engine is specified / offered with battery starting arrangement, the starter motor shall be capable of starting the engine without having to disengage the driven machine with the help of a clutch. Where the diesel engine is equipped with a dual starter the synchronizing switch and the corresponding wiring / connection with the starter motor shall be provided by the vendor.

In case of diesel engines driving fire water pumps, besides the engine mounted dynamo and voltage regulator, the Vendor shall also provide automatic battery charging equipment suitable for taking power from an alternating current power source and mounted on a free standing type of a panel.

The battery charger if specified in the equipment data sheet, shall be capable of delivering a current equal to 100 percent of the 20 hour discharge rate of the battery and also equipped with charging rate selector device.

4.2.3 Where the diesel engine is specified / offered with compressed air starting, the Vendor shall also provide the air compressor driven by a diesel engine / electric motor and equipped with necessary instruments and controls as specified in the equipment data sheets.

The air receiver supplied by the vendor shall provide batteries and battery charging equipment (see clause B. above) for operating the electrical controls of the diesel engine.

4.2.4 If as specified in the data sheets, the diesel engine is required to start / stop automatically, the vendor shall provide the necessary controls (automatic-cum-manual) in the engine panel and the interconnecting wiring and piping from the panel to the engine and starting equipment. A pilot lamp shall be provided in the line side of the starting equipment circuit to indicate that the controller is in the automatic position. In the event the engine does not start after three attempts have been made, the controller shall stop all further cranking and

operate the audiovisual alarm. AD.C. motor driven per lubrication pump with timer suitably interlocked with the starting system shall be provided by the vendor. Whenever the unit is arrange for automatic shut down, a running period time set for a specific time interval, and shall be provided.

4.3 **ENGINE COOLING:**

4.3.1 When radiator cooled engines are offered, the diesel engine shall be provided with a radiator for mounting on the common base plate, complete with the suction / blower fan, temperature control valve and a radiator guard.

4.3.2 Where the engine cooling is achieved by closed circuit cooling water system, the vendor shall provide the complete jacket water (primary water) circuit, heat exchanger with the make-up tank and its piping, as well as the raw water (secondary water) circuit including but not limited to the following :

4.3.2.1 Raw water pump with driver, unless the raw water is required to be obtained from the discharge of the pump driven by the diesel engine.

4.3.2.2 Raw water piping (prefabricated) and fittings, as specified in the equipment date sheets.

4.3.2.3 Instruments and controls as specified in the equipment data sheets.

4.4 **ENGINE FUEL SYSTEM:**

4.4.1 A fuel float (surge) tank if recommended by the manufacturer, shall be supplied with the diesel engine along with its interconnecting piping / hoses.

4.4.2 The daily service fuel tank shall be equipped with as air breather, shielded level gauge, strainer and a hand hole of not less than 150 mm diameter, besides the required fuel connections and a drain plug. The capacity of tank shall be as specified in the equipment data sheets.

4.4.3 The inside surfaces of the fuel tank and the float tank shall be coated with Enamel Red or Black of I.C.I. or its equivalent and the outside surface to be given two coats of the oil resistant primer paint. Both the fuel tank and the float tank, shall be hydrostatic tested at a pressure not less than 0.35 kg /Cm^2.

5.0 INSPECTION & TESTING:

5.1 The inspector representing Purchaser shall have entry to the plant while and wherever work for the equipment is being performed.

5.2 The vendor shall have the responsibility of providing purchaser's inspector with all requisite facilities / equipment for carrying out satisfactory testing.

5.3 The diesel engines shall be tested in the presence of purchaser's inspector in accordance with the latest edition of B.S. -5514 or any other equivalent standard as agreed to with the purchaser before the finalization of order.

5.4 The routine load and fuel consumption test shall be of the following duration :

5.5 Unless otherwise specified, 10% overload provision shall be kept while setting the fuel stop for the site running.

5.6 The hydrostatic test certificates for the heat exchanger / intercoler , fuel tanks and other pressure vessels shall be furnished to the purchaser's inspector for his review and approval at the time of load testing of the diesel engine.

5.7 The engine control panel/s after assembly and wiring, shall be functionally tested in the presence of the purchaser's inspector.

6.0 PREPARATION FOR SHIPMENT :

6.1 Immediately upon completion of all tests and inspections, all exposed machined surfaces shall be cleaned and coated with a suitable rust preventive by the vendor and the unmachined surface shall be painted by at least two coats of red oxide primer.

6.2 Diesel engines shall be transported assembled as far as possible.

6.3 All untapped opening shall be provided with 4mm thick metal closures with full rubber gaskets and bolted by not less than 4 bolts. All connections including those for instruments, instrument leads, lubricating oil and the like shall be identified with securely attached tags indicating the type of connection, the instrument or the line description as applicable.

6.4 The equipment shall be crated for domestic / export shipment as specified in the data sheets considering for storage at job site for at least 6 months. Lifting load-out, and handling instructions shall be securely attached to the exterior of the largest packing in a well marked weather proof container. Upright position lifting points, weight (including packing and dimensions shall be clearly identified with item no., serial no., package no., and the names of the equipment.)

7.0 PROPOSAL :

7.1 Proposals shall be accompanied with completely filled in Data Sheets. The vendor shall not use his own data sheets.

7.2 The proposals must include either a specified statement that all equipment is in accordance with the purchaser's specifications or exceptions, if any, to this general specification including attachments shall be clearly brought out by the vendor on separate sheets, supported with suitable reasons thereof for the consideration of the purchaser.

7.3 Additions or exclusions from the scope of supply shall be clearly brought out on separate sheets giving reasons for such deviations for the purchaser's approval.

7.4 Rating (HP) curves for the diesel engine for different duties and their interpretation as per the applicable standard, shall accompany the proposal.

7.5 The drawings and data as listed under "prints with Quote" on the vendor data requirement sheet attached with this specification shall be provided.

7.6 The vendor shall also submit a separate proposal for carrying out supervision of the installation and commissioning of diesel engine/s offered indicating per item rates, no. of specialists proposed to be deputed, completion time and a list indicating nature and quantity of consumable/ tools required and any other terms.

8.0 SCOPE:

8.1 This specification define the requirements of design, manufacture, testing and supply of self excited emergency generator complete with automatic voltage regulator, control panel, generator breaker and other accessories as specified in the material requisition.

8.2 Unless otherwise specified the emergency generator shall be supplied complete with

a) Brush less excitation system complete with AVR.

b) Electric panel including control cubicle and associated auxiliary devices, relay panel and generator breaker battery and charger (unless otherwise specified).

c) Air inlet and outlet for generator cooling (inlet shall be oriented to suit local plant layout).

d) Lifting arrangement for the machine.

e) Foundation frame complete with foundation bolts and base frame.

f) Lube oil system integral with the prime mover lube oil system.

g) Spares for commissioning

h) Spares for two years of operation and maintenance.

i) Any other part / accessories not specifically mentioned above but considered necessary for safe and reliable operation.

9.0 CODES AND STANDARDS:

Unless they are in variance with the clause of this specification the diesel engine driven generator and their components shall comply with the latest edition of the applicable standards listed below:

IS : 22534 Designation for type of construction and mounting arrangement of rotating electrical machines.

IS : 46914 Degree of protection providing by enclosures of rotating electrical machinery.

IS : 47284 Terminal marking of rotating electrical machines.

IS : 71324 Guide for testing 3 Ph. synch. Machines.
IS : 54224 Turbine type generators.

IS : 48894 Methods of determination of efficiency of rotating electrical machines.

IS : 12714 Insulating materials for Electric machinery and apparatus in relation to their thermal stability service, classification of

IS : 47224 Specification for rotating electrical machines.

IS : 25164 A.C. Circuit breakers.

Other codes shall be : AS2789, BS4999, BS5000, DIN6271, EGSA101P, IEC34/1, IS4722, ISO3046/1, ISO8528, NEMAMG1-22, SAEJ1349.

10.0 PERFORMANCE REQUIREMENTS :

10.1 Operative Conditions :

Generators shall be suitable for operating satisfactorily in humid and corrosive atmosphere found in pump house. Service conditions shall be as specified in the data sheet. The generator shall operate satisfactorily under sudden load application. Generator rating indicated in the data sheet shall be the net output of the set after accounting for all auxiliaries for the prime mover and generator.

10.2 Transient Voltage performance

The dip or rise in system voltage load variations is dependent on the leakage voltage drop of the machine which shall be kept to the minimum.

In case of sudden application of full load at rated power factor the voltage drop shall not exceed 15% of the rated voltage. The rated voltage shall be restored within 0.5 to 0.8 second depending on the size of the machine.

10.3 Voltage Regulation

The voltage regulation of the machine shall be within +/- 2 % of the nominal voltage under following conditions :

a). Between no load and nominal load with p.f. of 0.8 lag to unity.
b). With the machine cold or warm.
c). At a speed drop of approximately 3% of the nominal speed.

10.4 Voltage setting range :

The generator terminal voltage shall be adjustable with a continuously variable potentiometer. The adjustment range shall be +/- 5% of the nominal voltage with a possible extension to +/- 10%.

10.5 Harmonic Content

The maximum permissible deviation from the sine wave shall be 5%. The harmonic content of the voltage shall be less than 3% measured between phases off load and up to nominal rating for a power factor of 0.8 lag to unity and with symmetrical distortion free consumers in circuit.

10.6 **Frequency limits**

The Generator shall be suitable for continuous operation at rated load for frequency variation of +/- 3% of rated value in addition the vendor shall furnish the short time under-frequency operating limits.

10.7 **Overloads :**

The generator shall be capable of withstanding without injury the effect of a 10% overload for one hour and 50% overload for one minute.

10.8 **Short Circuit Conditions :**

The generator shall be capable of withstanding without damage, a three phase, a line to line, line to earth or two line to earth short circuit for a period of 3 seconds when operating at rated speed and with an excitation corresponding to 5% over voltage at no load.

10.9 **Parallel operation :**

Generator sets shall be suitable for parallel operation amongst themselves, or with other generating sets or with other sources (Grid supply) at operating voltage and under load conditions up to rated value. **The set shall be provided with Electronic governor system.**

10.10 **Excitation support system**

Excitation system shall be provided with short circuit support equipment (Series compounding) to maintain three times the rated current for three seconds in case of short circuit to ensure proper fault clearance in outgoing feeders.

11.0 DESIGN AND CONSTRUCTION :

11.1 The generator design shall meet the requirement specified in data sheet and shall be suitable for the site conditions specified therein.

11.2 The generator shall be mounted on a common base frame together with the prime mover unless otherwise agreed. The generator shall be provided with necessary lifting hooks and two earth terminals for connection to main earth grid.

11.3 The generator winding shall be class "F" insulation with temperature limitation for class "B" the windings and overhangs shall be braced to withstand the short circuit forces. For machines rated 1000 KW and above shall have six no. RTDs suitably distributed in stators winding.

11.4 The stators windings shall be brought out to six insulated terminals in two separate terminal boxes. The alternator shall, therefore, be provided with three separate terminal boxes i.e. for the line and neutral stators connections and for control connections. The terminal box for the line terminals shall have sufficient space for the termination of cable size specified in data sheet. The neutral box shall in addition to space for neutral earthing cable have sufficient room for current transformers

used for protection of generator. Star connection shall be formed in the neutral side terminal box. The terminal box for control cables shall contain properly marked terminals for all internal equipment e.g. embedded temperature detectors etc. All terminals shall be stud type. The terminal boxes shall be complete with lugs and double compression cable glands. Current transformers shall be as specified in data sheet.

11.5 All parts and accessories shall be suitable to withstand stresses due to over speed / overload / short circuit conditions specified.

11.6 Bearings shall be double shielded and relubricated. Grease in the bearing enclosure shall provide additional lubrication to bearing as well as provide sealing against dust and moisture.

11.7 The generator shall be air cooled unless otherwise agreed generator enclosure shall be as specified in data sheet.

11.8 The direction of rotation of the rotor of the machine shall be compatible with that of the prime mover. A clear indication of the direction of rotation shall be given on either end of the machine.

11.9 Space heaters shall be installed within the enclosure, location and max. surface temperature of the heaters shall be such that no damage can be caused to any insulation. Heaters shall suitable for operation on a single phase 240V AC supply unless otherwise specified.

A suitable double pole switch shall be mounted on or adjacent to the stators frame or enclosure for the manual switching off of the heaters.

11.10 Field winding shall have class "F" insulation with excellent electrical and mechanical properties. The field winding shall be capable of operating at a field voltage of 125% of rated load field voltage for at least one minute starting from stabilized temperatures at rated conditions.

11.11 All cabling on the generator set skid shall be in GI cable trays/ conduits. All cables shall be identified close to their termination point. Double compression type cable glands shall be used for cable termination.

11.12 A rating plate of corrosion resistant material shall be fixed on the generator frame and shall give the following information:

a) Manufacturer's name.
b) Serial Number, Type and frame reference
c) Rated output in MVA & MW
d) Rated power factor, frequency and voltage
e) Rated stators current and speed in Rev. / Min.
f) Class of insulation
g) Phase rotation (CW or CCW)
h) Customer's indent no.
i) Year of manufacture
j) Weight rotor and stators in KG.

12.0 EXCITATION SYSTEM :

The generator shall be provided with brush less type solid state excitation system with automatic voltage regulator. The excitation system shall include the automatic voltage regulator, AC exciter and rotary rectifier. The field of the exciter shall be fed from the stators winding through a suitable transformer and AVR. AC Voltage generated in the AC exciter shall be rectified by the rotary rectifier assembly and fed to the main field circuits. The rotor windings of the AC exciter, the rectifier assemble, main field winding of the generator and other accessories on rotor part shall be rigidly fastened to the shaft and the connection with different items shall be anti-loosening type.

The exciter capacity shall be at least 20% more than the maximum requirement at any time. The exciter winding shall be insulated with class "F" insulation.

Automatic solid state voltage shall be provided with the following features as a minimum.

- Under frequency protection.
- short circuit protection.
- Manual voltage control switch with adjuster.
- Cross current compensation for parallel operation.
- Voltage build up circuitry.
- Stators current limited.
- Field current limited.

The Current and potential transformers required to feed the AVR from the generator terminal shall be adequately rated.

13.0 SYSTEM OPERATION

The emergency generator set shall normally be in an unattended area. The Control system shall operate in fail safe mode and shall include all controls and protection necessary for the safe operation of the package. The generator set shall function as per one of the following schemes:

- Auto main failure scheme (AMF).
- Manual start in service mode.
- Manual test mode.

14.0 GENERATOR CONTROL PANEL :

14.1 The Local generator control panel for the generator set shall comprise of the following unless otherwise specified in the attached data sheet.

(a) Automatic Voltage Regulator.

(b) Protection and metering equipment's.

(c) Indicating instruments.

(d) Local breaker for DG set (Siemens / Schneider)

(e) Control gear for generator set auxiliaries.

Any other accessory require to make the generator set operational as a package shall be included in scope of supply . If required the generator control panel shall be split into various functional sections viz. protection, metering and control, regulation etc.

The generator break shall also be part of the control panel unless otherwise specified. The breaker rating shall be as specified in the drawing. The protective relays in the Gen. Control panel shall act to trip this breaker on fault conditions unless otherwise specified. This breaker also serves the purpose of local isolation.

All motor starters for generator set auxiliaries shall be DOL type.

Unless otherwise specified , the DC control supply required for relays , controls, closing/tripping of generator breaker, annunciation circuit and for any other purpose shall be met by a DC system consisting of battery and battery charger of suitable capacity to be supplied by the generator set manufacturer . The battery shall be sized for two hours load cycle a maximum. Battery charger shall be of the constant voltage type with current limiting feature and facilities for automatic and manual, normal and quick charging of batteries . Charger shall be sized for boost charging of batteries with 10 to 14 hours.

14.2 The panel shall be free standing , metal enclosed, dust and vermin proof type with a hinged door and having a degree of protection IP 51 as per IS:51 as per IS:2147 unless otherwise specified . Power and control equipment shall be segregated inside the panel as far as practicable. The maximum light of the operation handle/switches shall not exceed 1000 mm. and the minimum height not below 300 mm. All hardware shall be corrosion resistant and bolts, nuts and washers shall be made of galvanized zinc passivated of cadmium plated high quality steel. Unless otherwise specified the panel shall be suitable for bottom cable entry. Necessary glands shall be provided with the panel.

All auxiliary devices for control, indication, measurement and alarm such as push buttons control/selector switches, indicating lamps, metering instruments, annunciation's etc. shall be mounted on the front door of the panel. Adequate number of potential free contacts shall be provided in the control panel for any remote control, monitoring of the generator set.

14.3 All switches shall be load - break, heavy duty type. All fuses shall be non-deteriorating HRC cartridge pressure filled, link type. The contractor shall be air-break type having AC-3 duty rating. Thermal overload relays shall be three element, positive acting, ambient temperature compensated type with adjustable setting range and built in protection feature against single phasing. All indicating instruments shall be moving iron, flush mounting type and of 96 mm x 96 mm square pattern. All control / selector switches shall be rotary back connected type having a cam-operated contact mechanism with knob type handle. "STOP" push buttons shall be stay put type.

14.4 Wiring for power, control and signaling circuits shall be done with PVC insulated copper conductors having 660 / 1100 V grade insulation. Minimum size of control wires shall be 2.5 mm "ELEMEX" type terminals shall be acceptable for wires up to 10mm^2 size and for conductors larger than 10 mm^2 bolted type terminals with crimping lugs shall be provided. A minimum of 10% spare terminals shall be provided on each terminal block.

14.5 An adequately sized earth bus shall be provided in the panel for connection to the main earth grid. All non current carrying metallic parts of the mounted equipment's shall be earthed. Doors and movable parts shall be earthed using flexible copper connections.

14.6 Engraved nameplates shall be provided for all devices mounted on the front of the panel. Nameplate or polyester adhesive stickers shall be provided for each equipment mounted inside the panel.

15.0 PAINTING, PACKING AND TRANSPORT:

15.1 All metal surfaces shall be thoroughly cleaned of scale, rust and grease etc. prior to painting. Cleaned surfaces shall be given two coats of primer and prepared for final painting. Final finish shall be free from all sorts of blemishes.

15.2 The equipment shall be shipped to site suitably packed to prevent any damage. Each package shall have labels to show purchaser's name, purchase order and equipment no. suitable lifting lugs etc. shall be provided and lifting points shall be clearly marked on the package. Packing shall be suitable for storage at site for a minimum period of 6 months.

16.0 TESTS AND INSPECTION :

16.1 The owner or his authorized representative may visit the works during manufacture of equipment to assess the progress of work as well as to ascertain that only quality raw materials are used for the same. He shall be given all assistance to carry out the inspection.

16.2 Detailed test procedure along with the facilities available at vendors works shall be furnished along with the bid Owner's representative shall be given minimum four weeks advance notice for witnessing the final testing. Test certificates including test records and performances curves etc. shall be furnished by the vendor.

16.3 Tests

Equipment shall be tested to conform to the appropriate standards and the following tests shall be conducted in the presence of purchaser's:

16.3.1 Functional tests, continuity tests and high voltage test on control panel to establish the performance called for in the specification.

16.3.2 Power frequency voltage test on switch gear and mechanical / electrical operational check.

16.3.3 Routine tests for alternator as per IS : 4722.

16.3.4 Over speed test (1.2 times the rated speed for 2 minutes)

16.3.5 Transient response tests for sudden application and rejection of loads of 25%, 50%, 75% and 100% of rated capacity.
16.3.6 Wave form test (type test results are acceptable)
16.3.7 Phase sequence test.
16.3.8 Vibration test
16.3.9 Noise level test.
16.3.10 Dimensional and alignment test.
16.3.11 String test.

17. SPECIFICATIONS FOR UNDER GROUND DIESEL TANK WORKS

1 HSD STORAGE TANK :

Scope :
The contractor shall design, supply, install test and commission the HSD tank, fittings and accessories as per requirements of the following BIS codes :

IS 10987 / IS 823 / IS 1239
Rules and regulation of the chief inspector / Controller of Explosives India.
Petroleum rules 1936
All site welding shall be carried out by fusion welding as per IS 823. for all butt welds, the roof run and final run shall be carried out.

TANK

The U.G. tank shall conform to IS 10987-1992 with respect to lining, corrosion, storage under ambient temperature, atmospheric conditions, stresses, design fabrication and installation.

The compliance of the above standards does not absolve the manufacturer from compliance of statutory norms and provisions by Dept of explosives, CCOE and / or concerned statutory inspection agencies.

The Welding process shall conform to IS 813-1986. All welding shall be double butt welds. When the shell length is produced from more than one single plate, the longitudinal seams shall break point at intermediate circumferential seams. In case of longitudinal seams, such seams shall be situated at the upper third or top center line. All end plates shall be stiffened.

The plates used shall conform to IS 1730-1989. The thickness of plates used shall have a corrosion allowance of 1.5 mm.

The pipe and pipe couplings shall conform to IS 1978-1982

Bolts and nuts shall conform to IS 1367 (Part III) and IS 1367 (Part VI) 1980.

The tank shall be designed for a pressure of 0.05mPA when full of water. The tank design shall be capable of withstanding the earth pressure of 1.40mPA when tank is empty.

UG tanks shall have hinged and bolted manhole of minimum 500 mm diameter, fabricated in water proof manner.

The UG tank shall be provided with lifting hooks.

For filling of tanks from top, necessary fill connection pipe with 45 degrees champers shall be provided. The fill up shall terminate at 100 mm above bottom of tank.

Provisions for sensing low level of fuel and transmitting the same to building automation system shall be envisaged.

The tank shall have calibrated dip rod of non sparking brass material of size 12 mm square.

The tank shall be fitted with vent pipe of not less than 4 M height, bending downwards and the tip covered with two layers of non corrodible metal wire mesh of 11 meshes.

Two nos earthing bolts of minimum 12 mm size shall be provided on the end plate of either side of tank at about 200 to 300 mm below top level to facilitate 50 x 6 GI earth strip terminations.

The external surfaces of the tank shall be thoroughly cleaned free of rust scale, grease etc and painted with one coat of approved primer paint.

The entire interior surface shall be cleaned of rust, scales, grease etc and shall be primed twice with fuel prior to dispatch.

The tolerance in diameter of the tank shall be within plus or minus 0.35% of specified diameter.

Tank shall be subjected to Hydraulic test at a pressure of 0.05mPA and thoroughly checked for leakages.

The HSD tank shall be MS construction, horizontal cylindrical in shape with dished ends.

The tank shall be all welded construction and shall be suitable for storage of HSD up to maximum temperature of 40 deg. C at atmospheric pressure. Shell thickness of tank shall be 6 mm and thickness of dished ends 8 mm.

Tanks shall be painted externally and internally to prevent corrosion. The internal surface of the storage tanks shall be thoroughly cleaned with wires brush / emery paper to remove rust, scale etc and treated with coat of suitable oil resistant paint. The external surface of the tank shall be thoroughly cleaned with wire brush / emery paper to remove rust, scale etc. and painted with one coat of zinc chromate primer followed by two coats of finishing paint (Bitumen based).

All the oil supply pip shall be MS heavy class as per IS 1239 Part 1. All fittings shall be of heavy duty. Flanges shall be conforming to ASA class 150 weld necks and material to IS 226.

All valves shall be ball type and of body bonnet, gland nut of bronze material with brass or SS ball only.

The strainers shall be of cast iron body with FM or bronze mesh for fine filtration of the oil.

The HSD supply pipes from HSD yard to respective day oil storage tank shall be laid underground. These pipes shall be provided with corrosion proof and weather proof treatment.

CLEANILINESS

The area around the vessels shall be kept free from readily ignitable materials, such as weeds and long dry grass by providing stone pitching.

EARTHING

HSD tank and pipe lines shall be provided with copper earthing and earthed in efficient manner.

NO SMOKING

A permanent notice with letters minimum 5 cms high prohibiting smoking and naked lights shall be fixed to the fence surrounding the area.

FIRE PROTECTION

The area where tanks, pumping equipment, loading and unloading facilities are provided; shall be well protected from fire by providing fire hydrants and fire extinguishers. (Shall be part of FFTG tender)

INSPECTIONS, APPROVALS AND LICENCE

The contractor shall arrange the inspection, approval and license for the proposed HSD oil installation by the Chief Inspector / Controller of Explosives as given below:

Pre – Installation Approval

The contractor shall upon the award of the work shall prepare working drawings for the HSD installation and submit the drawings to the consultants for their provisional approval. The drawings so approved by the consultants shall be submitted to the Chief inspector / Controller of Explosives for his scrutiny and approval.

Procedures if required to be followed from local CFO office shall be followed.

Test & Safety Certificates.

It shall be the responsibility of the contractor to arrange test and safety certificates under rules 126 after the installation is commissioned.

Inspection / Storage License

It shall be the responsibility of the Contractor to arrange for inspection of the installation by the Chief inspector / Controller of Explosives and carry out any modifications / additions if required by the chief inspector / controller of explosives and obtain storage license and submit the same to owners.

FUEL OIL PIPING

Scope

The scope of this section comprises the supply and laying of pipes, pipe fittings and valves. Testing and balancing of all HSD piping required for the complete installation as shown on the drawings. All piping inclusive of fittings and valves shall follow the applicable BIS codes.

1. Pipes shall be MS class "B" and fittings shall be welded type fittings conforming to relevant BIS codes. All jointing in the pipe system shall generally be by welding flanges, unless otherwise mentioned or directed at site. All welding shall be done by qualified welders and shall strictly conform to BIS code of procedure for manual metal arc welding of mild steel.
2. All pipes and their steel supports shall be thoroughly cleaned and given on primary coat of red oxide paint before being installed. All welded piping shall be subject to the approval at site.
3. Threaded joint fittings shall be malleable casting of pressure rating suitable for the piping system. Fittings used on welded piping shall be of the wieldable type.
4. Tee-off connections shall be through equal or reducing tees otherwise ferrules welded to the main pipe shall be used. Drilling and tapping of the walls of the main pipes shall not be resorted to.

MOTORS AND PUMPS

SCOPE

This specification covers the design, manufactures and testing of three phase medium voltage squirrel cage induction motors.

STANDARDS

Unless they are at variance with the clauses of this specification, the squirrel cage induction motors and their components shall comply with the latest applicable Indian standards listed below. Where Indian standards do not exist, the relevant IEC, British or German (VDE) standards shall apply.

2.1	IS – 325	Three phase induction motors.
2.2	IS – 1076	Preferred numbers.
2.3	IS – 1231	Dimensions of three phase, foot mounted induction motors.
2.4	IS – 1271	Insulating materials for electric machinery and apparatus in relation to their therminal stability in service, classification of.

2.5	IS – 2148	Flame proof enclosures of electrical apparatus.
2.6	IS – 2223	Dimensions of flange mounted AC Induction motors.
2.7	IS – 2253	Types of construction and mounting of motors.
2.8	IS – 2254	Dimensions of vertical shaft motors for pumps.
2.9	IS – 2968	Slide rails for electric motors, dimensions of.
2.10	IS – 4029	Guide for testing three phase induction motors.
2.11	IS – 4691	Degrees of protection provided by enclosures for routing electrical machinery.
2.12	IS – 4722	Specification for rotating electrical machines.
2.13	IS – 4728	Terminal marking for rotating electrical machinery.
2.14	IS – 4889	Methods if determination of efficiency of rotating electrical machines.
2.15	IS – 6362	Methods of cooling for rotating electrical machines.
2.16	IS – 6381	Constructions and testing of electric apparatus with type of protection ‘e’.
2.17	IS – 7389	Pressurized enclosure of electrical equipment for use in hazardous area.
2.18	IS – 7816	Guide for testing insulation resistance of rotating machines.
2.19	IS – 8223	Dimensions and output ratings for foot mounted rotating electrical machines with frame numbers 355 to 1000.
2.20	IS – 8289	Specification for electrical equipment with type of protection ‘n’.
2.21	IS – 8789	Values of performance characteristics for three phase induction motors,
2.22	IS – 9283	Motors for submersible pump sets.
2.23	IS – 9628	Specification for three phase induction motors with type of protection ‘n’.
2.24	IS – 12075	Mechanical vibration of rotating Electrical Machines.
2.25	IS – 12065	Permissible limits of noise level for rotating electrical machines.
2.26	IS – 12802	Temperature rise measurement of rotating electrical machines.

2.27 IS – 13529 Guide on effects of unbalanced voltages on the performance of three phase cage induction motors.

2.28 IS – 13555 Guide for selection and application of three induction motors for different types driven equipment.

3. OPERATING CONDITIONS

3.1 Ambient Conditions

Motors shall be suitable for operating satisfactorily in humid and corrosive atmosphere found in Refineries, Petrochemical complex, fertilizer and metallurgical plants. Service conditions shall be as specified in the data sheets. If not specifically mentioned therein, a maximum ambient temperature of 40^{o} C and an altitude not exceeding 1000 meters above mean sea level, shall be taken into consideration.

3.2 Frequency and Voltage Variations

Unless otherwise agreed motors shall be designed for continuous, satisfactory operation at rated output under the following conditions:

a) The terminal voltage differing from its rated value by not more than +/- 6 %, or
b) The frequency differing from its rated value by not more the +/- 3 % or
c) Any combination of (a) and (b).

3.3 Starting

Unless otherwise specified motors shall be designed for direct –on-line starting. Motors shall be designed for re-acceleration under full load after a momentary loss of voltage with the residual voltage being 100% out of phase.

Minimum locked rotor thermal withstand time at rated voltage shall be 10 seconds under cold conditions and 8 seconds under hot conditions. The starting time of the motor shall be less than the hot thermal withstand time (time t_E in case of increased safety motors) to permit application of conventional bimetal relays or thermal release against locked rotor and overload conditions.

Unless otherwise specified, all motors shall be suitable for starting under specified load conditions with 75 percent of the rated voltage at the terminals.

Motors shall be designed to allow the minimum number of consecutive starts indicated below :

TABLE – I

Starts	**Min no. of consecutive starts**
No of consecutive start-ups with initial temp. of the motor at ambient level (cold)	: 3
NO of consecutive start-ups with initial temp. of the motor at full load operating level (hot).	: 2

3.4 Direction of Rotation

Motors shall be suitable for their direction of location. In case unidirectional fan is provided for motors, direction of rotation for which the motor is designed shall be permanently indicated by means of an arrow. A painted arrow shall not be acceptable. directional arrow should be manufactured from corrosion resistant material. When a motor is provided with bi-directional fans, a double headed arrow should be provided.

4. PERFORMANCE

4.1 Motors shall be rated for continuous duty (SI) unless otherwise specified.

4.2 The starting current (as % rated current) shall not 600% for motors upto and including 75 KW and 550% for motors above 75 KW subject to tolerance.

4.3 Starting torque and minimum torque of the motor shall be compatible with speed torque curve of the driven equipment under specified operating conditions. For heavy duty drives such as blowers, crushers etc. high starting torque motors shall be provided. In case where characteristics of driven equipment are not available while selecting the motor, minimum starting torque shall be 110% of rated value for motors up to 75KW and shall be 90% of rated value for motors above 75 KW.

4.4 The pull out torque at the rated voltage shall be not less than 175 percent of the rated load torque with no negative tolerance. Unless otherwise agreed, the pull out torque shall not exceed 300 percent of the rated load torque.

In case of motors driving equipment with pulsating loads (e.g. reciprocating compressors) the minimum value of pull out torque at 75 percent of the rated voltage shall be more than the peak value of pulsating torque and the current pulsation shall be limited to 40%.

4.5 The minimum value for product of efficiency and power factors for motors rated upto and including 37 KW shall be as per IS – 8789.

The minimum value for product of efficiency and power factors of 2 pol, 4-pole, and 6-pole motors rated above 37 KW shall be as given below.

Rated Output	**Product of efficiency and power factor at rated load (minimum)**		
	2-POLE	**4-POLE**	**6-POLE**
45 KW	0.82	0.80	0.79
55 KW	0.82	0.80	0.79
75 KW	0.82	0.80	0.80
90 KW	0.82	0.80	0.80
110 KW	0.86	0.80	0.80
125 KW	0.86	0.80	0.80
160 KW	0.86	0.81	0.80
180 KW	0.86	0.83	0.80
200 KW	0.86	0.83	0.80

Efficiency and power-factor figures for motors having synchronous speeds of 750 r.p.m. and below shall be as agreed between the purchaser and manufactured.

5. GENERAL REQUIRMENTS AND CONSTRUCTIONAL DETAILS

5.1 Windings

a)Insulations and bracing

Unless otherwise specified in the data sheet motors shall be provided with class 'B' insulation as a minimum. In case of motors with class 'F' insulation the permissible temperature rise as measured by resistance method above the specified ambient temperature shall be limited to those specified in the applicable Indian standards for class 'B' insulation.

The winding shall be tropicalized. The windings shall preferably be vacuum impregnated. Alternately the windings shall be suitably varnished, baked and treated with epoxy gel for operating satisfactorily in humid and corrosive atmospheres.

Windings shall be adequately braced to prevent any relative movement during operation and in this respect, particular care shall be taken for the stator windings of direct-on-line starting squirrel cage motors. Insulation shall be provided between coils of different phases which lie together. Core laminations must be capable of withstanding burnout for rewind at 400^{o}C without damage or loosening.

In case of motors driving equipment with pulsating loads, special attention shall be paid to the joints of rotor bars and end rings to avoid premature failure due to induced fatigue stresses.

b) **Phase Connections**

The windings shall be connected in delta. However, for motors rated 2.2 KW and below, star connection may be accepted.

If star- delta starting is required, this will be specified in the data sheet and the motor windings shall be fully insulated for delta connection.

c) **Winding Terminations**

The ends of the windings shall be brought out into a terminal box. They shall be terminated by means of terminals mounted on an insulating base made of no-hygroscopic and non-flammable material.

All motors shall be with six terminals and suitable links to connect them in star or in delta except for motors rated up to and including 202 KW which may be accepted with three terminals.

All terminals shall be adequately designed. Line terminals shall be thoroughly insulated from the frame with material resistant to tracking.

Anti-loosening, anti-vibration type of terminals shall be provided in case of increased safety (Type 'e') and non-sparking (Type 'n') type of motors.

d) **Terminal Box and Cable Entries**

Unless otherwise specified, the terminal box shall be located on the right hand side as viewed from the driving (coupling) end. It shall be rotatable in steps of 90^{o} to allow cable entry from any direction.

The terminal box shall be of sturdy construction and large enough to facilities easy connection of the cables. Terminal box cover shall be provided with handles to facilitate easy removal.

An adequately sized earth terminal shall be provided in the motor terminal box for termination of the forth core of specified cables.

The terminal box shall be provided with cables lugs and entries for suitable cables glands corresponding to the number and size of specified cable. Nickel glands shall be supplied along with the motor for mentioned cable sizes.

Equipment and accessories provided shall confirm to the hazardous area classification and the environmental conditions wherever required as specified in the motor data sheet.

Unless otherwise specified the terminals, cable lugs, terminal box, cable entries and cable glands shall be suitable for the cable sizes as specified below for 2 pole, 4 pole or 6 pole motors :

Motor rating upto and including	**Sizes of phase conductor (mm^2)**
2.2 KW and below	4 Al./2.5 cu
3.7 KW	6 Al./4.0 cu
5.5 KW	10 Al./6.0 cu
7.5 KW	10 Al./6.0 cu
9.3 KW	16 Al./10.0 cu
11.0 KW	16 Al./10.0 cu

NOTE : Cable sizes motors having synchronous speeds 750 rpm and below shall be as agreed between the purchase and manufacturer.

Cable Type

Cables used are of 650/1100 V grade aluminium conductor, XLPE insulated, PVC extruded inner sheath, armoured with overall PVC sheath for conductor cross- sections of 35 mm^2 & above. However for cables upto & including 16 mm^2 cross-section cables used may be with copper or aluminium conductor as indicated in the data sheet.

The terminal box shall be capable of withstanding internal short circuit conditions without danger to personnel or plane from the emission if hot gases or flame or due to excessive disfortion or damage o the terminal enclosure.

e) **Phase Marking**
appropriate phase markings as per IS : 4728 shall be provided inside the terminal box. The marking shall be non-removable and indelible.

5.2 Motor Casting and Type of Enclosure

Motors for use in safe areas shall be normal industrical degree of motor enclosures including terminal boxes and bearing housing shall be IP 55 as per IS : 4691.

Motors for use in hazardous areas (Zone 1 or Zone 2) shall have type of protection Ex(d) Or Ex(e) or Ex (n) as specified in the data sheet and shall meet the requirements of applicable Indian standards. Ex(d) type of motors shall have a BIS marking on the name plate.

Motors for outdoor use shall be suitable for installation and satisfactory operation without any protective shelter or canopy. Motor casing shall be provided with a suitable drain for removal of condensed moisture except in case of flameproof motors.

Vertical motors with downward shaft shall be provided with fully covering rain canopies. Vertical motors with upward shaft e.g. on fin-fan coolers, shall be adequately protected, (such as cowls/canopies) against ingress of water into the enclosure or the bearing housing even when standing still for long periods of time. Motors designed to handle external thrust from the pump shall be supplied with a thrust bearing at the non-driving end.

All internal and external metallic parts which may come into contact with cooling air, shall be of corrosion resistant material or appropriately treated to resist the corrosive agents which may be present in the atmosphere. Screws and bolts shall be hot dip galvanized or zing passivated to protect against corrosion.

Unless otherwise agreed, motors shall have standard frame size for various output ratings as stipulated in IS : 1231.

5.3 Bearing and Lubrication

Motors shall have grease lubricated ball or roller bearings. In all cases, the bearings shall be chosen to provide a minimum L-10 rating life of 5 years, (40 000 hours) at rated operating conditions. (The L-10 rating life is the number of hours at constant speed that 90% of a group of identical bearings will complete or exceed before the first evidence of failure). Unless otherwise specified the bearing shall be adequate to absorb axial thrust produced by the motor itself or due to shaft expansion. Vertical motors shall be provided with thrust hot liquids where the driven machine operates at high temperatures, bearings shall be cooled by a shaft mounted fan. This shall ensure efficient ventilation of the bearing and disperse the heat transmitted from the driven object by conduction or convention. For motors operating in hazardous areas fans shall be of an anti-static non-sparking material.

Bearing shall be capable of grease injection from outside without removal of covers with motors in the running conditions. The bearing boxes shall be provided with necessary features to prevent loss of grease or entry of dust or moisture e.g. labyrinth seal. Where grease nipples are provided, these shall be associated, where necessary, with appropriately located relief devices which ensure passage of grease through the bearing. Pre-lubricated sealed bearings may be considered provided a full guarantee is given for 4 to 5 years of trouble-free service without the necessity of re-lubrication.

5.4 Cooling System

All motors shall be self ventilated, fan cooled. Fans shall be corrosion resistant or appropriately protected. They shall be suitable for motors rotation in either direction without affecting the performance of the motor. If this is not possible for large outputs, it shall be possible to reverse the fan without affecting the balancing of the motor.

5.5 Rotor

The rotor shall be of squirrel cage type, dynamically balanced to provide a low vibration level and long service life for the bearings. The accepted values of peak to peak vibration amplitudes for a motor at rated voltage and speed on a machined surface bedplate with the motor leveled and with a half-key or coupling fitted shall not exceed those given in IS-12075. Die cast aluminium rotors for motors in hazardous areas may be accepted provided the same are type tested and approved by competent authorities.

5.6 Shaft Extension

Motors shall be provided with a single shaft extension with key-way and full key. Motor shaft shall be sized to withstand 10 times the rated design torque.

5.7 Lifting Hook

All motors except for fractional horse power motors shall be provided with lifting hooks of adequate capacity

5.8 Earth Terminals

Two earth terminals located preferably on diametrically opposite points shall be provided for each motors. Unless otherwise specified, the size of each earth stud shall be as given below :

Motor Rating	**Stud size**
Upto and including 3.7KW	6 mm
5.5KW to 30 KW	10 mm
Above 37KW	12 mm

Necessary nuts and spring washers shall be provided for earth connection.
An additional earth terminals shall be provided inside the terminal box as stated in 5.1

6 MISCELLANEOUS ACCESSORIES

6.1 Anti-Condensation Heaters

All motors rated above 30KW shall be provided with 240 V anti-condensation heaters, sized and located so as to prevent condensation of moisture during shut-down periods. Motors rated 30 KW and below shall be provided with anti-condensation heaters if specified in the requisition. Motors meant for humid location such as cooling tower fans, sump pump motors etc. shall be provided with space heaters irrespective of the motor rating in the motor data sheet. The

heaters shall permanently remain 'ON' when the motor is not in service and as such shall not cause damage to the windings.

The heater leads shall be brought out to separate terminal box of the same specification and grade of protection as the main power terminal box excepting that the cable glands provided shall be suitable for two core 4 sq. mm aluminum conductor, armored cable or 3 x 2.5 sq. mm. copper conductor armored cable.

A warning label with indelible red inscription shall be provided on the motor to indicate that the power line and the heater supply shall be isolated before carrying out any work on the motor.

6.2 Name Plates

A stainless steel name plate manufactured from series 300 stainless steel and as required under specification IS-325 shall be provided on each motor. In addition to the motor rating plate a separate motor plant equipment number plate shall be fixed in a readily visible position. This number shall be indicated in the data sheets attached with purchase requisition.

Additional information as stipulated in applicable Indian standards shall be included in the name plate for motors meant for use in hazardous atmospheres as per IS:13408

7. NOISE LEVEL

The permissible noise level shall not exceed the stipulations laid down in IS – 12065.

8. MOTOR VIBRATIONS

Motor vibrations shall be within the limits of IS – 12075 unless otherwise specified for the driven equipment.

9. CRITICAL SPEEDS

The first actual critical speed of stiff rotors shall not be lower than 125% of the synchronous speed. For flexible rotors this shall be between 60% and 80% of the synchronous speed; the second actual critical speed shall be above 125% of the synchronous speed.

10. PAINTING

Internal and external parts of the casing and all metal parts likely to come in contact with the surrounding air shall be protected with anti-acid paint that will resist the particular ambient condition.

All external surfaces shall be given a coat of epoxy based paint.

11. INSPECTION AND TESTING

The vendor shall allow purchaser or his authorized representative to visit the works during manufacture of motors to assess the progress of work as well as to ascertain that only quality raw material is used for the same. He shall be given all assistance to carry out the inspection.

The vendor shall give at least 4 weeks advance notice to the purchaser, regarding the date of testing to enable him or his representative to witness the tests.

The motors shall be tested in accordance with IS : 325 and IS : 4029. Type test including any specific test to ascertain compliance with these specification shall be carried out on one sample from each KW rating and frame size. Routine tests shall be carried out on all motors. In addition measurement of vibration and noise level (if desired) shall form a part of route tests.

Test on completely assembled motor shall be carried out in the presence of purchaser or his representative. The result shall be tabulated and signed by both vendor and purchaser or their representatives. Though the motors shall be accepted on the basis of the satisfactory result of the test at the works, it shall not absolve the vendor from liability regarding the proper functioning of the motor coupled to the driven equipment at site.

12. DRAWING AND DATA

12.1 Following minimum information shall be furnished along with Bid:

a) KW rating, make, frame size, full load speed, mounting, enclosure type and specific type of construction {Ex(d), Ex(n) etc.}.
b) For heavy duty drives starting torque, starting time and lock rotor withstand time of the motor shall also be furnished.

12.2 After placement of order, vendor shall furnish all necessary data / drawings / documents including but not limited to the following:

a) Completed motor data sheet.
b) GA, Dimension and mounting details.
c) Details of terminal box and auxiliaries.
d) Performance characteristics viz. speed v/s current and speed v/s torque.
e) Thermal withstand curves under hot and cold conditions.

Subsequent to completion of satisfactory inspection and testing, duly signed test certificates, installation, operation and maintenance manual shall be furnished by the vendor to complete the contractual obligations.

18.0 TECHNICAL DATA FOR EQUIPMENTS :

A. PRIME MOVER FOR D.G. SET

1.	Prime mover	Diesel Engine
2.	Qty, required	One No. for each alternator.
3.	Service	Prime mover for generating set.
4.	Horse power	
5.	RPM	1500 RPM
6.	Type	Radiator cooled set.
7.	Flywheel	Require
8.	Vibration damper	Require
9.	Fuel pump air cleaner	Require
10.	Fuel pump	Require
11.	Radiator	Require
12.	Oil filter, fuel filter etc.	Require
13.	Lub oil pump	Require
14.	110 V DC V electrical system	Require
15.	Safety controls	Require
16.	Silencer	Require
17.	Coupling	Require
18.	Instrument panel consist of :	
a)	Starter switch	Require
b)	Lub. oil temp. gauge	Require
c)	Water temp. gauge	Require
d)	Oil pressure gauge	Require
e)	Meter	Require
f)	Tachometer	Require
19	Fuel tank	Require
20	Battery charger	Require

21.	Engine testing	Require
a)	At shop	
b)	At site	
22.	Tool kits	Require
23.	Literature	Require
a)	Operation & maintenance manual	
b)	Parts catalogue/list	

Note :

1. The engine HP. should be selected so as to achieve required KW rating to be generated considering derating of engine due to altitude, temp. Humidity etc.

2. The engine test shall be witnessed by the client's representative.

ALTERNATOR

DATA SHEET - B

1.	Make	:	
2.	Rating	:	1010KVA
3.	Power factor	:	0.8
4.	Rated voltage	:	415 V
5.	Voltage regulation	:	As required
6.	Rated current		:
7.	Speed	:	1500 RPM.
8.	Frequency	:	50 Hz.
9.	Field current at rated output and power factor	:	to be specified by tenderer
10.	Field voltage at rated output and power factor	:	to be specified by tenderer
11.	Method of excitation and Regulation	:	Self
12.	Class of insulation	:	A) Starter - F with temp.rise of Cl.B B) Rotor - F --- do ------
13.	Degree of protection	:	Screen protected, drip proof.
14.	Base plate	:	The Engine & alternator shall be mounted and alignedon a common base plate fabricated from steel.
15.	Control Panel AMF	:	Consist of

1. ACB / MCCB with O/L, E/F and shunt trip releases
2. On/off indicator.
3. Auxiliary switch.
4. Ammeter & Voltmeter with assessors
5. KWH meters with CTs.
6. Over voltage relay
7. Under Voltage relay
8. Reverse & Forward Power relay.
9. Over & Under frequency Relay
10. KVA meter
11. Frequency meter.
12. Annunciation windows.

13. LED Lamp indicator.
14. Auto load sharing and synchronizing relay for 3 sets

16. Change over switch — Auto synchronizing with load sharing.

4.0 LT PANELS WITH ATS

1.0 Scope:

This specification covers performance, design, material, construction, manufacture, inspection, testing, packing forwarding, delivery at site, testing and commissioning of Low voltage panels with all accessories complete in all respects as described in this specification and single line diagrams.

Whether called for specifically or not, all accessories required for normal operation of equipment are deemed to be considered as a part of the contractor's scope of supply. Hardware / fabricated supports required for mounting and installation of the panels is within the scope of work.

It is not the intent to specify completely herein, all details of design and construction of the equipment. However, the equipment shall conform in all respects to high standard of Engineering, design and workmanship and be capable of performing in continuous commercial operation up to the Manufacturer's guarantees in a manner acceptable to the Engineer, who will interpret the meaning of the drawings and specifications and shall be entitled to reject any work or material which is not full accordance therewith.

2.0 Design standards :

All the Panel's shall be metal clad, totally enclosed, rigid, floor mounted, air - insulated, cubical type suitable for operation on three phase / single phase, 415 / 230 volts, 50 Hz.

The panels shall be designed for minimum expected ambient temperature of 45 degree Celsius, 80 percent humidity and dusty weather.

Should conform to Indian Electricity Act and rules (till last amendment) & approved as per FIA norms.

Applicable IS Standards

Meters (measuring) for analog meters	IS:1248-1958
Installation and maintenance of switch gears	IS:3072-1975
H.d. Air breaker, switch gears and fuses for voltage not exceeding 1000 volts	IS:4047-1977
Selection, installation and maintenance of fuses up to 650 volts	IS:8106-1966
General requirements for switch gear and gear for voltage not exceeding 1000 volts	IS:4237-1967
Degree of protection provided by enclosures For lv s/gears	IS:2147-1962
Insulated conductor rating	IS:8084-1972
Enclosed distribution fuse boards and cut-outs For voltage not exceeding 1000 volts	IS:2675-1983
Fuse wire used in re-wearable type electric fuses Up to 650 volts	IS:9926-1981
Conductor for insulated electric cables and Flexible cords	IS:8130

Shunt capacitors for power systems	IS:2834-1954
Hrc cartridge fuses and links up to 660 volts	IS:2208
Hrc fuses having rupturing capacity of 50 ka	IS:9224
Ac electricity meters: part – 1 general requirements And tests	IS:772 PART 1
Direct acting electrical indicating instruments	IS:1248
Current transformers	IS:2705
Electrical relays for power systems protection	IS:3231
Phosphate treatment of iron and steel for protection Against corr0sion	IS:3618
Guide for marking of insulated conductor	IS:5578
Code of practice of phosphating of iron and steel	IS:6005
Factory built assemblies of switchgear and control-Gear for voltages upto and including 1000v ac and 1200v dc.	IS:8623
Guide for uniform system marking and identification Of conductors and apparatus terminals	IS:11353
Low voltage fuses	IS:13703
Lv switchgear and control gear (part 1 to part 5)	IS:13947
Structure construction (IP-54)	IS:2147
Miniature circuit breaker (MCB)	BS:3871 PART-1 1965 IS:8825 (1996)
Fuse	IS:2000-1962
Air circuit breaker	IS:2516 PART 1,2,3
Contactors	IS:2959 & BS:775
Digital meter	IS:13779
Electrical power & control wiring connection Wiring inside themodule for power, control Protection	IS:694 & IS:8130
Danger notice plate	IS:2551-1982 & IS:5-1978
MCCB	IEC 60439-2 / IS:8623-2
SFU	IS:13947 (PART-3) & IEC 60947-3
ELCB	BS 3871 & 4293, IS.,CEE 27

2.1 Construction :

Switchboard connection

All connection and tap offs shall be through adequately sized connectors appropriate for fault level at location. This shall include tap off to feeders and instrument/control transformers.

For unit ratings upto & including 63 amps, PVC insulated copper conductor wires of adequate size to carry full load current shall be used. The terminations of such

interconnections shall be crimped. Solid connections (busbars) shall be used for all rating above 63A.

All connections, tapings, clamping, shall be made in an approved manner to ensure minimum contact resistance. All connections shall be firmly bolted and clamp with even tension. Before assembly joint surfaces shall be filed or finished to remove burrs, dents and oxides and silvered to maintain good continuity at all joints. All screws, bolts, washers shall be zinc plated. Only 8.8 grade nuts and bolts shall be used for busbar connections.

All nut bolts for busbar shall be high tensile cadmium plated with 2 plain washer and 1 spring washer. Hardware should be provided at cable termination end.

Switchboard Construction and operation

The low-voltage electrical switchboards shall be made up of identified functional volumes including the busbar compartment, switchgear and control gear component compartment, connection compartment and auxiliaries compartment.

The different busbars shall be the main busbars, distribution busbars and auxiliary busbars.

The busbars shall be made of electrolytic Al. with current density of 0.8A/Sqmm.

The compartments shall be located inside a metal enclosure with walls providing protection against direct contact with live parts and guaranteeing a degree of protection IP 2X. The frame, the external panels (doors, side and rear panels, tops) and internal elements (ducts) shall be made of 2 mm thick steel sheet metal and protected by an epoxy-paint coating.

The max height of panel shall be 2375mm including the base channel of 75 x 40 mm ISMC coloured black.

All the panels shall be as per form 3B construction.

Sheet metal elements in the immediate proximity of high current flow generating potential eddy current shall be made of aluminium.

Drawers or air circuit breakers shall have four different positions: connected, test, disconnected and removed. With drawability of upstream and downstream power circuits and of auxiliary circuits shall be total, i.e. in compliance with standard IS – 8326.

The switchboard cover panels shall be removable.

The construction system shall provide a complete set of elements for installing fixed or with drawable switching and protective devices, measurement devices and control / monitoring devices in the switchboard.

The drawers shall be designed such that the rated degree of protection (IP, as per IS 2147: 1962) is maintained whatever their position (connected, test, disconnected, removed).

Switchboard Compartmentalization

For compartmentalized switchboards, separate totally enclosed compartments shall be provided for horizontal busbars, vertical busbars, ACBs, MCCBs, and cable alleys.

Sheet steel hinged lockable doors for each separate compartment shall be provided and duly interlocked with the breaker in "ON" and "OFF" position.

For all Circuit Breakers separate and adequate compartments shall be provided for accommodating instruments, indicating lamps, control contactors and control MCB etc. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker, busbars and connections. Panel should be single front operated and cable Entry should be at TOP. Busbar and cable allay access should be from front only.

LDB/PDB should be with double door arrangement. Acrylic cover to be considered on front hinged door. Inside cover should be fixed plate type with MCB cutout features.

Each switchgear cubicles shall be fitted with label in front and back identifying the circuit, switchgear type, rating and duty. All operating device shall be located in front of switchgear only.

A horizontal wire way with screwed cover shall be provided at the top to take interconnecting control wiring between vertical sections.

Separate cable compartments running the height of the switchboard in the case of front access boards shall be provided for incoming and outgoing cables. Outgoing all control and power terminals should be KUT type.
Cable compartments shall be of adequate size for easy termination of all incoming and outgoing cables entering from bottom or top. The construction shall include necessary and adequate and proper support shall be provided in cable compartments to support and clamping the cable in the cable alley / cable chamber.

Min size shall be as follows;

a. Basbar Chamber should be min. 300mm.
b. Cable Alley should be min. 300mm wide for termination of one side section(6 Starters). For LDB/PDB, cable alley should be min 400 mm
c. Feeder operating height should be max. 1950mm
d. Feeder width should be min 450mm and higher as per rating
e. Horizontal dummy chamber at top min 150mm
f. Feeder height min. – SFU / MCCB, S/D, DOL-300mm and higher as per rating
g. Minimum Depth -450mm
h. Only one compartment feeder for PLC/BMS IOs (Marshelling box). Section to section wiring connected with plug in type accessories. (If asked)
i. Control busbar to be required for control bus.
j. Lighting (Holder & CFL) + Heater with thermostat to be considered in cable alley with separate control MCB in each alley.

Min fabrication standards shall be as follows;

a. Load bearing members – Frame-2.0mm

b. Partitions (if separate) – 1.6 mm
c. Doors/Covers-2.0mm
d. Electrical accessories mounting plate-2.0mm
e. Gland Plate-3.0mm
f. Lock should be metallic as discussed.

Lifting hook shall be provided for each shipping section.

Vendor shall provide dimensions of MCC. Final GA layout will be approved by TPL.

2.2 Bus Bars

Bus bars shall be made of high conductivity, high strength Al. of ETP grade. Bus bars shall be of rectangular cross sections suitable for full load current for phase bus bars and full rated current for neutral bus bar. Bus bar shall be suitable to withstand the stresses of fault level as specified in SLD. The certification for conductivity of the Al. shall be made available from third party certifying agency if required by engineer.

The bus bars shall be supported on non-breakable, non-hygroscopic epoxy resin or glass fibre reinforced polymer insulated supports able to withstand operating temperature of 110°C at regular intervals, to withstand the forces arising from a fault level as stipulated in schedule of quantities. The material and the spacing of the bus bar supports should be same as per the type tested assembly.

The minimum clearances to be maintained for enclosed indoor air insulated bus bars for medium voltage applications shall be as per IS guidelines. The bus bar shall be as per current density of 0.8 A/Sq.mm Cross Section area.

The bus bar shall be housed in separate compartment and shall be isolated with 3 mm thick FRC sheet to avoid any accidental contact. The bus bar shall be arranged such that min. clearances between the bus bars are as mentioned below:

Between phases – 27 mm minimum
Between phase and neutral – 25 mm minimum
Between phase and earth – 25 mm minimum
Between neutral and earth – 23 mm minimum

The bus bar and interconnection shall be insulated with heat shrinkable PVC sleeves and shall be colour coded in Red / Yellow / Blue / Black / Green to identify the three phases / neutral and earth of the system . The bus bar shall be supported on unbreakable, non-hygroscopic DMC insulated supports (no bakelite material should be used in panel) at sufficiently close intervals to prevent bus bar sag and shall effectively withstand electromagnetic stresses in the event of short circuit capacity of 65KA RMS symmetrical fault for 1 sec and peak short circuit withstand of 105KA minimum.

All bus bar connections shall be done by drilling holes at factory in bus bars and connecting by chromium plated bolts and nuts. Additional cross section of bus bar shall be provided in all panels to cover up for the holes in the bus bars. Spring and flat washers shall be used for tightening of bolts.

All Cu/Al joints (if any) shall be connected with bi-metal sheet.

Neutral link in each feeder to be considered in each TP feeder.

2.3 Instrument Accommodation

All voltmeter and ammeter and other instruments shall be flushed mounted type of size 96X96 mm conforming to class 1.0 to IS 1248 for accuracy. All voltmeter shall be protected with suitable SCPD device.

Instruments and indicating lamps shall not be mounted on the Circuit Breaker Compartment (in case of ACB) door for which a separate and adequate compartment shall be provided and the instrumentation shall be accessible for testing and maintenance without danger of accidental contact with live parts of the Switchboard.

For MCCBs, instruments and indicating lamps can be provided on the compartment doors.

The current transformers for metering and for protection shall be mounted on the solid copper bus bars with proper supports.

On all the incomers of switch boards ON/OFF indicators lamps shall be provided suitable for operation on AC 230 volts supply. All lamps shall be protected with proper protection device. Where phase indicator lamps are to be provided, these shall be associated with necessary ON/OFF toggle switch. All the lamps shall have testing facility.

For instruments control MCB shall be used (Fuse with link not accepted)

2.4 Wiring

All wiring for relays and meters shall be with PVC insulated copper conductor wires. The wiring shall be coded and labelled with approved ferrules for identification. The minimum size of copper conductor control wires shall be 1.5 sq. mm. Runs of wires shall be neatly bunched and suitably supported and clamped. Means shall be provided for easy identification of wires. Identification ferrules shall used at both end of wires. All control wires meant for external connections are to be brought out on a terminal board. The cables shall be suitable for withstanding 105 deg C.

2.5 Space Heaters

Anti- condensation heaters shall be fitted in each cubicle together with an ON/OFF isolating switch suitable for electrical operation at 230 volts A.C 50 Hz single phase of sufficient capacity to raise the internal ambient temperature by 5° C. The electrical apparatus so protected shall be designed so that the maximum permitted rise in temperature is not exceeded if the heaters are energized while the switchboard is in operation. As a general rule, the heaters shall be placed at the bottom of the cubicle.

2.6 Ventilation Fans

The Switchboard shall be provided with panel mounting type ventilation fans in each panel with switchgear rated for 2000 amp and above or as required by engineer. The fan shall be interlocked with switchgear operation. The degree of enclosure protection

to be maintained even with fans. The fans shall be fitted with temperature sensors for automatic operation.

2.7 Earthing

Continuous earth bus sized for prospective fault current to be provided with arrangement for connecting to station earth at two points. Hinged doors / frames to be connected to earth through adequately sized flexible braids. Calculations shall be provided for the earthing strip size as per the fault level of the panel. Min size of earth bus shall be 50 x 6 mm Al.

2.8 Sheet Steel Treatment And Painting

Sheet steel used in the fabrication of switchboards shall undergo a rigorous cleaning and surface treatment seven tank process comprising of alkaline degreasing, descaling in dilute sulphuric acid and a recognized phosphating process after which a coat of primer paint compactively with the final paint shall be applied over the treated surface. Final paint coat of oven baked powder coating, of minimum 75 micron thickness, of sheet approved by Engineer-in-Charge shall then be provided. Painting shade shall be Siemens Grey-RAL 7032.

2.9 Name Plates and Labels

Identification labels of Aluminium with black base and silver fonts shall be provided on all feeders / lamps / panel name plate / relays / contactors etc. These shall indicate the feeder number and feeder designation also along with rating of the switchgear. Sample for the same shall be first approved by engineer.

2.10 Installation

Splices shall be implemented to ensure the electrical continuity of the horizontal bus bars, auxiliary buses and the protective conductor between adjacent sections.

It shall be possible to secure the sections to a floor that is flat (max variation within 2 mm/m:)

- by anchoring directly to a concrete floor using anchor bolts;
- by securing to ordinary metal profiles.

Extensions to the low-voltage electrical switchboards shall be possible on either side (right or left).

2.11 Protection and Safety

The low-voltage electrical switchboards shall ensure the safety of life and property as well as provide a high level of continuity of service.

- Switching safety shall be ensured by a mechanical device preventing on-load withdrawal & on-load access to live parts, except by strictly following a defined procedure & using defined tools.
- Operating safety shall be ensured by the use of compartments in compliance with standard IEC 60439-1 and according to form types 3b.
- Current interruption shall be of the "visible break isolation" or "positive contact indication" type as defined by standard IS 13947: 1993.

In view of reducing the risk of electrical shock:

- Power and control circuits shall be separate and completely isolated;
- Auxiliary circuits shall be of the extra-low voltage type.
- Aux. contacts / Auxiliary contactor should be used for feeder (Relays are not preferred)

The low-voltage electrical switchboards shall be equipped with two types of mechanical locking compatible with the different positions of drawers. The locking system shall be partially mobile and implement three padlocks.

Optionally, the safety of persons shall be enhanced by a version complying with the requirements of standard IEC 61641 concerning the propagation of an arc inside electrical switchboards. Test certificates shall be available.

Provisions must be made, around the equipment critical zones, for visual/infrared inspection during equipment operation, with respect to operator safety.

Earthed metal or insulated shutters shall be provided between drawout and fixed portion of the switchgear such that no lives parts are accessible with equipment drawn out. Degree of protection within compartments shall be at least IP 2X.

Overall IP rating of panel shall be IP 52 (except VFD starter).

IP rating for all PCC'S/MCCB in wet area like pump room shall be IP-65. (to be confirmed with engineer before quoting)

2.12 Internal Components:

The panels shall be equipped complete with all type of required number of air circuit breakers, switch fuse unit, contactor, relays, fuses, meters, instruments, indicating lamps, push buttons, equipment, fittings, busbar, cable boxes, cable glands etc. and all the necessary internal connections /wiring as required and as indicated on relevant drawings. Components necessary for proper complete functioning of the panels but not indicated on the drawings shall be supplied and installed on the panels.

All part of the panels carrying current including the components, connections, joints and instruments shall be capable of carrying their specified rated current continuously, without temperature rise exceeding the acceptable values of the relevant specifications at any part of the panels.

All units of the same rating and specifications shall be fully interchangeable.

2.13 L. T. Switchgears:

2.13.1 General:

The type, size, and rating of the components shall be as indicated on the relevant single line diagrams0.

2.13.2 Miniature Circuit Breaker (MCB) / MPCB / ELCB:

MCB / MPCB shall be quick make and break and break type conform with IS: 8828 (1996). The housing shall be heat resistant and having high impact strength. The fault current of MCBs / MPCBs shall not be less than 10000 amps, at 230 volts.

The MCBs shall be flush mounted and shall be provided with trip free manual operating mechanism with mechanical "ON" and "OFF" indications.

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

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

MPCB with extended support should be consider along with front operating mechanism. MPCB should be with all accessories like; auxiliary contacts, door rotary mechanism etc.
The RCCB should suffices all the requirements of IS as per code IS - 12640 - 1988. The RCA should be current operated and not on line voltage.

The RCCB should ensure mainly the following functions:

i) Measurement of the fault current value.

ii) Comparison of the fault current with a reference value.

iii) The RCCB should have a torroidal transformer witch has the main conductors of primary (P - N) which check the sum of the current close to zero.

iv) All metal parts should be inherently resistant to corrosion and treated to make them corrosion resistant.

v) It should be truly current operated.

vi) It should operate on core balance torroidal transformer.

vii) Its accuracy should be ± 5 %.

viii) It should operate even in case of neutral failure.

ix) It should trip at a present leakage current within 100 mA

x) Its enclosure should be as per IP 30.

xi) Its mechanical operation life should be more than 20,000 operations.

xii) It should provide full protection as envisaged by IE rules - 61-A, 71 - ee, 73 - ee, 1985 and also rule 50 of IE rule1956.

It should conform to all national and international standards like IS: 8828-1993, IS: 12640-1988, BS 4293 - 1983, CEE 27 (International commission Rules for the approved of electrical equipment).

2.13.3 Fuse:

Fuses shall be of high rupturing capacity (HRC) fuse links and shall be in accordance with IS : 2000-1962 and having rupturing capacity of not less than 35 MVA at 415 Volts.

Fuse link to be considered along with SFU.

2.13.4 Air Circuit Breaker:

The ACB shall meet with IS : 2516 part I, II and III. Each pole of the ACB's shall be equipped with over current, earth fault and short circuit release. The ACB's shall be equipped with under voltage trip only on those used as main incomer of all sources, bus coupler and inter connector. The trip devices shall be direct acting.

Disconnecting devices of approved type shall be provided to facilitate the removal of the circuit breakers from the housing for test and maintenance purpose.

The ACB's shall have an arc-quenching device on each pole. The ACB's shall have auxiliary contacts for signalling, interlocking etc. The ACB's shall have slow close facilities for checking contact operation and contact gap adjustment.

All contacts subject to arcing shall be tipped with arc resisting material. Main contacts shall be silver plated, multi-finger and spring-loaded type. Facilities shall be provided to isolate the circuit breaker for inspection purpose.

Interlocks shall be provided to:

Prevent the breaker from being isolated unless it is in the "OFF" position.

Prevent the breaker from being racked in to the service position unless it is in the "OFF" position.

Prevent the breaker from being accidentally pulled completely "OFF" the guide rail. Safety shutters of insulating material shall be provided to prevent access to all live contacts, when the breaker is in the inspection position or completely withdrawn.

Facilities shall be provided for earthing the circuit breaker.

Air circuit breaker shall be capable of clearing the maximum fault current, which can occur.

The breaker plates shall have an ON-OFF indicators, spring charge indicators, provision to padlock manual handle and provision to lock draw-out mechanism. Electrically operated breaker shall have provision for emergency manual closing by inserting a tool through the fuse plate. A control isolating switch shall be provided on the fuse plate to isolated the supply to the charging motor.

The breaker shall be have feature such as to indicate voltage status / trip / fault alarm indicators / remote operation from BMS – ON/OFF, shunt trip release and motorised reclosing / contacts for remote indication of open / close / trip wired to BMS, communication modules providing LAN interface with BMS and draw out pattern with test facility provision.

All ACB releases shall be with long time + short time + instantaneous + earth fault selective protection.

2.13.5 Moulded Case Circuit Breaker:

2.13.5.1 General

Moulded-Case Circuit Breakers (MCCB) shall comply with IS 13947: 1993 standards.

- they shall be of utilisation category A on all the operational voltage range – till 250A and category B on all the operational voltage range – for any rating with adjustable short time delay (if specified) with a rated service breaking capacity (Ics) equal to the ultimate breaking capacity (Icu) up to 500V for the greater ratings
- They shall have a rated operational voltage of 690 V AC (50/60 Hz),
- They shall have a rated insulation voltage of 800 V AC (50/60 Hz),
- They shall be suitable for isolation, as defined by IS 13947: 1993 for the Overvoltage Category IV for a rated insulation voltage up to 690 V .

MCCBs shall be designed according to Eco-design complying with ISO 14062 Especially MCCB's materials shall be of halogen free type. They shall be supplied in recyclable packing complying with European Directives.

The manufacturer shall implement non polluting production processes that do not make use of chlorofluorocarbons, chlorinated hydrocarbons, ink for cardboard markings, etc

MCCBs shall be mounted in panel as fixed type versions in 3-pole and 4-pole versions. A safety trip shall provide advanced opening to prevent connection and disconnection of a closed circuit breaker

MCCBs shall be designed for both vertical and horizontal mounting, without any adverse effect on electrical performance. It shall be possible to supply power either from the upstream or downstream side

MCCBs shall provide class II insulation between the front and internal power circuits

2.13.5.2 Construction, Operation, Environment

For maximum safety, the power contacts shall be insulated in an enclosure made of a thermosetting. material from other functions such as the operating mechanism, the case, the trip unit and auxiliaries

All poles shall operate simultaneously for circuit breaker opening, closing and tripping.

MCCBs shall be actuated by a toggle or handle that clearly indicates the three positions: ON, OFF and TRIPPED.

In order to ensure suitability for isolation complying with IS 13947: 1993:
- the operating mechanism shall be designed such that the toggle or handle can only be in OFF position (O) if the power contacts are all actually separated,
- In OFF position, the toggle or handle shall indicate the isolation position.

Isolation shall be provided by a double break on the main circuit.

MCCBs shall be able to receive a device for locking in the "isolated" position, with up to 3 padlocks, Ø8 maximum.

MCCBs shall be equipped with a "push to trip" button in front to test operation and the opening of the poles.

MCCB rating, "push to trip" button, performances and contact position indication must be clearly visible and accessible from the front, through the front panel or the door of the switchboard.

2.13.5.3 Current Limitation, Discrimination, Durability

MCCBs shall be capable of greatly limiting currents. For short-circuits, the maximum thermal stress I^2t shall be as per IEC / IS.

These characteristics will allow high cascading performance with moulded-case or miniature circuit-breakers downstream
MCCBs shall be equipped with a tripping unit independent of the thermo-magnet or electronic one. This unit will trip the circuit-breaker for high value short-circuits currents. The breaking will be carried out in less than 10ms for short-circuit currents above 25In.

MCCBs shall comprise a device, designed to trip the circuit-breaker in the event of high-value short-circuit currents. This device shall be independent of the thermal-magnetic or electronic trip unit.

MCCBs, the current ratings of which are identical with the ratings of their trip units, shall ensure discrimination for any fault current up to at least 35 kA rms, with any downstream circuit-breaker having a current rating less or equal to 0.4 times that of the upstream circuit-breaker.

The electrical durability of MCCBs, as defined by IS 13947: 1993 standard.

MCCBs shall be equipped with a self-test of the connection between the electronic trip unit, the current transformers and the actuator, that will not cause the circuit-breaker to trip. The self-test will be of positive logic and visible through the flashing of a green LED in case the self-test occurred correctly and the extinction of the LED in case the self-test failed.

The MCCB shall trip in case the environmental conditions of the circuit-breaker get out of their specified range. However, it will be possible to overrule this feature.

2.13.5.4 Auxiliaries and Accessories

It shall be possible to equip MCCBs with a motor mechanism for electrically controlled operation if specified in SLD. An "auto/manual" switch in front shall, when set to the "manual" position, lock out electrical control; when set to "auto", lock out the manual control; remote indication of "manual" or "auto" mode shall be possible. It shall also be possible to seal the access to the "auto" control.
Closing shall take place in less than 80 ms.

Following tripping due to electrical faults (overload, short-circuit, earth fault if mentioned in SLD), remote reset shall be inhibited.

It shall however be possible if opening was initiated by a voltage release.

The operating mechanism shall be of the stored-energy type only

The addition of a motor mechanism or a rotary handle shall in no way affect circuit breaker characteristics:
- Only three stable tripping mechanism positions (ON, OFF and TRIPPED) shall be possible with the motor mechanism,
- Suitability for isolation shall be provided by positive contact indication (ON and OFF) in front of the motor mechanism module

MCCBs shall be designed to enable safe on-site installation of auxiliaries such as voltage releases (shunt and under voltage releases) and indication switches as follows:
- They shall be separated from power circuits,
- All electrical auxiliaries shall be of the snap-in type and fitted with terminal blocks,
- All auxiliaries shall be common for the entire range,
- Auxiliary function and terminals shall be permanently engraved on the case of the circuit breaker and the auxiliary itself,
- The addition of auxiliaries shall not increase the volume of the circuit breaker.
- MCCB should be with all accessories like; spreads links, shrouding terminals, auxiliary contacts, phase barrier, door rotary mechanism etc. Spreader links should be copper with Ni-Cr plated
- Outgoing terminal of MCCB should be 3Ph+N+E.

The addition of a motor mechanism module or a rotary handle, etc., shall not mask or block device settings

It shall be possible to assemble earth fault protection moulded-case circuit breakers by adding a residual current device (RCD) directly to the circuit breaker case. The resulting device shall:
- comply with IS 13947: 1993 standard,
- be immunised against nuisance tripping,
- be capable of working normally down to -25 °C ambient temperature,
- operate without an auxiliary power supply, i.e. it shall be capable of operating normally on any 2-phase or 3-phase power network with a voltage between 200 V and 440 V, and of tripping the circuit-breaker even in the event of voltage dips down to 80 V

It shall be possible to equip MCCBs with devices indicating faults without tripping the circuit breaker

2.13.5.5 Protection Functions

General Recommendations

MCCBs with ratings up to & including 250 A shall be equipped with fully interchangeable trip units in order to ensure the protection against overcharge and short-circuit. The trip units shall be of thermal magnetic adjustable type.

MCCBs with ratings over 250 A shall be equipped with microprocessor based trip units with O/C / S/C & E/F.

2.13.5.6 Common Features

Electronic and thermal-magnetic trip units shall be adjustable and it shall be possible to fit lead seals to prevent unauthorised access to the settings

Electronic trip units shall comply with IS 13947: 1993 standard (measurement of rms current values, electromagnetic compatibility, etc.)

Protection settings shall apply to all circuit breaker poles

The trip units shall not augment overall circuit breaker volume

All electronic components shall withstand temperatures up to 125 °C.

2.13.5.7 Microprocessor Trip Units

Characteristics
- Long time protection (LT)
Selectable Ir threshold settings from 36% to 100 % of the trip unit rating
- Short time protection (ST)
Isd threshold shall be adjustable from 1,5 to 10 times the thermal setting Ir,
The time delay shall be either adjustable or fixed at 40 ms,
- Instantaneous protection

The threshold shall be either adjustable or fixed (starting from 1.5 times In and up to a value between 11 and 15 times In, depending on the rating)

Four-pole devices shall be equipped for neutral protection:
- as standard with a 3-position setting : - neutral not protected - neutral tripping threshold equal to half the phase value - neutral threshold equal to the phase value
- if required by harmonic 3 neutral current circulation with a specific 4-position setting - neutral not protected - neutral tripping threshold equal to half the phase value - neutral threshold equal to the phase value - neutral setting according to the rating of the phases in a ratio 1.6 (Oversized Neutral).

Load Monitoring Function

The following monitoring functions shall be integral parts of electronic trip units:
- 2 LED for load indication, one lighted above 90 % of Ir, and one lighted above 105 % of Ir
- a test connector shall be installed for checks on electronic and tripping mechanism operation using an external device.

Thermal Memory

In the event of repeated overloads, the electronic trip unit shall optimise protection of cables and downstream devices by memorising temperature variations.
Options:

It shall be possible to install all options for the electronic trip unit:
- High-threshold earth-fault protection,
- Auxiliary contact to indicate the cause of tripping (long time, short time, instantaneous, earth fault if requested),
- Data transmission via a BUS, in particular all the trip unit settings, current measurements for each phase, tripping causes, circuit breaker status.

It shall be possible to install a specific module that can provide the data transmission, in particular all the trip unit settings, all electrical parameters (current, energy, THD, voltage, etc.) measurements for each phase, tripping causes, circuit breaker status, control and alarms.

Software that allows these data to be analysed on PC shall be provided by the manufacturer.

2.13.6 Contactors / Relays / Starter :

2.13.6.1 The contactor shall meet with the requirements of IS: 2959.
2.13.6.2 Contactors shall be air break and electromagnetic type rated for uninterrupted duty as defined in relevant IS.
2.13.6.3 The main contacts shall be of silver or silver alloy.
2.13.6.4 The insulation for the coils shall be of class 'f'.
2.13.6.5 Each contactors shall be provided with 2 normally open and 2 normally closed auxiliary contacts.
2.13.6.6 The contactors shall be in accordance to type 2 co-ordinations for short circuit protection.
2.13.6.7 The contactor shall be suitable for uninterrupted duty (AC3) category.
2.13.6.8 All 3 Contactor sizes should be identical rating in Star-Delta feeders.
2.13.6.9 The electrical and mechanical endurance shall be as specified in IS code.
2.13.6.10 For all starters, component sizing shall be as per type-II co-ordination chart prescribed by switchgear manufacturer + Contactor shall be one rating higher than specified in type-2 coordination.
2.13.6.11 Remote start, stop, interlock wire should be wire up at terminals apart than PLC/BMS/SCADA signals/commands.
2.13.6.12 Outgoing terminal of Starter should be 3Ph+E.
2.13.6.13 Auto-Manual Status and ON-OFF-Trip potential free signal required for BMS/PCL wherever asked.
2.13.6.14 Thermal overload relays shall be of three elements positive acting ambient temperature compensated type with adjustable settings.
2.13.6.15 Thermal overload relays shall be of self/hand reset type as specified in the schedule.
2.13.6.16 All control terminals to OCS / PLC shall wired to single compartment. (marshalling box).
2.13.6.17 Separate control terminal blocks shall provide for control wiring.
- From MCC to field in cable chamber.
- From MCC to OCS / PLC in marshalling jb.
- Al, Ao, Di & Do shall be provided on separate terminal block.

2.13.6.18 Following control signal exchange between OCS / PLC & MCC panel shall be considered for AHU panel & package systems in process mcc —

a. <u>From MCC panel to DES / PLC</u>
- On, off & trip feedback — separate continuous potential free contacts.
- For VFD feeders — 4—2oma speed (rpm) feedback.
- Potential free contact for remote selection.

b. From DES / PLC to MOE panel
- Start & stop command — single latched contact.
- For VFD feeders only — 4—2oma reference current for speed control.
- Start permissive in local & remote mode.

2.13.6.19 Following control signal exchange between push button station & mcc panel shall be considered.
a. On, off & trip feedback — separate continuous potential free contacts.
b. Start & stop command — seperate continuous potential free contacts.

2.13.6.20 Control philosophy
a. Under local mode selection start command will be executed from push button station near motor.
b. Under remote mode selection start command will be executed from PLC panel.
c. Stop command can be executed without selection.

2.13.6.21 Motor feeder shall have motor protection circuit breaker (MPCB) with S/C and O/C release.

2.13.6.22 Heavy duty bmr to be provided for blowers & fan application.

2.13.7 Multi Function Meter:

Flush mount 96 x 96 x 80 mm load manager type CONSERV EM 6400 or equivalent meter of accuracy class 1 as per IS 13779 shall be provided. The meter shall be accurate on distorted waveforms; simultaneous sampling of voltage and amperes shall be done. It shall have low burden on PT and CT shall have bright display, shall view 3 parameters together shall have auto scaling from kilo to mega to giga units, shall have programmable CT, PT ratios with built in phase analyser. Auto scrolling shall be programmable as per user choice and communication with PC; PLC DCS shall be possible through RS 485 serial port. It shall be dust proof, tamper proof with data import export option and 10 years back up of integrated data.

Parameters to be monitored shall be Frequency, Line to line and average and line to neutral and average voltage, phase wise and average current, phase wise and total KVA, KW and P.F. reading and KWH monitoring.

User programmable facility for delta 2e and star 3e measurement, C.T. and P.T. ratios, sliding window auto sync. And auto scrolling of parameters shall be available.

Sensing shall be 3 phase, 4 wire measuring True RMS with voltage input range of 110 to 415 V nominal and current input of 5 amps or 1 amps as per field configuration. Current range shall be from 50 mA to 7.5 A and burden on PT or CT shall be app 0.2 VA.

Accuracy for kW / kWh shall be as per IS 1377 / CBIP88 and for all other parameters shall be +/- 0.5% of full scale + 0.5% of reading + 1 digit. Digital readout shall be of 3 rows of 4 digits each (12.5 mm size) with 7 segments bright red LED. Input frequency shall be 50Hz / 60Hz +/- 5%. Power factor range shall be 0.5 lag – unit – 0.8 lead.

Resolution for power parameters shall be for 4 digits and energy parameters shall be 8 digits. Display update shall be at every 15 seconds for demand parameters and

1 sec for other parameters. Display sequence shall be parameter followed by value. Temperature range shall be 0-50°C and humidity <95% non-condensing.

Display pages shall be as follows:
Instantaneous – VLL, A avg., F
VLn, A avg., F
KVA, kW, PF
Individual pages of above parameters.
Integrated - kVAh
KWh
Run hours
On hours
Interruption

2.13.8 Current Transformer:

Where called for, CT's shall provide for current measuring. Each phase shall be provided with separate CT of class I accuracy and VA burden as shown in SLD for operation of associated metering and controls. Current transformer shall be in accordance with IS: 2705 - 1964 as amended up to date.

Separate CT for each protection devices and instrumentation device shall be provided.
The CT shall be able to withstand max short time withstands current indicated for the assembly.
The CT shall be cast resin type.
Test links at secondary – to facilities testing of instruments / meters and protection device.

2.13.9 Push Button & Indicating Lamp :

The push button unit shall comprise of the contact element, a fixing holder, and push button actuator. The push button shall be momentary contact type. The contacts shall be of silver alloy and rated at 10 Amps continuous current rating. The actuator shall be of stranded type and colour as per its usage for ON, OFF and Trip.

Indicating Lamp shall be LED type and shall supplied complete with translucent covers to diffuse the lamp light. Indicating lamps shall be part of push buttons where ever both are required and shall have testing facilities. Protection in form of MCB / HRC fuse shall be provided for the lamps.

Colour shade for the indicating lamps shall be as below:

ON indicating lamp : Green
OFF indicating lamp : Red
TRIP indicating lamp : Amber
PHASE indicating lamp : Red, Yellow, and Blue.

2.13.10 Selector Switches:

Selector Switches shall be of the heavy duty rotory type, with plates clearly marked to show the operating position. They shall be of the semi-flush mounted type with only the front plate and operating handle projecting.

Circuit breaker control switches shall be of the spring return to neutral type.

2.14 All panels short circuit integration:

The panel vendor / contractor shall be responsible for carrying out necessary study for type 2 co-ordination for complete system with fault discrimination. All the data considered for the study shall be discussed with the engineer.

2.15 Testing

2.15.1 CPRI Testing

Switchboard configurations offered shall be subject to CPRI testing (Testing if required by the User). In case of no CPRI testing request by E/C, copies of the CPRI test certificates shall be submitted with the tender for the similar rated busbar panel.

2.15.2 Routine Test:

a) Physical variation and dimensional check – To cross check dimensions with approved GA drawings.
b) Verification of bill of material – Physically count all the components.
c) Continuity test – shall be carried out for complete busbar system with continuity tester or actual charging.
d) Functional check – Operation of all the switchgears and control logic to be checked after charging at works.
e) HV test – 2500 V for 1 minute shall be applied and no tripping / Arching / Flashing shall occur.
f) IR test – 1000 V shall be applied through meggar and the value shall be more than 30 M ohms.
g) Polarity and Phase sequence test – Shall be checked for each feeder with phase sequence meter.

2.15.3 Type Test:

Type test certificates for all switchgears and panel of similar rated busbar shall be provided for

a) Short circuit withstand test
b) IP protection.
c) All switchgears and other components.
d) Temperature rise test

2.16 415V Auto Transfer Switch - ATS

1.1 General

1.1.1 Scope

This specification covers performance, design, material, construction, manufacture, inspection, testing, packing forwarding, delivery at site, testing and commissioning of microprocessor controlled Auto transfer switches – with double throw power transfer switch mechanism as per single line diagrams, with all accessories complete in all respects as described in this specification.

Whether called for specifically or not, all accessories required for normal operation of equipment are deemed to be considered as a part of the contractor's scope of supply. Hardware / fabricated supports required for mounting and installation of the ATS is within the scope of work.

It is not the intent to specify completely herein, all details of design and construction of the equipment. However, the equipment shall conform in all respects to high standard of Engineering, design and workmanship and be capable of performing in continuous commercial operation up to the Manufacturer's guarantees in a manner acceptable to the Engineer, who will interpret the meaning of the drawings and specifications and shall be entitled to reject any work or material which is not full accordance therewith.

1.1.2 Codes and Standards

The automatic transfer switches and controls shall conform to the requirements of:

UL 1008 - Standard for Transfer Switch Equipment

IEC 947-6-1 - Low-voltage Switchgear and Control gear; Multifunction equipment; Automatic Transfer Switching Equipment

NFPA 70 - National Electrical Code

NFPA 99 - Essential Electrical Systems for Health Care Facilities

NFPA 110 - Emergency and Standby Power Systems

IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications

NEMA Standard ICS10-1993 (formerly ICS2-447) - AC Automatic Transfer Switches

UL 508 - Industrial Control Equipment

1.2 Products

1.2.1 Mechanically Held Transfer Switch

The transfer switch shall be electrically operated and mechanically held. The electrical operator shall be a momentarily energized, single-solenoid mechanism. Main operators which include overcurrent disconnect devices, linear motors or gears shall not be acceptable. The switch shall be mechanically interlocked to ensure only two possible positions, normal or emergency. The switch shall be rated for AC-33A duty cycle for mixed load application as mentioned in IEC 60947-6-1.

All transfer switch sizes shall use only one type of main operator for ease of maintenance and commodity of parts.

The switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.

All main contacts shall be silver composition. Switches rated 600 amperes and above shall have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.

Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. Switches rated 600 amps and higher shall have front removable and replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.

Designs utilizing components of moulded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.

Where neutral conductors must be switched as shown on the plans, the AS shall be provided with fully rated complete overlapping neutral transfer contacts. The neutrals of the normal and emergency power sources shall be connected together only during the transfer and retransfer operation and remain connected together until power source contacts close on the source to which the transfer is being made. The overlapping neutral contacts shall not overlap for a period greater than 100 milliseconds. Neutral switching contacts which do not overlap are not acceptable.

Where neutral conductors are to be solidly connected as shown on the plans, a neutral conductor plate with fully rated CU pressure connectors shall be provided.

1.2.2 Microprocessor Controller

The controller's sensing and logic shall be provided by a single built-in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate serially through an optional serial communication module.

A single controller shall provide twelve selectable nominal voltages for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to ± 1% of nominal voltage. Frequency sensing shall be accurate to ± 0.2%. The panel shall be capable of operating over a temperature range of -20 to +60 degrees C and storage from -55 to +85 degrees C.

The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Sensing and control logic shall be provided on multi-layer printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. The protective cover shall include a built-in pocket for storage of the operator's manuals.

All customer connections shall be wired to a common terminal block to simplify field-wiring connections.

The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:

EN 55011:1991 Emission standard - Group 1, Class A

EN 50082-2:1995 Generic immunity standard, from which:

EN 61000-4-2:1995 Electrostatic discharge (ESD) immunity

ENV 50140:1993 Radiated Electro-Magnetic field immunity

EN 61000-4-4:1995 Electrical fast transient (EFT) immunity

EN 61000-4-5:1995 Surge transient immunity

EN 61000-4-6:1996 Conducted Radio-Frequency field immunity

IEEE472 (ANSI C37.90A) Ring Wave Test.

1.3 Operation

1.3.1 Controller Display and Keypad

A four line, 20 character LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the serial communications input port. The following parameters shall only be adjustable via DIP switches on the controller:

Nominal line voltage and frequency

Single or three phase sensing

Operating parameter protection

Transfer operating mode configuration
(Open transition, Closed transition or Delayed transition)

All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.

1.3.2 Voltage, Frequency and Phase Rotation Sensing

Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout and trip setting capabilities (values shown as % of nominal unless otherwise specified):

Parameter	Sources	Dropout / Trip	Pickup / Reset
Undervoltage	N&E,3ϕ	70 to 98%	85 to 100%
Overvoltage	N&E,3ϕ	102 to 115%	2% below trip
Underfrequency	N&E	85 to 98%	90 to 100%
Overfrequency	N&E	102 to 110%	2% below trip
Voltage unbalance	N&E	5 to 20%	1% below dropout

Repetitive accuracy of all settings shall be within ± 0.5% over an operating temperature range of -20°C to 60°C.

Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.

The controller shall be capable (when activated by the keypad or through the serial port) of sensing the phase rotation of both the normal and emergency sources. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC or CBA).

Source status screens shall be provided for both normal & emergency to pro-vide digital readout of voltage on all 3 phases, frequency, and phase rotation.

1.3.3 Time Delays

An adjustable time delay of 0 to 6 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals. Capability shall be provided to extend this time delay to 60 minutes by providing an external 24 VDC power supply.

A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.

Two time delay modes (which are independently adjustable) shall be provided on re-transfer to normal. One time delay shall be for actual normal power failures and the other for the test mode function. The time delays shall be adjustable from 0 to 60 minutes. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.

A time delay shall be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.

A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minute time delay in any of the following modes:

Prior to transfer only.

Prior to and after transfer.

Normal to emergency only.

Emergency to normal only.

Normal to emergency and emergency to normal.

All transfer conditions or only when both sources are available.

The controller shall also include the following built-in time delays for optional Closed Transition and Delayed Transition operation:

1. 1 to 5 minute time delay on failure to synchronize normal and emergency sources prior to closed transition transfer.

2. 0.1 to 9.99 second time delay on an extended parallel condition of both power sources during closed transition operation.

3. 0 to 5 minute time delay for the load disconnect position for delayed transition operation.

All time delays shall be adjustable in 1 second increments, except the extended parallel time, which shall be adjustable in .01 second increments.

All time delays shall be adjustable by using the LCD display and keypad or with a remote device connected to the serial communications port.

1.3.4 Additional Features

A three position momentary-type test switch shall be provided for the **test / automatic / reset** modes. The test position will simulate a normal source failure. The reset position shall bypass the time delays on either transfer to emergency or retransfer to normal.

A SPDT contact, rated 5 amps at 30 VDC, shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool down

setting, regardless of whether the normal source restores before the load is transferred.

Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact closed, when the ATS is connected to the emergency source.

LED indicating lights (16 mm industrial grade, type 12) shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red).

LED indicating lights (16 mm industrial grade, type 12) shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal and emergency sources, as determined by the voltage sensing trip and reset settings for each source.

The following features shall be built-in to the controller, but capable of being activated through keypad programming or the serial port only when required by the user:

Provide the ability to select "commit/no commit to transfer" to determine whether the load should be transferred to the emergency generator if the normal source restores before the generator is ready to accept the load.

Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal. Both of these inhibit signals can be activated through the keypad or serial port.

An In phase monitor shall be provided in the controller. The monitor shall control transfer so that motor load inrush currents do not exceed normal starting currents, and shall not require external control of power sources. The in phase monitor shall be specifically designed for and be the product of the ATS manufacturer.

The controller shall be capable of accepting a normally open contact that will allow the transfer switch to function in a non-automatic mode using an external control device.

1.3.5 Engine Exerciser

The controller shall provide an internal engine exerciser. The engine exerciser shall allow the user to program up to seven different exercise routines. For each routine, the user shall be able to:

1. Enable or disable the routine.

2. Enable or disable transfer of the load during routine.

3. Set the start time
- time of day
- day of week
- week of month (1st, 2nd, 3rd, 4th, alternate or every)

4. Set the duration of the run.

At the end of the specified duration the switch shall transfer the load back to normal and run the generator for the specified cool down period. A 10-year life battery that supplies power to the real time clock in the event of a power loss will maintain all time and date information.

1.3.6 System Status

The controller LCD display shall include a "System Status" screen which shall be readily accessible from any point in the menu by depressing the "ESC" key a maximum of two times. This screen shall display a clear description of the active operating sequence and switch position. For example,

Normal Failed
Load on Normal
TD Normal to Emerg
2min15s

Controllers that require multiple screens to determine system status or display "coded" system status messages, which must be explained by references in the operator's manual, are not permissible.

1.3.7 Self Diagnostics

The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.

1.3.8 Communications Interface

The controller shall be capable of interfacing, through an optional serial communication module, with a network of transfer switches, locally (up to 4000 ft.) or remotely through modem serial communications. Standard software specific for transfer switch applications shall be available by the transfer switch manufacturer. This software shall allow for the monitoring, control and setup of parameters.

1.3.9 Data Logging

The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in a non-volatile memory:

1. Event Logging

1. Data and time and reason for transfer normal to emergency.
2. Data and time and reason for transfer emergency to normal.
3. Data and time and reason for engine start.
4. Data and time engine stopped.
5. Data and time emergency source available.
6. Data and time emergency source not available.

2. Statistical Data

1. Total number of transfers.
2. Total number of transfers due to source failure.
3. Total number of days controller is energized.
4. Total number of hours both normal and emergency sources are available.

1.3.10 Communications Module

A full duplex RS485 interface & Ethernet TCP/IP RJ45 socket shall be installed in the ATS controller to enable serial communications. The serial communications shall be capable of a direct connect or multi-drop configured network. This module shall allow for the seamless integration of existing or new communication transfer devices through Modbus open protocol. The proprietary protocols are not acceptable.

1.4 Additional Requirements

1.4.1 Withstand and Closing Ratings

The ATS/BPS shall be rated to close on and withstand the available RMS symmetrical short circuit current at the ATS/BPS terminals with the type of overcurrent protection shown on the plans.

The ATS/BPS shall be UL-1008 and IEC-60947-6-1 complied & in accordance with UL 1008 listing and be labeled in accordance with that standard's 1½ and 3 cycle, long-time ratings. ATS/BPS which are not tested and labeled with 1½ and 3 cycle (any breaker) ratings and have series, or specific breaker ratings only, are not acceptable**.**

The ATS rated 800A and above must be tested for 18/30 cycles short time withstand capacity matching breaker fault level to enable use of ACB as a back up protection device with short time delay setting for providing discrimination with the downstream breakers.

1.5 POWER FACTOR CORRECTION

1.0 Scope :

This specification covers design, manufacture, supply, installation, testing, commissioning of thyristorised zero crossing – Real Time Power Factor Correction (RTPFC) system with capacitor banks and harmonic filters suitable for continuous duty. The capacities given in SLD are for reference only and are to be verified by contractor after doing complete reactive load analysis and also necessary changes if required in the rating of capacitors and harmonic filters is within scope of contractor. All necessary hardware / supports required for installation of the panel is scope of the works.

2.0 Standards :

The design, manufacture and performances of the power factor correction panel with capacitor banks shall comply with all currently applicable statutes, regulations and safety codes in the locations of installations. The capacitors used will also conform to the latest applicable Indian / British / IEC standards. In particular, the equipment shall conform to the latest revisions of the following.

IS **:** 13340 , 13341 & 12672	Capacitors for power system.
IS **:** 2208 , 13703	HRC cartridge fuse and links upto 600V
IS : 8828	MCB
IS : 13947	MCCBs

When the above standards are in conflict with these specifications, this specification shall prevail.

3.0 Capacitor Bank

Capacitor bank shall comprise of identical three phase capacitors in case of RTPFC. The individual capacitor unit shall be manufactured out of MPP design, comprising of bi-axially oriented metalised polypropylene film. Capacitor shall be tubular (Cylindrical) MPP self filling type. The capacitor shall consist of many such elements in series / parallel combinations for getting desired kVAr output. The dielectric losses of capacitor shall be restricted to 0.5 watts per kVAr. The phase terminal connections of the capacitor unit shall be brought out at the top, for suitable connections. The capacitor shall be provided with suitably rated discharge resistor.

The capacitor shall be provided with over pressure interrupter mechanism, which will automatically disconnect faulty capacitor unit from the network without bursting, bulging or exploding the capacitor.
The rating of the step should be decided by due consideration of de-rating due to harmonic reactors, so as to ensure that each capacitor feeder delivers net output equivalent to the step rating. PF capacitors should be rated for minimum 480/525 VAC, 3-ph, 50 Hz and shall be suitable to operate continuously with the harmonic filters.

4.0 Harmonic Filter Reactors

Each feeder shall be provided with 7 % detuned harmonic filter reactor 440 V, 3-phase, 50 Hz of step rating. This reactor should be anti-resonance type, copper wound, low noise with high linearity-low loss core (CRGO lamination of 46/51 grade insulation class F). The linearity of the reactor should not be less than 1.5 In and suitable for continuous operation at system voltage without excess heating. One no temperature switch should be provided internally with terminals brought outside for control.

5.0 Capacitor Panel

The capacitor control panel shall operate in Automatic mode as specified in the data sheet. The panel for capacitor shall be fabricated from 2 mm thick sheet steel and shall be finished with 7tank process followed by powder coating.
Earthing terminal shall be provided as per clause No 4.0 of this specification. The panel shall be provided with suitably rated T.P. copper bus bar supported on epoxy insulator. Each capacitor unit shall be connected to main bus bar through thyristor of suitable rating with safety margin. Protective HRC/MCBs /MCCBs fuses of suitable rating shall be provided with base / holder as mentioned in the drawing. Connection shall be made with PVC insulated flexible copper cables having crimped copper lugs. All capacitor units shall be earthed; sufficient ventilation shall be provided to limit the temperature rise to maximum 85^{o}C. Cooling fans shall be provided to each heat sink as per requirement. Suitable exhaust fans shall be provided in order to dissipate the internal heat of the panel and maintain the internal temperature rise of the panel within safe limits. The operation of fans shall be automatic with temperature sensor. Drawing pocket shall be provided at the door of each panel. A 15-amp switch & socket and the lamp holder shall also be provided for panel illumination at the suitable location.
The main Bus bar shall be terminated on suitably rated SFU /MCCB /SDU / ACB. Detachable gland plates shall be provided with suitable knockout for incoming cable connection from bottom/top as specified. Capacitor unit shall be mounted a frame of adequate strength construction.
The panel shall be mounted on MS channel section at the bottom for easy installation. The panel shall be provided with lifting hooks /eye bolts for handling. Automatic Power Factor Correction Relay shall be provided with all related circuits and three load CT's for each phase in order to control/ achieve target Power Factor OR unity as per setting.

The controller shall be capable of correcting Power Factor within 2 to 120 sec in case of RTPFC. The capacitor shall be switched ON and OFF using thyristors from APFC controller.

Average compensation required and compensation supplied shall be continuously monitored for all the three phase simultaneously and total low kVAr requirement shall be calculated accordingly. It would automatically switch ON and OFF the capacitor bank so as to attain the set target power factor. The panel shall be provided as per respective drawing.

The thyristoried switching system shall have following minimum features.

1. Capacitor switching shall be at zero crossing and shall be smooth and surgeless, **as demonstrated at the test bench.**
2. No electromagnetic contactor/ relays/ moving parts shall be used in the switching circuit or parallel to the switching device;
3. Forced cooling system to thyristor shall be provided;
4. Diagnostic capability shall be provided to analyse and indicate type of fault;
5. Power factor controlling shall be on cycle-to-cycle basis. Proportionate correction or cutting A.C. waveform will not be allowed;
6. The controller shall be capable to work at phase to phase voltage between 200 to 440 volts;
7. Digital controller shall be provided which minimum indication of line voltage and current, capacitor current, Power factor, active power /reactive power/ apparent power, injected capacitive kVAr, uncompensated capacitive kVAr, CT ratio selected, switching time;
8. LED indication for capacitor bank step switch ON, power factor lag/lead shall be provided.

The thyristorised switching system shall inclusive of following facilities.

1. Over voltage protection.
2. Under voltage protection.
3. Over temperature protection.
4. Voltage imbalance protection in each phase.
5. Facility of manually operating capacitor bank on First-in-First out basis

6.0 EARTHING

The enclosure of capacitor unit shall be provided with 2 nos. 10 mm earth terminals or strip, each complete with two plain and one spring washer, nuts etc. These terminals shall be effectively bonded to the common sheet steel framework. Each bank in case of APFC will have two external terminals in the bus bar chambers complete with hardware.

6. VENDORS DATA: TO BE SUBMITTED WITH OFFER :

Approved Makes:

Vendor shall provide information on the offered make and Cat nos. of items offered for respective Panels:

Sr. No.	Item Description	Specified Make	Vendor Confirmation
1.0	Air Circuit Breakers Ics=Icu=Icw(1sec)	Schneider Master Pack NW range with Micrologic 6.0E releases / L&T U power with UW MTX 3.5EC releases / Legrand DMX3 with MP4 - LSIG type. And as per MCGM schedule make	
2.0	MCCB – Ics = 100% Icu FOR above 250Amps	Schneider CVS Microprocessor range / L & T Dsine range (Microprocessor MTX1.5 release)/ Legrand DPX3 with Micro Processor S1 Release) And as per MCGM schedule make	
2.0A	MCCB till 250A, Ics=100% Icu	Schneider CVS Thermal Magnetic trip Unit / L & T Dsine Thermal Magnetic Release) Legrand DPX / DPX3 with Thermal Magnetic release) And as per MCGM schedule make	
3.0	MCB	Legrand (DX3)/Schneider – Acti 9)/ Hager And as per MCGM schedule make	
4.0	Capacitors – APP type – to be derated as per reactors.	EPCOS / L&T / Schneider And as per MCGM schedule make	
5.0	Contactors	Schneider / Siemens / L&T And as per MCGM schedule make	
6.0	Starters	As above And as per MCGM schedule make	
7.0	CRCA sheet	Tata / SAIL And as per MCGM schedule make	
8.0	Gaskets	Neoprene And as per MCGM schedule make	
9.0	Meters	Schneider / L&T / Legrand And as per MCGM schedule make	

10.0	Indicating lamps - LED	Schneider / Siemens / L & T - ESBEE And as per MCGM schedule make	
11.0	Push Buttons	Schneider / Siemens / L & T – ESBEE And as per MCGM schedule make	
12.0	Connectors	Wago / Connectwell / Elmex And as per MCGM schedule make	
13.0	C.T.s – cast resin type.	Kappa / Ashmore / A.E. And as per MCGM schedule make	
14.0	Reactors – 7% detuned	Copper winding And as per MCGM schedule make	
15.0	Selector Switches	Schneider / L&T / Salzer And as per MCGM schedule make	
16.0	SPD	Emerson / Legrand / Phoneix And as per MCGM schedule make	

5. LIGHT FIXTURES

A. SPECIFICATIONS

Light fixtures as mentioned in the BOQ with the catalogue nos and makes shall be installed. The fixtures shall be complete with ballast and shall be prewired by the manufacturer.

Fans of the approved makes and size shown in the drawing shall be used and install in the hook type M.S. box used by the CLIENT.

B. WORKMANSHIP

The fixture shall be installed on wall / ceiling as directed and as per manufacturer's instruction, with necessary accessories for surface, concealed, suspended from ceiling, bracket mounting etc. The job also includes connection of fixture with respective outlet point with heat resistant wires through heat resistance sleeve and PVC connector. The exhaust fan shall be installed complete with M.S. angle iron mounting frame/ ring, G.I. louvers, wire mesh and plug at the end of the cord including wiring & earthing etc. Proper earthing shall be provided to the fixtures

C. MODE OF MEASUREMENT

The unit rate shall be considered for fitting one fixture. The rate shall include following

All fixing accessories, mounting bracket, ballast condensers and control gear wherever applicable.
Supplying and fixing Ball and socket joints wherever required.
Earthing of fittings.
Electrical connections to fittings/fans from the junction box/ceiling rose.
Installation and interconnection of Electronic regulators for ceiling fans.
Supplying and fixing 300 mm. GI down rod for ceiling fans.

6.0 UPS

1.0 Scope

The present special contract specifications constitute a call for best offers for the supply of:

Uninterruptible Power System(s) (hereinafter referred to as UPS) rated at 4 X 250kVA + 3 X 100KVA, featuring NiCad batteries housed in one or more external racks/cubicles and providing a minimum autonomy as defined under "Batteries" herein.

The present specifications contain minimum requirements. All offers must be completed strictly in accordance therewith, either by confirming data or by filling in the spaces provided, where requirements are not met.

Any deviations or exceptions to the minimum requirements must appear in the offer.

Where no exceptions are shown, the requirements of the present specifications will be considered as accepted.

RELEVANT REFERENCE STANDARDS

The choice of materials and components, engineering developments and the construction of the equipment must comply with current directives and standards.

The UPS will have a CE mark as specified by Directives 73/23, 93/68, 89/336, 92/31 and 93/68.
The UPS will be designed and produced according to the following specifications:

- IEC/EN 62040-1-1 "General and safety requirements for UPS used in operator access areas."
- EN 62040-2 “Electromagnetic compatibility (EMC) requirements”
- IEC/EN 62040-3 “Performance requirements and test methods”

3.1 Design Specifications

The Uninterruptible Power System (UPS) will include the following operational components:

- Full IGBT Rectifier/battery charger
- IGBT Inverter
- Maintenance bypass switch
- Static switch
- Batteries.

3.2 IGBT Rectifier/Battery charger

The IGBT Rectifier/Battery charger will have an input isolating switch and a PWM digital vector control system (DSP based) which, in addition to normal functions

(AC/DC conversion), will automatically correct the input power factor to a value > 0.90 and limit the harmonic rejection to the mains at a THD_I value < 3% at full output load, and a THDi value < 7% for any other condition.

For the battery charger function, this converter will include built-in fuses and a control circuit for the voltage and battery recharging current. The ripple current to the batteries will be less than 0.05 C_{10}. A microprocessor control function will perform the following operations:

- Test the battery by automatically performing a partial battery discharge at weekly intervals or at intervals defined by the user
- Adjust battery float voltage as a function of ambient temperature
- Calculate the remaining battery autonomy time during discharge
- Automatically compensate battery shutdown voltage as a function of the time for prolonged discharges.

3.3 IGBT Inverter

The IGBT inverter will have a PWM digital vector control system (DSP based), capable of converting DC voltage from the IGBT rectifier or battery into AC voltage. A rated output filter will create an output voltage sinusoidal envelope.
The control circuit, in addition to normal functions, will automatically adjust nominal output power in accordance with ambient temperature.

Inverter should be able to deliver full active power at Unity power factor (KVA=KW)

3.3.1 UPS compatibility to Load Power factor

UPS should support the full Power factor range (Lagging & leading) of load without any deration in power rating

3.4 Static bypass switch

The static bypass switch will feature a separate power input and will consist of the following:

- Static switches (SCR type), which can support overloads and short circuits downstream of the UPS
- A back feed detection circuit as specified by IEC/EN 62040-1-1, clause 5.1.4
- A bypass and maintenance bypass input isolating switch with auxiliary indicator contact
- An output load switch.

The control logic will be handled by digital algorithms (using vector control techniques), similar to those used for the rectifier and the inverter. The static bypass shall be equipped with a back feed protection device compliant with clause 5.1.4 of IEC/EN 62040-1-1; and a relay signal contact for the control of the external back feed isolator to be installed on the bypass line upstream from the UPS.

3.5 Batteries

The VRLA, WET or NiCad batteries will feature an enclosure made of self-extinguishing material.
The batteries will be housed in one or more racks/ cubicles and will be protected by fuses located on each pole and via a dedicated switch.

4.0 OPERATING MODES

This section describes the different operating modes of the Uninterruptible Power System.

The UPS, using the above-mentioned digital vectorial control (DSP system), will be able to operate both in double conversion and digital interactive modes.

The operating mode may be factory set by the manufacturer during testing or by the customer using the appropriate diagnostic and control software.

The IGBT inverter will be synchronized with the bypass line so that the load can be transferred from the inverter (conditioned line) to the bypass supply (direct line) and vice versa without any break in the supply to the load.

In all operating modes, the battery charger will provide the power necessary to keep the battery fully charged.

4.1 Double conversion operation

In this operating mode, under normal service conditions, the load will always be supplied from the inverter, guaranteeing maximum protection for the load.

Upon failure or reduction of the primary AC source, the load will be supplied by the battery through the inverter. During this phase, power will be drawn from the battery. Visible and audible signals will alert the user to this operating state. The remaining autonomy time will be calculated by a diagnostic algorithm.

Upon return of the primary AC source to within tolerance limits, the Uninterruptible Power System will recommence operating in normal mode.

In the event of an inverter overload, manual stop or failure or temporary overload downstream of the UPS, the load will be automatically transferred to the bypass supply source without interruption.

In the event of an overload with an unsuitable supply, the Uninterruptible Power System will not transfer the load but will continue to supply it from the inverter for a period of time dependent upon the extent of the overload and the characteristics of the UPS.

The user will be alerted of these anomalous operating conditions via the alarm.

4.2 Digital interactive mode

In this operating mode, under normal service conditions, the load will always be supplied from the direct line through the bypass static switch. The quality of the direct line will be monitored constantly using algorithms operated in real time by the

DSP control system.

If the direct line is outside the permitted tolerances, the load will be automatically transferred to the conditioned line (inverter) without interruption.

In the absence of power supply to the direct and conditioned lines, the battery will supply power to the loads through the inverter. During this phase, power will be drawn from the battery and the battery charge will be reduced. Visible and audible signals will alert the user to this operating state. The remaining autonomy time will be calculated by a diagnostic algorithm.

When the quality and reliability of the direct line return within permitted limits, the UPS will automatically start supplying the load from the direct line.

4.3 Maintenance bypass switch

The UPS will be equipped with a bypass switch capable of transferring the load to the bypass supply without interruption so as to enable the UPS to be switched off and isolated for maintenance operations. The supply to the load will be maintained.

4.4 Controls and diagnostics

The controls for the electronic power supply modules will guarantee the following:

- A three-phase power supply which is ideal for the load
- Controlled battery recharging
- Minimum harmonic rejection to the upstream mains power supply (THDi<3% at full load, THDi<7% in any other condition).

The UPS will feature a digital vector control based on a DSP (Digital Signal Processor).
The special DSP algorithms must be designed to ensure rapid and flexible processing of the detected data, allowing rapid generation of controlled variables. It must also be possible to run the control for the electronic inverter devices in real time to:

- Improve short-circuit behavior (300% I_n for 10 ms, 150% I_n up to 5 s)
- Have a synchronised (precise phase) angle between UPS output and bypass network, in the event of mains voltage distortion
- Highly flexible parallel operation.

5 . 0 Microprocessor control and diagnostics

Operation and control of the UPS should be provided through the use of micro-processor-controlled logic. Indications, measurements and alarms, together with battery autonomy, will be shown on a graphic liquid crystal display (LCD). The procedures for start up, shutdown and manual transfer of the load to and from bypass will be explained in clear step-by-step sequences on the LCD display.

Warning/fault: this page contains information regarding various anomalies concerning power converters such as the bypass, rectifier, inverter and booster/charger. In addition to this there is also warning and fault information relating to the battery and the load.
Events log: displays the date and time of important UPS events, alarms and other warnings.

Measurements: this page holds the full set of measurements for each functional block (rectifier, bypass, booster/charger, batteries, inverter and load).
Battery: displays the battery status/values including temperature, cell voltage, capacity and run time as well as commands for allowing the user to configure battery testing.
Tools: this page allows users to customize the settings of the LCD display and to select the desired language, choosing between 15 languages.

5.1 Controls

The UPS will be provided with the following controls:

- Inverter start
- Inverter stop
- Reset faults
- Buzzer/mute alarm

5.2 Measurements

The UPS will provide the measurements (voltage, current and frequency) for every single internal functional block and this information will be directly accessible on the display, via the measurements button.

5.3 Signals and alarms

The UPS must provide signals and alarms for every single functional block. These signals must be directly accessible via the display, by clicking the warning and fault button.

The UPS will also:

- Clearly display, upon mains failure, the remaining battery autonomy which will be a function of battery status and charge (discharge curve, degradation, operating temperature, etc)
- Have three serial RS232 ports for compatibility and communications with special peripheral units and for remote connections
- Be able to support remote graphic measurement and signalling software
- Be able to interface with a network monitoring system using SNMP slot-in cards
- Provide a Tele-monitoring function (see description under section 6.0 "Tele-monitoring")

A voltage-free input will also be provided to disable the static switches and all power converters (EPO) in case of emergency.
Programmable I/O contacts (at least 4 voltage-free outputs and 2 inputs).

6.0 TELEMONITORING

This section defines the requirements of the system for remote monitoring and control from the Service Centre.

6.1 Monitoring and control from service centre

The system will be capable of analysing UPS operation and electrical supply in order to identify faults and thus prevent the occurrence of conditions likely to damage the equipment protected by the UPS.

The system will guarantee single or parallel UPS surveillance, 24 hours a day for

365 days a year by authorised technical personnel operating remotely. The system will provide a detailed, preventive analysis of connected UPS, without any of the disruption associated with an on-site visit.

The Tele-monitoring system will offer the following main features:

- Continuous monitoring and control of the performance of end-user UPS
- Bi-directional communications between end-user UPS, Authorised Service Centre and its authorised field service engineers
- Automatic location of Service Engineers in the event of anomalous UPS functioning (even at night and during public holidays)
- Possibility of using graphic software for remote in-depth analysis and control
- Periodic reports on UPS performance with advice from Service Centre engineers.

7.0 UNINTERRUPTIBLE POWER SYSTEM

TECHNICAL DATA SHEET

PARAMETERS	UNIT	SPECIFICATION	VENDOR CONFIRMATION
Inverter input characteristics			
Nominal voltage	(V)	400 V 4wire	
Tolerance on voltage	(%)	-15%,+20% @100% load	
Nominal frequency (60 Hz selectable)	(Hz)	50	
Tolerance on frequency	(%)	± 10	
Input power factor @ 100% load		>0.99	
Total harmonic distortion (THDi) @ full load	(%)	< 3	
Walk in /Soft start	(Sec)	10 (1 to 90 selectable)	
Rectifier Hold OFF (Sec)	(Sec)	10 (1 to 180 selectable)	
Inverter output characteristics			
Nominal voltage (380/415 selectable)	(V)	400 V 4wire	
Nominal frequency (60 Hz selectable)	(Hz)	50	
Nominal power @ 40°C	(kVA)	200	
Nominal Power @ 40°C	(kW)	200	
Automatic adjustment of nominal output power as a function of temperature	(%)	@25 °c = 110%	
	(%)	@30 °c = 110%	
	(%)	@40° c = 110%	
Output voltage stability in steady-state condition for input within permitted limits and load variations from 0 to 100%	(%)	±1%	

PARAMETERS	UNIT	SPECIFICATION	VENDOR CONFIRMATION
Stability in dynamic conditions for 100% load step variations	(%)	±5%	
Load crest factor without derating		3:1	
Output voltage distortion with 100% linear load	(%)	<1	
Output voltage distortion with non-linear load as specified by IEC/EN 62040-3	(%)	<3	
Output frequency stability in synchronization with mains (± 2 ± 3 ± 4 selectable)	(%)	±1	
Output frequency stability with internal clock	(%)	±0.1	
Frequency slew rate	(Hz/sec)	<1	
Permitted overload:			
for 10 minutes	(%)	125	
for 60 seconds	(%)	150	
Short circuit current:			
300% In	(ms)	10	
150% In	(s)	5	
Characteristics of electronic static changeover switch			
Nominal voltage (380/415 selectable)	(V)	400	
Tolerance on voltage (± 5 ¸ ± 15 selectable)	(%)	±10	
Nominal frequency (60 Hz selectable)	(Hz)	50	
Tolerance on frequency (± 2 ± 3 ± 4 selectable)	(%)	±1	
UPS characteristics			
Maximum UPS cabinet dimensions WxHxD	(mm)		
Noise level measured @ 1 meter and @ 100% load according to ISO 3746	(dBA)	70 dba	
AC/AC efficiency – double conversion mode @ 100% load(inbuilt K13 iso. Transformer)	(%)	94.5	
Efficiency in digital interactive mode @ 100% load	(%)	98	
EMC compatibility as per EN 62040-2		Class C3	
Degree of protection		IP 20	
Frame colour		RAL 7021	

The constructional and functional characteristics of UPS must be in line with the state-of-the-art technology in this field.
The supplying company must be able to provide proof that it is ISO 9001-2000 and ISO 14001 certified for design and manufacturing and for the provision of services.
The UPS will be guaranteed for one year during which time the Supplier will provide technical assistance.
The offer must include:

- a draft maintenance contract providing for 24 hour service with guaranteed minimum service call response time of 4 hours (references are required)
- the addresses of all Service Centres, divided according to geographical areas, and the number of engineers working for each centre
- Indication of main Tele-monitoring installations in operation.

7. LIGHTING ARRESTOR SYSTEM

1.0 GENERAL

1.1 The lightning protection system shall be of the enhanced type which is designed to attract lightning to a preferred point and safely convey the lightning energy to ground with minimal risk of side flashing via a predetermined route.

1.2 The complete lightning protection system will comprise the following key components.

(a) Advanced lightning rod
(b) Mounting support
(c) High voltage shielded cable
(d) Lightning Strike Recorder
(e) Dedicated earthing system

2.0 THE LIGHTNING ROD

2.1 The advanced lightning rod shall be of a "Controlled Advanced Triggering" type and will respond dynamically upon leader activity in the near area.

2.2 The advanced lightning rod shall be configured as a spheroid which is comprised of separate electrically isolated panels surrounding an earthed central finial.

2.3 The insulation material used to electrically isolate the panels shall be comprised of a base polymer which provides high ozone and UV resistance with a dielectric strength of 24 – 38 KV/mm.

2.4 The external shape of the advanced lightning rod shall be such that it will limit the development of sharp point corona discharge under static thunderstorm conditions.

2.5 The upper section of the central finial shall be rounded to provide a blunt surface.

2.6 The upper section of the central finial shall be rated to withstand 200KA.

2.7 An air gap shall be provided between the individual electrically isolated panels (4 panels) and the blunt configured tip of the central rod. Dome shapes and pointed central rods will not be acceptable.

2.8 Arcing shall occur between the panel sections of the spheroid and the blunt configured finial tip only upon the progression of a lightning leader.

2.9 The advanced lightning rod shall have no moving parts and will have no dependence on external power supply or batteries. There should be no high impedance static drain unit between the central rod and the panels.

2.10 Under a normal atmosphere all components of the advanced lightning terminal shall be non corroding.

2.11 The advanced lightning rod shall be installed at a minimum of 10 metres from the ground.

2.12 The advanced lightning rod shall be insulated from all surrounding points and features of the structure being protected.

2.13 The advanced lightning rod shall not be installed in a corrosive environment unless the manufacturers written approval has first been granted.

2.14 The advanced lightning rod shall be installed as per the manufacturers instructions.

2.15 The advanced lightning rod shall not be of the ESE type and all lightning terminals claiming compliance to NF C17-102 shall not be considered suitable.

2.16 The advanced lightning rod shall have been tested to the following standard IEC 601:1989.

2.17 The lightning rod shall be shown to have withstood a minimum current impulse of a 180kA 8/20 µs waveform as per the test standard IEC 60-1:1989.

3.0 MOUNTING SUPPORT OF LIGHTNING ROD

3.1 The mounting pole used to support the lightning rod shall be a circular insulating fibreglass tube at a minimum height of 2 metres. The pole will have an outside diameter of 68mm.

3.2 The mounting pole and supports shall be securely fixed with brackets and guy wires where required.

3.3 The downconductor shall pass through the centre of the insulating pole for the entire length of the pole.

4.0 HIGH VOLTAGE SHIELDED CABLE

4.1 The high voltage shielded cable shall consist of a core filler, stranded copper conductor, insulation material, outer copper conductor with external conductive sheath.

4.2 The main copper conductor within the high voltage shielded cable shall have a minimum cross sectional area of 50mm^2.

4.3 The outer diameter of the high voltage shielded cable shall be less than 38mm.

4.4 The high voltage shielded cable shall have a maximum inductance of 25 nH/m.

4.5 The main copper conductor shall allow for direct connection to the lightning rod through the use of a compression lug.

4.6 The high voltage shielded cable shall be fixed to the structure through the use of suitable saddles every two metres for the length of the cable route.

4.7 The high voltage shielded cable shall be installed as per manufacturers instructions and shall not be subject to bends of less than 0.6 metres radius.

4.8 The high voltage shielded cable shall have been tested to the following standard IEC 60-1:1989.

4.9 The high voltage shielded cable shall have been subjected and successfully withstood a maximum voltage of 280kV in compliance to IEC test standard, IEC 600601, 2nd edition, 1989-11.

5.0 EVENT RECORDING DEVICE

5.1 All systems shall be installed complete with the lightning strike recorder.

5.2 The lightning strike recorder shall contain a mechanical 6 digit display which will register all lightning discharges with a sensitivity of 1500A 8/20 µs peak current impulse.

5.3 The lightning strike recorder shall be housed in a IP 67 rated enclosure and will operate without reliance on batteries or an external power source.

5.4 The lightning strike recorder shall be installed as per the manufacturers instructions.

5.5 It shall be shown that the event recording device has been successfully tested under test standard IEC 60-1:1989.

6.0 EARTHING

6.1 The earthing system shall incorporate the following individual components or a combination of the following – 25 x 1mm flat copper tape buried to a depth of not more than 800mm or by deep driven copper bonded steel core earth rods. All components of the earthing system shall be electrically connected to the central injection rod which is securely connected to the lower end of the high voltage shielded cable.

6.2 The earthing system shall be installed so that the final impedance reading does not exceed 10 Ohms unless otherwise stipulated by the lightning protection manufacturer or consulting engineer.

6.3 It is recommended that the earthing system is bonded to all structural reinforcing steel of the building, along with all connecting services.

6.4 The use of ground resistance improvement material shall be applied in order to reduce the resistivity levels of the earthing system.

8. AUTOMATIC TRANSFER SWITCH

1.0 415V Auto Transfer Switch

1.1 General

1.1.1 Scope

This specification covers performance, design, material, construction, manufacture, inspection, testing, packing forwarding, delivery at site, testing and commissioning of microprocessor controlled Auto transfer switches – with double throw power transfer switch mechanism as per single line diagrams, with all accessories complete in all respects as described in this specification.

Whether called for specifically or not, all accessories required for normal operation of equipment are deemed to be considered as a part of the contractor's scope of supply. Hardware / fabricated supports required for mounting and installation of the ATS is within the scope of work.

It is not the intent to specify completely herein, all details of design and construction of the equipment. However, the equipment shall conform in all respects to high standard of Engineering, design and workmanship and be capable of performing in continuous commercial operation up to the Manufacturer's guarantees in a manner acceptable to the Engineer, who will interpret the meaning of the drawings and specifications and shall be entitled to reject any work or material which is not full accordance therewith.

1.1.2 Codes and Standards

The automatic transfer switches and controls shall conform to the requirements of:

UL 1008 - Standard for Transfer Switch Equipment

IEC 947-6-1 - Low-voltage Switchgear and Control gear; Multifunction equipment; Automatic Transfer Switching Equipment

NFPA 70 - National Electrical Code

NFPA 99 - Essential Electrical Systems for Health Care Facilities

NFPA 110 - Emergency and Standby Power Systems

IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications

NEMA Standard ICS10-1993 (formerly ICS2-447) - AC Automatic Transfer Switches

UL 508 - Industrial Control Equipment

1.2 Products

1.2.1 Mechanically Held Transfer Switch

The transfer switch shall be electrically operated and mechanically held. The electrical operator shall be a momentarily energized, single-solenoid mechanism. Main operators which include overcurrent disconnect devices, linear motors or gears shall not be acceptable. The switch shall be mechanically interlocked to ensure only two possible positions, normal or emergency. The switch shall be rated for AC-33A duty cycle for mixed load application as mentioned in IEC 60947-6-1.

All transfer switch sizes shall use only one type of main operator for ease of maintenance and commodity of parts.

The switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.

All main contacts shall be silver composition. Switches rated 600 amperes and above shall have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.

Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. Switches rated 600 amps and higher shall have front removable and replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.

Designs utilizing components of moulded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.

Where neutral conductors must be switched as shown on the plans, the AS shall be provided with fully rated complete overlapping neutral transfer contacts. The neutrals of the normal and emergency power sources shall be connected together only during the transfer and retransfer operation and remain connected together until power source contacts close on the source to which the transfer is being made. The overlapping neutral contacts shall not overlap for a period greater than 100 milliseconds. Neutral switching contacts which do not overlap are not acceptable.

Where neutral conductors are to be solidly connected as shown on the plans, a neutral conductor plate with fully rated CU pressure connectors shall be provided.

1.2.2 Microprocessor Controller

The controller's sensing and logic shall be provided by a single built-in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate serially through an optional serial communication module.

A single controller shall provide twelve selectable nominal voltages for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to ± 1% of nominal voltage. Frequency

sensing shall be accurate to ± 0.2%. The panel shall be capable of operating over a temperature range of -20 to +60 degrees C and storage from -55 to +85 degrees C.

The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Sensing and control logic shall be provided on multi-layer printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. The protective cover shall include a built-in pocket for storage of the operator's manuals.

All customer connections shall be wired to a common terminal block to simplify field-wiring connections.

The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:

EN 55011:1991	Emission standard - Group 1, Class A
EN 50082-2:1995	Generic immunity standard, from which:
EN 61000-4-2:1995	Electrostatic discharge (ESD) immunity
ENV 50140:1993	Radiated Electro-Magnetic field immunity
EN 61000-4-4:1995	Electrical fast transient (EFT) immunity
EN 61000-4-5:1995	Surge transient immunity
EN 61000-4-6:1996	Conducted Radio-Frequency field immunity

IEEE472 (ANSI C37.90A) Ring Wave Test.

1.3 Operation

1.3.1 Controller Display and Keypad

A four line, 20 character LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the serial communications input port. The following parameters shall only be adjustable via DIP switches on the controller:

Nominal line voltage and frequency
Single or three phase sensing
Operating parameter protection
Transfer operating mode configuration
(Open transition, Closed transition or Delayed transition)
All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.

1.3.2 Voltage, Frequency and Phase Rotation Sensing

Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout and trip setting capabilities (values shown as % of nominal unless otherwise specified):

Parameter	Sources	Dropout / Trip	Pickup / Reset
Undervoltage	N&E,3ϕ	70 to 98%	85 to 100%

Overvoltage	N&E,3ϕ	102 to 115%	2% below trip
Underfrequency	N&E	85 to 98%	90 to 100%
Overfrequency	N&E	102 to 110%	2% below trip
Voltage unbalance	N&E	5 to 20%	1% below dropout

Repetitive accuracy of all settings shall be within ± 0.5% over an operating temperature range of -20°C to 60°C.

Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.

The controller shall be capable (when activated by the keypad or through the serial port) of sensing the phase rotation of both the normal and emergency sources. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC or CBA).

Source status screens shall be provided for both normal & emergency to pro-vide digital readout of voltage on all 3 phases, frequency, and phase rotation.

1.3.3 Time Delays

An adjustable time delay of 0 to 6 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals. Capability shall be provided to extend this time delay to 60 minutes by providing an external 24 VDC power supply.

A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.

Two time delay modes (which are independently adjustable) shall be provided on re-transfer to normal. One time delay shall be for actual normal power failures and the other for the test mode function. The time delays shall be adjustable from 0 to 60 minutes. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.

A time delay shall be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.

A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minute time delay in any of the following modes:

Prior to transfer only.
Prior to and after transfer.
Normal to emergency only.
Emergency to normal only.
Normal to emergency and emergency to normal.
All transfer conditions or only when both sources are available.

The controller shall also include the following built-in time delays for optional Closed Transition and Delayed Transition operation:

1. 1 to 5 minute time delay on failure to synchronize normal and emergency sources prior to closed transition transfer.
2. 0.1 to 9.99 second time delay on an extended parallel condition of both power sources during closed transition operation.
3. 0 to 5 minute time delay for the load disconnect position for delayed transition operation.

All time delays shall be adjustable in 1 second increments, except the extended parallel time, which shall be adjustable in .01 second increments.

All time delays shall be adjustable by using the LCD display and keypad or with a remote device connected to the serial communications port.

1.3.4 Additional Features

A three position momentary-type test switch shall be provided for the **test / automatic / reset** modes. The test position will simulate a normal source failure. The reset position shall bypass the time delays on either transfer to emergency or retransfer to normal.

A SPDT contact, rated 5 amps at 30 VDC, shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.

Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact closed, when the ATS is connected to the emergency source.

LED indicating lights (16 mm industrial grade, type 12) shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red).

LED indicating lights (16 mm industrial grade, type 12) shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal and emergency sources, as determined by the voltage sensing trip and reset settings for each source.

The following features shall be built-in to the controller, but capable of being activated through keypad programming or the serial port only when required by the user:

Provide the ability to select “commit/no commit to transfer” to determine whether the load should be transferred to the emergency generator if the normal source restores before the generator is ready to accept the load.

Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal. Both of these inhibit signals can be activated through the keypad or serial port.

An In phase monitor shall be provided in the controller. The monitor shall control transfer so that motor load inrush currents do not exceed normal starting currents, and shall not require external control of power sources. The in phase monitor shall be specifically designed for and be the product of the ATS manufacturer.

The controller shall be capable of accepting a normally open contact that will allow the transfer switch to function in a non-automatic mode using an external control device.

1.3.5 Engine Exerciser

The controller shall provide an internal engine exerciser. The engine exerciser shall allow the user to program up to seven different exercise routines. For each routine, the user shall be able to:

1. Enable or disable the routine.
2. Enable or disable transfer of the load during routine.
3. Set the start time
- time of day
- day of week
- week of month (1st, 2nd, 3rd, 4th, alternate or every)

4. Set the duration of the run.

At the end of the specified duration the switch shall transfer the load back to normal and run the generator for the specified cool down period. A 10-year life battery that supplies power to the real time clock in the event of a power loss will maintain all time and date information.

1.3.6 System Status

The controller LCD display shall include a “System Status” screen which shall be readily accessible from any point in the menu by depressing the “ESC” key a maximum of two times. This screen shall display a clear description of the active operating sequence and switch position. For example,

Normal Failed
Load on Normal
TD Normal to Emerg
2min15s

Controllers that require multiple screens to determine system status or display “coded” system status messages, which must be explained by references in the operator’s manual, are not permissible.

1.3.7 Self Diagnostics

The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.

1.3.8 Communications Interface

The controller shall be capable of interfacing, through an optional serial communication module, with a network of transfer switches, locally (up to 4000 ft.) or remotely through modem serial communications. Standard software specific for transfer switch applications shall be available by the transfer switch manufacturer. This software shall allow for the monitoring, control and setup of parameters.

1.3.9 Data Logging

The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in a non-volatile memory:

1. Event Logging
1. Data and time and reason for transfer normal to emergency.
2. Data and time and reason for transfer emergency to normal.
3. Data and time and reason for engine start.
4. Data and time engine stopped.
5. Data and time emergency source available.
6. Data and time emergency source not available.

2. Statistical Data
1. Total number of transfers.
2. Total number of transfers due to source failure.
3. Total number of days controller is energized.
4. Total number of hours both normal and emergency sources are available.

1.3.10 Communications Module

A full duplex RS485 interface & Ethernet TCP/IP RJ45 socket shall be installed in the ATS controller to enable serial communications. The serial communications shall be capable of a direct connect or multi-drop configured network. This module shall allow for the seamless integration of existing or new communication transfer devices through Modbus open protocol. The proprietary protocols are not acceptable.

1.4 Additional Requirements

1.4.1 Withstand and Closing Ratings

The ATS/BPS shall be rated to close on and withstand the available RMS symmetrical short circuit current at the ATS/BPS terminals with the type of overcurrent protection shown on the plans.

The ATS/BPS shall be UL-1008 and IEC-60947-6-1 complied & in accordance with UL 1008 listing and be labeled in accordance with that standard's 1½ and 3 cycle,

long-time ratings. ATS/BPS which are not tested and labeled with 1½ and 3 cycle (any breaker) ratings and have series, or specific breaker ratings only, are not acceptable**.**

The ATS rated 800A and above must be tested for 18/30 cycles short time withstand capacity matching breaker fault level to enable use of ACB as a back up protection device with short time delay setting for providing discrimination with the downstream breakers.

9 BUSDUCT

Scope:

The specifications comprises of performance, design, material, construction, manufacture, inspection, testing, packing forwarding, delivery at site, testing and commissioning of medium voltage sandwich type bus duct / rising mains, indoor/outdoor type as per site requirement for interconnection between indoor M.V. switchgear & outdoor transformer.

Whether called for specifically or not, all accessories required for normal operation of equipment are deemed to be considered as a part of the contractor's scope of supply. Hardware / fabricated supports required for mounting and installation of the busducts / rising mains is within the scope of work.

It is not the intent to specify completely herein, all details of design and construction of the equipment. However, the equipment shall conform in all respects to high standard of Engineering, design and workmanship and be capable of performing in continuous commercial operation up to the Manufacturer's guarantees in a manner acceptable to the Engineer, who will interpret the meaning of the drawings and specifications and shall be entitled to reject any work or material which is not full accordance therewith.

General

The current rating of bus duct shall be as indicated in the specific requirements/schedule of quantities/drawing.

The size of the neutral bus bar shall 100% of the phase busbar.

Note: Before fabrication and installation of the bus duct is taken up, the layout of the M.V. switchgear and transformer shall be got approved by Engineer and the bus duct layout properly co-ordinated.

Standards

The following standards shall be recognized:

IS : 8623 – 1993 I & II – Busbar trunking system
IS : 4237 - General requirement of switchgear.
IS: 375 - Marking arrangement for switchgear, busbar.
IS: 5 - Colours for ready mixed paints
IS: 2147- Degree of protection provided by the enclosure for L.V. switchgear.
IS: 158 – Ready mixed water and hear resistant paint for general purposes.

Rating details:
(I) Rated 3 Phase voltage: 415 volt, IP 54 Category
(II) Standard insulation withstand for one minute: 1000 v
(III) Rated frequency: 50 HZ
(IV) Asymmetrical short circuit current: 60 KA r.m.s.
(V) Maximum bubar operating temperature at full rated current above ambient: $55^{o}C$
(VI) Maximum ambient temperature: 50^{0} C
(VII) Current rating: 3500 A TPN EC grade sleeved Cu busbars busduct.
(VIII) Rated impulse withstand voltage – 12 KV at 1000 V

9.1 Enclosures

9.1.1 Construction

The eclosure shall be made from 16 SWG GI / CRCA sheet steel powder coated to shade RAL 7032 (or such other shade) or from extruded aluminium sheet. Busbars would be in sandwich construction and the conductors shall be individually insulated with four layers of insulating film. Inner layer shall be of glass MICA and outer layer shall be of polyester material of Class F. Alternatively extrusion of class

F material in form of epoxy insulation may be provided. No drilling of busbars is permitted. Copper conductors shall be of 99.9% purity and ETP grade with radialised edges. Lengths of section shall be limited to max 3 meters. Busbars of one section shall be connected to busbars of adjacent section by uniblock joint system removable as separate sub assembly so that it can be inserted or removed without disturbing the adjacent sections.

9.1.2 Installation as rising mains

For installation as rising mains / vertical installation at each floor a set consisting of 2 spring hangers shall be provided for fixing it on channels grouted in wall. At the start of run hangers without springs may be used for the rigid support. In addition horizontal supports shall be provided -2 nos per floor to hold busbars in position. On rising mains on front face of the busbar trunking Tap Off points shall be provided for inserting plug in boxes. No. of tap of points at each floor shall be as per requirement given in BOQ / SLD; but min distance between tap off points shall be kept around 500 mm. Each tap off opening closed by insulated shutters forming part of BBT, when not occupied by plugin boxes. Neutral cross section shall be same as phase cross section. Necessary vertical / horizontal bends / Tees / fire barriers etc shall be provided as required by the layout.

Busbar trunking shall be rigidly fixed to the side walls or suspended from ceiling by supports as per requirements detailed in the shop layout.

At the termination either on the transformer side / generator end / switchgear end, busduct shall be provided with flange end / adaptor box / copper flexible (preferably multisheath types) / phase change overs if required to connect busbars of busduct to the busbars of switchgears / transformers / generator terminals.

Expansion units shall be installed after every 50 mtrs of uninterrupted run for composite expansion of complete bus trunking run.

9.1.3 Earth Bus

Integral Earth Bus of copper should be provided for entire length of the bus trunk. Suitable copper links shall be provided at the joints of bus duct. Earth bus at the point of wall entry should have suitable arrangement as approved by the purchaser. Size of earth bus shall be as per IEC 60439.

9.2 Plug In Boxes:

These are required for rising Mains. Plug in boxes will be of draw out type. Contacts will be of silver plated copper and spring loaded. Earth connection will be the first to make and last to break during insertion and withdrawal. Plug in box will be made from 1.6mm CRCA sheet steel powder coated or GI. Inside the plug in boxes MCCB / ACB will be located as per requirements. The operating handle will be interlocked with plug in box cover so that MCCB can be operated only with suitable cover in closed position. If required the plug in box will be interlocked with bus bar trunking so that it could be inserted or removed with the plug in box lid opened. MCCB/ACB will be of 4 pole type unless otherwise specified in BOQ. Short circuit breaking capacity of MCCB in PIB should preferably be same as short circuit with stand for one second of bus bar trunking.

9.3 End Feed Unit:

The End feed unit will be manufactured from 1.6mm thick steel with powder coating to shade RAL 7032 or of GI. Inside the End feed unit MCCB/ACB of required rating and specification will be located. End feed units at top will be connected to Bus bars of Rising Mains through solid connections. Terminals at the bottom will be provided to accept cable connections as required. The operating handle of MCCB/ACB will be interlocked so that the door can be opened only when MCCB or ACB are in off position. The current rating of MCCB should correspond with current rating of bus bar trunking and short circuit breaking capacity with one second short circuit withstand of bus bar trunking.

9.4 Transposition:

Transposition of bus bars should be done preferably in ACB adaptor chamber. Cost of adaptor chamber should be included in indoor bus duct. The tenderer should indicate clearly for any extra prices if required, for adaptor chamber and the length of adaptor chamber in that case should be indicated clearly. Terminal arrangement of transformers will be furnished to the successful tenderer at a later date.

9.5 Current Rating Of Bus Duct:

The tenderer must furnish complete data for the bus duct for calculating the net current rating of bus duct.

Details of bus duct:

The following data must be furnished along with the tender:

(a) Material of bus bars and its purity.
(b) Overall size of the bus duct enclosure.
(c) No of bus bars for each phase and neutral and bus bar size
(d) Clearance between bus bars of same phase.
(e) Sketch showing arrangements of bus bars.
(f) Net current ratings of bus duct.

9.6 Drawing:

Detailed layout and fabrication drawings showing the sizes of bus bars enclosure, fixing, details, supports, bends, joints, wall entry assembly etc. shall be submitted by the Contractor for approval of Engineer in charge/purchaser's comments /modifications suggested by; the Purchaser shall be incorporated by the Contractor. **Actual fabrication of the bus duct shall be carried out only after the approval of the purchaser, with respect to actual physical location of main panel incomer and transformer L.T. cable box for dimensions (i.e. cross checking of dimensions and phase sequence shown in panel / transformer GA drawings)**

10. 1.1 KV GRADE L.T. CABLES AND CABLE TERMINATION

L. T. XLPE CABLE : - FRLSH CU CATEGORY

GENERAL :

The medium voltage cables shall be supplied, laid, connected, tested and commissioned in accordance with the drawings, specifications, relevant Indian Standards specifications, manufacturer's instructions. The cables shall be delivered at site in the original drums with manufacturer's name, size and type clearly written on the drums.

All cables shall be adequately protected against any risk of mechanical damage to which they may be liable in normal conditions of handling during transportation, loading, unloading etc.

The cable shall be supplied in single length i.e. without any intermediate joint or cut unless specifically approved by the client.

The cable ends shall be suitably sealed against entry of moisture, dust, water etc. with cable compound as per standard practice.

CONDUCTOR :

Uncoated, annealed copper of high conductivity, upto 4 mm2 size the conductor shall be solid and above 4 mm2 the conductors shall be concentrically stranded as per IEC : 228.

INSULATION :

Cross link polyethylene (XLPE) extruded insulation rated at 70oc.

CORE INDENTIFICATION :

Two core	:	Red and Black
Three core	:	Red, Yellow and Blue
Four core	:	Red, Yellow, Blue and Black
Single core	:	Green, Yellow for earthing.

Black shall always be used for neutral.

ASSEMBLY :

Two, three or four insulated conductors shall be laid up, filled with non-hygroscopic material and covered with an additional layer of thermoplastic material.

ARMOUR :

Galvanised steel flat strip / round strips applied helically in single layers complete with covering the assembly of cores.

For cable size upto 10 sq mm : Armour of 1.4 mm dia G.I. round wire

For cable size above 10 sq mm: Armour of 4 mm wide 0.8 mm thick GI strip

SHEATH :

ST -2 PVC along with polypropylene fillers to be provided.

Inner sheath shall be extruded type and shall be compatible with the insulation provided for the cables.

Outer sheath shall be of an extruded type layer of suitable PVC material compatible with the specified ambient temp. of 50oc and operating temperature of cables. The sheath shall be resistant to water, ultra violet radiation, fungus, termite and rodent attacks. The colour of outer sheath shall be black.

Sequential length marking along with size and other standard parameters shall be required at every 1.0 mtr on the outer sheath.

The product should be coded as per IS :- 7098 Part-I as follows :-

Aluminium Conductor	A
XLPE Insulation	2X
Steel round wire armour	W
Steel flat strip armour	F
Steel Double round wire armour	WW
Steel Double flat strip armour	FF
Non-magnetic (Al.) round wire armour	Wa
Non-magnetic (Al.) flat strip armour	Fa
PVC outer sheath	Y

TESTING :

Finished cable tests at manufacturers works : The finished cables shall be tested at manufacturer's works for all the routine tests for all the length and size of cables to be delivered at site and the certificate for the same shall be furnished to client. If required the cables shall be tested in presence of the client's representative.

Voltage test : Each core of cable shall be tested at room temperature at 3 KV A.C. R.M.S. for duration of 5 minutes.

Conductor resistance test : The D.C. resistance of each conductor shall be measured at room temperature and the results shall be corrected to 20oc to check the compliance with the values specified in the Is 8130 – 1976.

Cable tests before and after laying cables at site :

Insulation resistance test between phases, phase to neutral and phase to earth.

Continuity test of all the phases, neutral and earth continuity conductor.

Earth resistance test of all the phases and neutral.

All the tests shall be carried out in accordance with the relevant IS code of practise and Indian Electricity Rules. The vendor shall provide necessary instruments, equipments and labour for conducting the above tests and shall bear all the expenses in connection with such tests. All tests shall be carried out in the presence of client and the results shall be prescribed in forms and submitted.

CABLE MARKING :

The outer sheath shall be legibly embossed at every meter with following legend :

ELECTRIC CABLE : 1100 V, SIZE :___C X ____ MM2 with Manufacturers name, year of manufacturing and ISI symbol.

SEALING DRUMMING AND PACKING :

After tests at manufacturer's woks, both ends of the cables shall be sealed to prevent the ingress of moisture during transportation and storage.

Cable shall be supplied in length of 500 mtrs or as required in non-returnable drums of sufficiently sturdy construction.

Cables of more than 250 meters shall also be supplied in non-returnable drums.

The spindle hole shall be minimum 110 mm in diameter.

Each drum shall bear on the outside flange, legibly and indelibly in the Englist literature, a distinguishing number, the manufacturer's name and particulars of the cable i.e. voltage grade, length, conductor size, cable type, insulation type, and gross weight shall also be clearly visible. The direction for rolling shall be indicated by an arrow. The drum flange shall also be marked with manufacturer's name and year of manufacturing etc.

CABLE TERMINATION:

Cable terminations shall be made with aluminium crimped type solder less lugs for all aluminium cables and stud type terminals. For copper cables copper crimped solder less lugs shall be used.

Crimping shall be done with the help of hydraulically operated crimping tool.

For joints where by cable is with aluminium conductor and busbars are aluminium, bimetallic lugs shall be used with compound. CUPAL type of washers shall be used.

Crimping tool shall be used for crimping any size of cable.

CABLE GLANDS:

Cable glands shall be of brass single compression type. Generally single compression type cable glands shall be used for indoor protected locations and double compression type shall be used for outdoor locations.

FERRULES:

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

CABLE JOINTS:

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

WORKMANSHIP

Cables shall be laid in the routes marked in the drawings. Where the route is not marked, the Contractor shall mark it out on the drawings and also on the site and obtain the approval of the CLIENT AND/OR ITS ARCHITECT before laying the cable. Procurement of cables shall be on the basis of actual site measurements and the quantities shown in the schedule of work shall be regarded as a guide only.

Cables shall be laid on walls, cable trays, inside shafts or trenches. Saddling or support for the cable shall not be more than 500 mm apart. Plastic identification tags shall be provided at every 30 m.

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

In the case of cables buried directly in ground, the cable route shall be parallel or perpendicular to roadways, walls etc unless marked on drawing by architect / consultant. Cables shall be laid on an excavated, graded trench, over a sand or soft earth cushion to provide protection against abrasion. Cables shall be protected with brick or cement tiles on all the three sides as shown on drawings. Width of excavated trenches shall be as per drawings. Back fill over buried cables shall be with a minimum earth cover of 750 mm to 1000 mm. The cables shall be provided with cables markers at every 10 meters and at all loop points.

All cables shall be full runs from panel to panel without any joints or splices. Cables shall be identified at end termination indicating the feeder number and the Panel/Distribution board from where it is being laid. Cable termination for conductors up to 4 sq.mm. may be insertion type and all higher sizes shall have compression type lugs. Cable termination shall have necessary brass glands. The end termination shall be insulated with a minimum of six half-lapped layers of PVC tape. Cable armouring shall be earthed at both ends.

In case of cables entering the buildings. It would be done duly only through pipes. The pipes shall be laid in slant position, so that no rainwater may enter the building. After the cables are tested the pipes shall be sealed with M. seal & then tarpaulin, shall be wrapped around the cable for making the entry watertight.

Testing : MV cables shall be tested upon installation with a 500 V `Meggar and the following readings established:
Continuity on all phases.
Insulation Resistance.
between conductors.
all conductors and ground.

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

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

Format for cable testing certificate :

a. Drum no. from which cable is taken :
b. Cable from _____ to _____
c. Length of run of this cable _____ mtr
d. Insulation resistance test
between core 1 to earth _____mega-ohm
between core 2 to earth _____mega-ohm
between core 3 to earth _____mega-ohm
between core 1 to core 2 _____mega-ohm
between core 2 to core 3 _____mega-ohm
between core 1 to core 3 _____mega-ohm
duration used :
e. High voltage test : Voltage Duration
between core and earth
between individual cores

3 FACTORY ACCEPTANCE TEST FOR ALL BOUGHT OUT ITEMS

client, his consultant and their authorized representative shall have the right to inspect and test or get inspected and tested the goods at the works of the Seller or its sub suppliers any time during manufacture and prior to dispatch and to inspect within a reasonable time after arrival of goods at the ultimate destination and during and after erection, testing and commissioning. The goods shall not be deemed accepted until after the said inspection, testing and commissioning and signing of the Acceptance Certificate. Failure to make any inspection of or payment for or acceptance of goods shall in no way impair client right to reject non-conforming goods or to avail itself of any other remedies to which client may be entitled, notwithstanding client knowledge of the nonconformity, its substantiality in the case of its discovery. In the event of failure of Seller to remove the rejected goods within the time allowed, client shall have the right to dispose of the same at the seller's risk and cost. During the time the rejected goods lie with client awaiting removal by the seller, they will so lie at the seller's risk. All goods rejected by client after receipt at the destination shall be removed by the seller within a reasonable time allowed by client, not exceeding 30 (thirty) days at seller's expense and risk.

The Seller will permit client Inspectors, Consultant and their authorized representatives free access during normal working hours to his works, godown, storage or loading spot etc. and will give them all necessary assistance to perform their task including free use of all accessories, testing and control instruments. The seller shall ensure that the same facilities are granted by his sub-suppliers.

Unless specifically stated to the contrary in the order, all expenses relevant to the preparation and performance of testing, inspection and preparation of any test reports or certificates shall be borne by the Seller EXCEPT for the salaries, fees,

traveling, lodging and boarding expense of the Consultant's / client's representatives. However, if the visit duration of Consultant's / client's representatives is extended for the reasons not attributable to Consultant / client, the cost of the extended period of visit shall be borne by the seller.

The sellers shall carry out tests related to performance tests as described in the specifications and specified in the order. All such performance tests shall be at supplier costs. Supplier shall also provide all the tests certificates and documents as demanded by the Inspector for his satisfaction that the order has been executed as per PO specifications. All such certificates, documents in original shall be submitted to the Client before dispatch of material. The goods shall be dispatched from suppliers shop only after written confirmation from clients / or its authorized representative.

The contractor shall consider all cost towards inspection of goods by consultant / EIC at factory / manufacturers works prior to shipping for 2 persons. (travelling (Air / 1st AC) / stay etc complete)

Technical Specification for Lightning Protection Devices as per IEC 62305 at different protection level.

Standards:

IEC 62305- 2 – Risk Management
IEC 62305-3 – Protection against Lightning.
IS/IEC 62305 - Protection Against Lightning Part 2 Risk Management.
IS 2309 – Code of Practice for the protection of Building.
IEC 62561 -2 & 7 – Earthing and Bonding.

Lightning Protection:

This part of IEC 62305 provides the requirements for protection of a structure against physical damage by means of a lightning protection system (LPS), and for protection against injury to living beings due to touch and step voltages in the vicinity of an LPS.

Lightning is one of the most devastating natural phenomena. There are many discharges during lightning storms and some of them can even reach hundreds of kilo amperes. The electrical discharges are a great hazard to people, animal, buildings and electronic equipment's. Until now, there is no device that can prevent lightning formation or lightning strikes. However, it is possible to create a path (divert) for the lightning discharge to the ground which will minimise the damage to the environment through a well-designed Lightning Protection System (LPS). The purpose of a lightning protection system is to protect buildings from direct lightning strikes and possible fire or from the consequences of lightning currents (non-igniting flash). If national regulations such as building regulations, special regulations or special directives require lightning protection measures, they must be implemented. If these regulations do not specify a class of LPS, a lightning protection system which meets the requirements of class of LPS III according to IEC 62305-3 (EN 62305-3) is recommended as a minimum. In principle, a risk analysis, which is described in the IEC 62305-2 (EN 62305-2) standard (see chapter 3.2.1), should be performed for an overall assessment.

An external LPS is intended to:

a) intercept a lightning flash to the structure (with an air-termination system);
b) conduct the lightning current safely towards earth (using a down-conductor system);
c) disperse the lightning current into the earth (using an earth-termination system).

An internal LPS prevents dangerous sparking within the structure using either equipotential bonding or a separation distance (and hence electrical insulation) between the external LPS components and other electrically conducting elements internal to the structure.

Lightning Current & Protection levels.

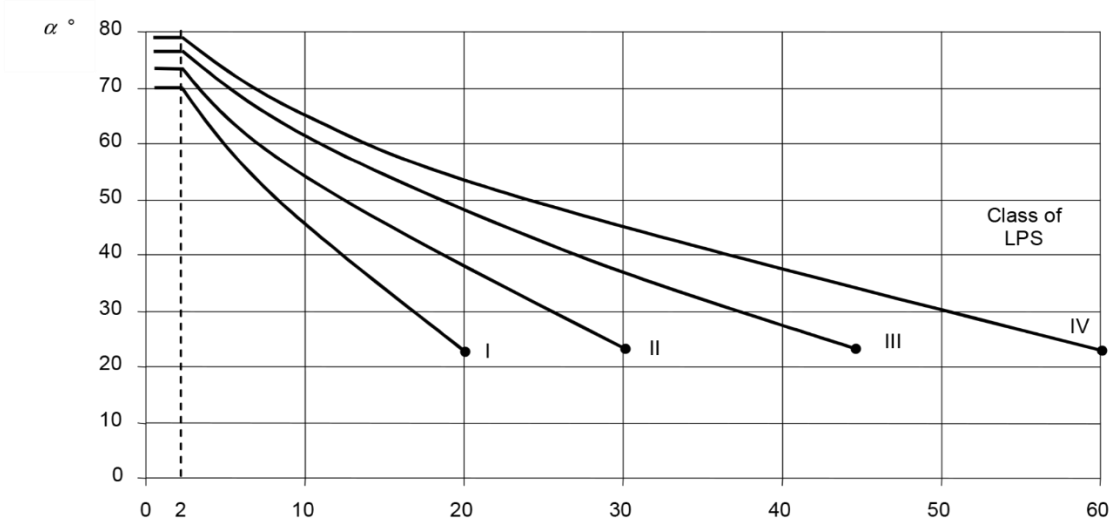
In order to define lightning as a source of interference, lightning protection levels I to IV are laid down. Each lightning protection level requires a set of

• maximum values (dimensioning criteria used to design lightning protection components to meet the demands expected to be made of them).

• minimum values (interception criteria necessary to be able to determine the areas with sufficient protection against direct lightning strikes (radius of rolling sphere).

Maximum value of rolling sphere radius, mesh size and protection angle corresponding to the class of LPS

Protection Method			
Class of LPS	**Rolling Sphere Radius r m**	**Mesh size W m**	**Protection angle α**
I	20	5 x 5	As per figure below
II	30	10 x 10	
III	45	15 x 15	
IV	60	20 x 20	



LPL levels basic design consideration:

Class of LPS	Lightning current		Interception probability	Rolling sphere radius (m)	Mesh siz (m)	Down Conducto Spacing
	MINIMUM	MAXIMUM				
1	3 kA	200 kA	98%	20	5 x 5	10
2	5 kA	150 kA	95%	30	10 x 10	10
3	10 kA	100 kA	88%	45	15 x 15	15
4	16 kA	100 kA	81%	60	20 x 20	20

Protection Class for the structure as per LPL (Lightning Protection Level)

Application	LPL*
Computer Data Centres, Military Applications, Nuclear Power Stations, High raise Hotels/Hospitals, airports, essential services such as telecom towers	**I**
EX-Zones in the industry and chemical sector, Low raise Hospitals & Hotels, fuel retail outlets, gas station, compressor station etc.	**II**
Schools, Banks, Residential Buildings, Temple, Churches, Mosques	**III or IV**

Air Terminal System:

An air-termination system shall be installed to protect the upper part of tall structures from direct lightning strike (i.e. typically the topmost 20 % of the height of the structure) and the equipment installed on it.
for positioning air-termination systems on roofs shall also apply to those upper parts of structures.
In addition, for structures taller than 120 m, all parts which may be endangered above 120 m
should be protected.

Materiel Description: For Mesh (Horizontal) arrangement 8 mm dia Aluminium round conductor.
For Vertical Air terminal: 25mm dia, 16 mm dia, 10 mm dia APS make copper plated pipe.

Connectors & Joints:

Materiel details	**Connector Type**
Aluminium to Aluminium	Aluminium, Gun Metal
Aluminium to Steel	Gun Metal

Round conductor Holder:

For Concrete / RCC Roof: The fixing of roof conductor holder with DMC insulator min height of 50 mm 8 mm round at every 1 meter and The Holder can be fixed with glue and screw.
For Metal shed.

If any structure like AC panel, Vent, ducts etc need to protect from Vertical Air Terminal after calculation of separation distance.

Down Conductor:
In order to reduce the probability of damage due to lightning current flowing in the LPS, the down-conductors shall be arranged in such a way that from the point of strike to earth:

a) several parallel current paths exist;
b) the length of the current paths is kept to a minimum;
c) equipotential bonding to conducting parts of the structure is performed according to the
requirements.

Typical value of the distance between down- conductor and between ring conductors according to the class of LPS

Class of LPS	**Typical distance m**

I	10
II	10
III	15
IV	20

Down Conductor Holder:

For Concrete wall: The fixing of roof conductor holder with DMC insulator min height of 50 mm 8 mm round at every 1 meter and The Holder can be fixed with glue and screw.
For Metal shed.

Test Joint:
At the connection of the earth termination, a test joint should be fitted on each down conductor,
except in the case of natural down-conductors combined with foundation earth electrodes.
For measuring purposes, the joint shall be capable of being opened with the aid of a tool. In
normal use it shall remain closed. The test joint shall be in IP 65 rated box and copper bus bar of 25 x 3 x 150 mm.

Earthing arrangement:
An earthing system or grounding system connects specific parts of that installation with the Earth's conductive surface for safety and functional purposes.

For earth-termination systems, two basic types of earth electrode arrangements apply.

Type A arrangement:
This type of arrangement comprises horizontal or vertical earth electrodes installed outside
the structure to be protected connected to each down-conductor. In type A arrangements, the total number of earth electrodes shall be not less than two.

Type B arrangement

This type of arrangement comprises either a ring conductor external to the structure to be Protected, in contact with the soil for at least 80 % of its total length, or a foundation earth electrode. Such earth electrodes may also be meshed.

Materiel used for Type A and B:
Earthing Rod: Low carbon high tensile copper bonded ground rod ul listed & CPRI Tested of dia 25.4 mm, length 3000 mm with pure copper 99.9 % coating of 250 micron as per IEC 62561 – 2. CPRI Tested 50 KA peak.
JK Reslow Earth Enhance Material as per IEC 62561 – 7 is used along with the ground rod to reduce earth resistance value.

Lightning Counter: At least two lightning strike counters need to installed in down conductors as per IEC 62561. The Counter shall have facility to record 6 digits nexus.

16. SOLAR PV SYSTEM:

16.1 SCOPE OF WORK

The job involves designing, manufacturing, supply, installation, testing and commissioning with complete warranty of Solar PV Grid connected power plant in interactive operation with existing power system. The scope of work shall include the followings.

Design, manufacture, supply, installation and commissioning of Solar PV Grid connected Power Plant including supply of all sundry materials as per approved list of material as required for installation and commissioning of the system. Complete commissioning of plant includes the integration of solar PV plant with existing grid.

Detailed planning and smooth execution of the project. Energy yield report for the designed system showing month-wise energy yield and loss diagram. Detailed engineering document consisting of layout, single line diagram and component specifications.

Performance testing of the complete system for faultless operation from the date of plant commissioning

Replacement warranty for 12 months for any damaged/broken modules & BOS etc. However, the solar PV modules and inverter shall continue to carry their respective warranties (i.e 25 years and 5 years respectively) as per practice over & above the 12 months complete system warranty.

Risk liability of all personnel associated with the implementation/realization of the project.

16.2 MISCELLANEOUS TECHNICAL REQUIREMENTS

The vendor to provide yield report (kWh/kWp) and loss diagram of the proposed grid connected system being offered to Client

The Vendor to specify the space needed for installing the system. Lowest space usage will be preferred.

Provide Single Line Diagram (SLD) of the system

16.3 TECHNICAL OFFER/COMPLIANCE STATEMENT:

The Vendor shall submit the technical offer complete in all respect and as per the items of technical data sheet

The Vendor shall submit enclose compliance statement against the technical specifications sheet clearly mentioning YES or NO along with duly signed & seal.

The compliance statement is required to be supported by technical literature/brochure, wherever possible.

DETAILED BILL OF MATERIAL

Item	Item description	Brands	UOM	IEC Standards
Supply installation and commissioning of Solar Modules	Solar modules with following verifiable and test report supported characteristics only qualify for supply: 1. Panel level efficiency 19.0 or above. 2. Temp coefficient of Pmax should be less than or equal to -0.29 %/Degree Centigrade. 3. Panel structure should have a Water Drainage System for removal of excess water for easier O&M. 4. Refer to more details in annexure **Requirements of High effiecency panels.**	**Panasonic /Sun power/ Benq /Tata**	59.590 X 2 = 120 KWp	**IEC612 15 IEC617 30-1 IEC617 30-2**
Supply installation and commissioning of **Solar Inverter with remote monitoring.**	**98.3% Conversion efficiency**. With 100 MW plus sales In India/Abroad. More than two MPPT inputs will be preferred. Single or multiple inverters can be used to achieve the capacity.	**SMA/Huwai/Ginlong/Goodwe**	**120,000 Watts**	UL 508, UL 60950-1,CSA C22.2No. 60950-1-07, EN 60950-1,EN 55022 Class A,EN61000-3-2Class D, EN61000-3-3,EN 55024,FCC Part 15, Sub-part B Class A
Supply installation and commissioning of AJB	14 in 1 Out |IP65/66 PC Enclosure with 1000V 12A fuse at each Positive i/p | Terminal Block at Negative I/P and 14 No's of 2P MCB | 4 No's of Type-2 40kA SPD at Output | MC4	**LEPL/ trinity touch/ adler**	01	IEC 60529

	Compatible Connectors at both input and output terminals.			
Supply installation and commissioning of ACDB	1 In 1 Out|IP43 Wall Mount CRCA Metal Enclosure|4P, 440V 100A MCB at solar side input | 4P, 440V 100A RCCB along with phase indication lamp| Class 1 MFM | Type-2 40kA SPD at grid side output.	**LEPL/ trinity touch/ adler**	01	IEC 60529
Supply installation and commissioning of DC CABLE	PVC CABLES AS PER IS 694 (1C 4SQMM.CU)	**Polycab/Siechem/Lapp**	TBD	1C x 4 SQMM
Supply installation and commissioning of Ac Cable	AL conductor XLPE 4 C 95 Sqmm	**Havells/Polycab**	TBD	4Cx95 Sqmm

Supply installation and commissioning of LIGHTING ARRESTOR		**OBO Bettermann/ Ericko/ GE**	Approximately 120	As per IS-IEC 62305 -3
Supply installation and commissioning of Equipotential bonding	EARTH STRIPS	**OBO Bettermann/ JINDAL**	Approximately 40	IEC 62561-part 2
MCCB for grid panel		**Siemens/Scheni der/ L&T**	1	

16.4 HIGH EFFICIENCY SOLAR PV MODULES

The PV modules convert the light reaching them into DC power. The amount of power Solar PV Module produce is nearly proportional to the intensity and the angle of the light reaching them. They are therefore required to be positioned to take maximum advantage of available sunlight within string constraints. Bidder will position the PV modules in such a manner that the maximum power shall be obtained with the sun's movements during the day.

The supplier / manufacturer of the PV Module shall be in existence for at least 15 years in the Solar PV manufacturing field with proven track record.

The Photovoltaic modules must be qualified as per IEC 61215 and in addition, the modules must conform to IEC 61730-1 and IEC 61730-2 requirements for construction & Part-2 requirements for testing, for safety qualification. The modules shall be RoHS compliant. The test certificates can be from any of the International Accredited Testing Calibration Laboratories.

The PV Modules shall be “PID Free” and the certification of the same shall be submitted along with the modules by the supplier from a Internationally Recognized certification agency for PID testing.

The PV Modules shall be “LID Free” and there shall not any effect of LID on the modules in the first year of installation.

Minimum proven cell efficiency shall be greater than or equal to 22% on commercial scale and on lab scale the minimum proven cell efficiency

shall be greater than or equal to 25%.

The minimum efficiency of the module shall be greater than or equal to 19.0%. Supplier shall follow the latest engineering practice; ensure long-term compatibility requirements and continuity of equipment supply and the safety of the operating staff.

The PV Modules shall be Salt Mist Corrosion Tested Panels of min severity level 5 or above, since the modules may be installed very close to seashore or factories emitting pollutant gases or harsh environmental conditions.

The optimum generation of electricity of PV capacity installed vis-à-vis available solar radiation at the site may be obtained through use of either a seasonal tilt structural arrangement or single axis solar tracking system, lower cable losses, maximization of power transfer from PV modules to electronics, maximization of power generation by enhancing incident radiation by optional methods like seasonally changing tilt angles etc.

The manufacturer of the modules shall provide certification on qualification of PV modules.

The SPV cells shall be manufactured using unique highly efficient diffusion process or any other technology in vogue so as to ensure uniform diffusion profiler to achieve close spread and higher efficiency for each cell.

Stabilized net output of the Solar PV Array for the Solar Power System shall not be less than the Nominal design level for the System under Standard Test Condition.

The PV module shall perform satisfactorily in humidity up to 100 % with temperature between - 20 deg. C to +40 deg C and with stand wind dust up to 150 km/h from back side of the panel. Photo / electrical conversion efficiency of the modules of SPV module shall be greater than or equal to 19.0 %. Since the modules would be used in a low/medium voltage circuit, the insulation test shall be carried out on each module and a test certificate to that effect provided. The bidder shall indicate minimum efficiency. PV modules used in solar power plants/ systems must be warranted for minimum 90% output of Pmin capacity for the first ten years and 80% output of Pmin capacity at the end of 25 years. The product workmanship shall be guaranteed for 10 years. The warrantee shall be given in judicial stamp paper.

The panel shall have positive tolerance of Maximum output power and the maximum voltage shall not exceed 1000V. The negative temperature coefficient of power max shall be equal to or less than -0.3% per deg C temperature.

The PV modules shall be suitable for continuous outdoor use.

The material used for constructing the PV module shall be selected in such a way that its gives the maximum efficiency and the latest technology shall be adopted for the construction of PV module.

PV module shall be provided with frame of Anodized Aluminum (either Black or Other) channels for size and simplicity in installation offered as a single module or series parallel combination of modules. The module frame, if any, shall be made of a corrosion-resistant material which shall be electrolytic ally compatible with the structural material used for mounting the modules.

The PV 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 and the Glass shall be AR Coated tempered glass.

The PV module shall use lead wire with weatherproof connector for output terminal.

The power output of the PV system under Standard Test Conditions (STC) should be sufficient to meet the requirement and the required power made of suitable module size depending upon manufacturer prudent practice with required output voltage. The number of modules to be supplied shall be worked out accordingly. Module less than 240 Wp capacity shall not be supplied or installed.

In order to optimize the overall structural cost, each of the PV Modules shall be less than or equal to 18 Kg weight in order to reduce the overall civil cost of the project.

Test report from any Indian Lab or agency Like NISE will be preferred.

16.5JUNCTION BOXES (JBs):

The junction boxes to be provided in the PV array for termination of connecting cables. The Juction Boxes (JBs) shall be made of GRP/FRP/Powder Coated Aluminium /cast aluminium alloy with full dust, water & vermin proof arrangement. 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 thread

Conforming to IP65 standard and IEC 62208 Hinged door with EPDM rubber gasket to prevent water entry. Single/double compression cable glands shall be provided for cable connections and entry to the junction boxes or panel. Provision of earthings with placement of 5 feet height or above for ease of accessibility.

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 monitoring and disconnection for 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

16.6DC DISTRIBUTION BOARD

DC Distribution panel shall receive the DC output from the array field.

DC DPBs shall be of enclosed dust & vermin proof conform to IP 65 protection. The bus bars shall be made of copper in required sizes and ratings. Suitable capacity MCBs/MCCB shall be provided for controlling the DC power output to the PCU along with necessary surge arrestors.

16.7AC DISTRIBUTION PANEL BOARD

AC Distribution Panel Board (DPB) shall control the AC power from PCU/ inverter with necessary surge arrestors. Interconnection required from ACDB to mains at LT Bus bar while in grid tied mode. All switches, circuit breakers and connectors shall conform to IEC 60947, part I, II and III/ IS60947 part I, II and III.

The changeover switches, cabling work shall be undertaken by the bidder as part of the project. All the Panel's shall be metal clad, totally enclosed, rigid, floor mounted, air - insulated, cubical type suitable for operation on three phase / single phase, 415 or 230 volts, 50 Hz

The panels shall be designed for minimum expected ambient temperature of 50 degree Celsius, 100 percent humidity and dusty weather.

All indoor panels shall have protection of IP54

All outdoor panels shall have protection of IP65 and conform to Indian Electricity Act and rules (till last amendment).

All the 415 AC or 230 volts devices / equipment like bus support insulators, circuit breakers, SPDs and VTs etc., mounted inside the switchgear shall be suitable for continuous operation and satisfactory performance under the supply voltage +/- 10 % Variation in supply frequency
+/- 3 Hz

16.8 PCU/ Inverter:

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. A these components of the system are termed the "Power Conditioning Unit (PCU)". In addition, the PCU shall also house MPPT (Maximum Power Point Tracker) an interface between Solar PV array & the Inverter to the power conditioning unit/inverter shall also be DG set interactive. The Inverter output shall be compatible with the grid frequency. Typical technical features of the inverter shall be as follows:

Switching devices : IGBT
Control : Microprocessor /DSP

Nominal AC output voltage and frequency: 415V, 3 Phase, 50 Hz

(In case single phase inverters offered, suitable arrangement for balancing the phases must be made.) Output frequency : 50 Hz
Grid Frequency Synchronization range : + 3 Hz or more
Ambient temperature considered : -20Deg C to 50Deg 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 : - 20% & + 15 %
No-load losses : Less than 1% of rated power Inverter efficiency (minimum) : >93% (In case of 10kW or above) THD : < 3% PF > 0.9

Three phase PCU/ inverter shall be used with each power plant system (10kW and/or above) PCU/inverter shall be capable of complete automatic operation including wake-up, synchronization & shutdown.

The output of power factor of PCU inverter is suitable for all voltage ranges or sink of reactive power, inverter shall 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.

The power conditioning units / inverters shall 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 charge controller (if any) / MPPT units environmental testing shall qualify IEC 60068-2(1, 2, 14, 30)/Equivalent BIS std. The junction boxes/ enclosures shall 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 international test houses.

16.9INTEGRATION OF PV POWER WITH GRID:

The output power from SPV would be fed to the inverters which converts DC produced by SPV array to AC and feeds it into the main electricity grid after synchronization. In case of grid failure, or low or high voltage, solar system shall be out of synchronization and shall be disconnected from the grid. Once the DG set comes into service PV system shall again be synchronized with DG supply and load requirement would be met to the extent of availability of power. 4 pole isolation of inverter output with respect to the grid/ DG power connection need to be provided.

NAME OF PROJECT: - PROPOSED MULTI-SPECIALITY BHANDUP HOSPITAL AT LAND BEARING C.T.S.NO681A/88,681A/3,681A/4 OF VILLAGE NAHUR IN S-WARD, BHANDUP MUMBAI

TECHNICAL SPECIFICATIONS FOR HVAC SYSTEM

SHASHI PRABHU & ASSOCIATES

SHASHI PRABHU AND ASSOCIATES

MUNICIPAL CORPORATION OF GREATER MUMBAI

INDEX

1 SPECIAL CONDITIONS OF CONTRACT

General

These special conditions are meant to amplify the specifications and General Conditions of Contract

The materials, design and workmanship shall satisfy the specifications contained herein and Codes Referred to. Where the technical specifications stipulate the requirement in addition to those contained in the Standard Codes and specifications those additional requirements shall also be satisfied. In the absence of any Standard/ Specifications covering any part of the work covered in this tender document, the instructions/ directions of Construction Manager will be binding on the contractor.

The scope of this section is to describe materials and systems for HVAC installations of building which form together with the project documents, a complete volume of work and quality description.

All HVAC installations shall be of high quality, complete and fully operational including all necessary items and accessories whether or not specified herein. All HVAC work shall be completed in accordance with the regulations and standards to the satisfaction of the Construction Manager/ Consultants. The general provisions, special provisions and general requirements apply to the entire installation.

The work shall be carried out simultaneously with building work and shall be continued till it is completed satisfactorily along with the completion of essential portions of the building works. All installed HVAC works shall be protected till the end by the HVAC contractor.

During the progress of work, completed portion of the building may be occupied and be put to use by the Client but the contractor shall remain fully responsible for the maintenance of HVAC works till the entire work covered by this contract is satisfactorily completed by him and handed over to the Client.

Scope of Work:

The general character and the scope of work to be carried out under this contract are illustrated in the drawings, specifications. The Contractor shall carryout and completes the said work under this contract in every respect in conformity with the rules and regulations of the Local Authority. The contractor shall furnish all labour, supply and install all new materials, appliances, equipment necessary for the complete provision and testing of the complete HVAC services installation as specified herein and in accordance with relevant codes. This al so includes any material, appliance, equipment not specifically mentioned here in or noted on the drawings as being furnished or installed but which are necessary and customary to make a complete installation. In

general, the work to be performed under this contract shall comprise but not limited to the following:

a) Without restricting to the generality of the foregoing, the HVAC Installations shall

Include but not limited to the following:

1. Air-conditioning works
2. Toilet Ventilation Works
3. Kitchen Ventilation Works
4. Smoke Extraction works
5. Pressurization works
6. Miscellaneous, unforeseen & client requirement's Works

All incidental jobs connected with HVAC services installation such as excavation in trenches and back filling, cutting chases in concrete and brick and making good, cutting/ drilling holes through walls, floors and fixing of fixtures, small equipment foundation, Structural supports & other supports as required at site shall be part of HVAC works.

Contractor shall submit the samples/ catalogues of each material/equipment giving technical data. Only after written approval of samples/ catalogues, the Contractor shall place the order.

Preparation of shop/ working drawings Contractor shall submit the detailed shop/Working drawings after detailed design calculations, coordinating with structural, architectural and other services drawings/ service agencies. All structural openings & pipe sleeves shall be identified. Shop/ working drawings shall be furnished complete in all respect along with all relevant details.

Contractor shall furnish and install complete HVAC services installation as per approved shop drawings and as described in this specification.

Before starting the work at site the contractor shall examine all services drawings and report to client/ Consultant for discrepancies and obtain clarifications. Any work done without regard for consultation with other trades, shall be removed by the contractor without additional cost to the Client.

Cleaning of all fixtures/ equipment and piping including flushing of all pipe work to remove any foreign matter shall be carried out in sections as the work progresses.

Contractor shall temporarily cover & protect all fixtures & accessories, equipment's & open pipe/ Duct ends etc. It is the responsibility of the Contractor to protect all the installed fixtures/ fittings and all equipment's until the time of testing, commissioning & handing over to the Clients.

Painting of all concealed and exposed pipes, equipment as specified including weather proof treatment on exposed & treatment of buried pipe work shall be part of this contract, even if it is implicitly/ explicitly not specified.

Testing & commissioning of all systems including submission of test reports.

Contractor shall submit as installed drawings, operation and maintenance manual for all equipment's/ operations etc. Framed operating & maintenance instructions shall be provided in plant room.

All equipment shall be of the class most suitable for working under the conditions specified and shall withstand the atmospheric conditions without deterioration. All the material selection will be done for maximum life span of the equipment's and system.

Work And Workmanship:

To determine the acceptable standard of workmanship, the Construction Manager/Consultant may order the Contractor to execute certain portions of works and services under the close supervision of the Construction Manager/ Consultant. On approval, these items shall be labelled by them as guiding samples so that further works are executed to conform to these samples.

Co-Ordination With Other Contractors And Agencies:

The Contractor during the execution of the Works shall coordinate with other Contractors, and other Agencies associated with the Project and shall work in harmony with them without causing any hindrance or obstruction or impeding the progress of their work in any way.

Protection Of Other Contractor's Works And Safety Of Personnel At Site:

Since many other contractors and agencies will be engaged on site and working simultaneously, the Contractor shall ensure at all times that during the execution of his work or during the operations and movements of equipment's and supply vehicles and machinery, no dam age or injury is caused to the work or property or personnel of other contractors and agencies.

In case of any such loss or damage the Contractor shall take full responsibility for same and shall bear all cost and expenses thereof. Also, the Contractor shall be responsible and liable for all delays caused due to such damage and or injury and for the consequences which the other Contractors and Agencies may have to face or to which they may be subjected to or be accountable for as a result of such delays.

Safety of Materials:

The contractor shall provide proper and adequate storage facilities to protect all the materials and equipment including those issued by the Client against damage from any cause whatsoever.

Materials Supplied By the Client:

The Contractor shall conduct all checks and carry out all tests and obtain test certificates necessary to ascertain and ensure that the Client supplied materials are in conformity with the requirements stipulated in the Contract Documents. Should any of the Client supplied materials obtained from any supplier not be in conformity with the requirements stipulated in the Contract Documents then the Contractor shall not take acceptance of such materials and he shall not incorporate them in the Works unless so specifically authorized by the Construction Manager/ Consultants and it shall be the Contractor's responsibility to bring this matter to the immediate attention of the Construction Manager/ Consultants and seek his instructions in respect of the disposal of such materials. Should the Contractor fail to com ply with this procedure then all costs and/or delays which are a result and consequence thereof shall be to the account of the Contractor.

With respect to reconciliation of Client supplied materials, the quantities of such materials allowed towards consumption for the Works by the Contractor shall be the theoretical requirement plus permissible wastage. The theoretical requirement shall be determined by measurements made in accordance with the dimensions shown on the Drawings to which the Works shall be executed. Client supplied materials used due to any reason whatsoever for replacement and/or rectification work shall not be deemed to be theoretical requirement, and the costs in respect of these materials used for such work shall be borne by the Contractor.

Actual Route Of Pipe Lines:

The location of the AC pipe lines, indicated in the drawing is only indicative. The actual route of AC pipe lines may differ from the plans according to the details of the building construction and the conditions of executions of the installations.

The contractor shall supply and install at his expense all secondary materials and special fittings found necessary to overcome the interference and to supply the modifications on the route of HVAC pipe lines that are found necessary during the work, to the complete satisfaction of the Construction Manager/Consultants.

Rating:

Rating of all items shall be appropriate for the conditions on the particular site on which the item will be used. All the equipment shall be fit for continuous work under the most severe conditions of site.

Inspection and Testing:

The Construction Manager reserves the right to request inspection and testing at manufacturer's works at all reasonable times during manufacture of items for this contract. Tests on site of completed works shall demonstrate, among other things:

That the equipment installed complies with specification in all particulars and is of the correct rating for the duty and site conditions. VRV & AHU unit shall be tested in factory with client & consultant. All Expenses shall be in contractor scope.

That all items operate efficiently and quietly to meet the specified requirements.

The contractor shall provide all necessary instruments and labour for testing, shall make ad equate records of test procedures and readings, shall repeat any tests requested by the Construction Manager/Consultants and shall provide test certificates signed by a properly authorized person. Such test shall be conducted on all materials and equipment's and on completed work as called for by the Construction Manager/Consultants.

If it is proved that the installation or part thereof is not satisfactorily carried out then the contractor shall be liable for the rectification and retesting of the same as called for by the Construction Manager/ Consultants at the cost of the contractor. The Construction Manager/Consultants decision as to what constitutes a satisfactory test shall be final.

The above general requirements as to testing shall be read in conjunction with any particular requirements specified elsewhere. All tests shall be carried out by a test house approved by the Construction Manager/Consultants.

Samples And Catalogues:

Before ordering the material necessary for these installations, the contractor shall submit sample/ technical data sheets to the Construction Manager/Consultants for approval.

Also contractor shall ensure that the dimensional details of the equipment fit into the allot ted space provided in the building.

Shop Drawings:

The contractor shall prepare and submit to the Construction Manager/Consultants for his approval six (6) sets of detailed layout drawings of all HVAC equipment's and piping layouts.

He shall prepare shop drawings incorporating the details given by manufacturers for the items included in his contract and also Client supplied items and any other items which need to be coordinated with other contractors for interfacing.

Before starting the work, the contractor shall submit to the Construction Manager/Consultants for his approval in the prescribed manner, the shop/execution drawings for the entire installation.

The Construction Manager/Consultants, reserves the right to alter or modify these drawings if they are found to be insufficient or not complying with the established technical standards or if they do not offer the most satisfactory performance or accessibility for maintenance. Contractor shall supply in eight (8) sets of all approved shop drawings for execution.

Shop drawings shall be submitted under the following conditions:

Large scale drawings showing fixing detail equipment and showing coordination with other services.

Showing any change in layout in the HVAC drawings.

Equipment layout, ducting, piping and wiring/control diagram.

Manufacturer's or Contractor's fabrication drawings for any materials or equipment supplied by him.

No work will be carried out without approval of shop drawings by the Consultants.

"AS BUILT" DRAWINGS:

At the completion of work and before issuance of certificate of completion the contractor shall submit eight (8) sets to the Construction Manager/Consultants, layout drawing drawn at appropriate scale indicating the complete HVAC system "as installed" and the same shall be approved by the Consultants before handing over to the Client.

Instruction/Maintenance Manual:

The Contractor shall prepare and produce instruction, operation and maintenance manuals in English for the use, operation and the maintenance of the supplied equipment and installations, and submit to the Construction Manager/Consultants in (8) copies at the time of handing over. The manual shall generally consist of the following:

Description of the project.

Operating instructions.

Maintenance instructions including procedures for preventive maintenance.

Manufacturers catalogues.

Spare parts list.

Trouble shooting charts.

Drawings.

Type and routine test certificates of major items.

One (1) set of reproducible `as built' drawings.

Completion Certificate:

On completion of the HVAC installation a certificate shall be furnished by the contractor countersigned by the licensed supervisor, under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form as required by the local supply authority. The contractor shall be responsible for getting the HVAC installation inspected and approved by the local concerned authorities and for obtaining the necessary clearance certificates from the authorities.

Guarantee:

At the close of the work and before issuance of final certificate of completion by the Construction Manager/ Consultants, the contractor shall furnish written guarantee Indemnifying the Client against defective materials and workmanship for a period of one year after completion. The contractor shall hold himself fully responsible for reinstallation or replacement, free of cost to Client, the following:

Any defective work or material supplied by the Contractor.

Any material or equipment supplied by the Client which is damaged or destroyed as a result of defective workmanship by the contractor.

Any material or equipment damaged or destroyed as a result of defective workmanship by the contractor.

Staff:

The contractor shall employ competent fully licensed qualified, full time HVAC engineers to direct the work of HVAC installation in accordance with the drawings and specifications.

The engineers shall be available at all times at site to receive instructions from the Construction Manager., in the day to day activities throughout the duration of contract. The engineer shall correlate the progress of the work in conjunction with all the relevant requirement of the supply authority.

Safety Barriers and Construction Safety:

The Contractor shall at his own cost provide for the protection and safety of the persons working in the area, safety barriers around all openings in every location and at the periphery and edges of all slabs, staircases and stairwells, lift shafts, ducts etc., all to the approval and satisfaction of the Construction Manager. However, contractor shall take appropriate safety precautions suitable for specific locations/ situations and as instructed by the Construction Managers.

The Contractor shall, in general, be fully responsible for all matters with regard to every form of safety during construction and in connection with the execution of the Works, and the Contractor shall take all necessary precautions and provide at his cost everything necessary to ensure such safety at all times. Should any accidents occur due to the Contractor's failure to comply with such safety requirements and to take all other safety measures necessary, the Contractor shall be fully responsible for all such accidents and he shall bear and pay for all costs and damages in connection therewith and as a consequence there of.

Disposal Of Rubbish From The Works And The Site And Provision Of Safety Netting/Screens By Contractor:

The Contractor shall at all times keep the Works and the site in clean, neat and tidy condition. All rubbish from the Works and the site shall be collected and deposited in large bins provided on the site for such purpose by the Contractor at his own cost. The rubbish from such bins shall be regularly carted away by the Contractor to rubbish tips and dump yards beyond the site.

At no time or stage shall any rubbish be thrown over the edges of slabs or through any openings or shafts or ducts or stairwells.

The Contractor shall, at his own cost and to the approval and satisfaction of the Construction Manager, provide safety netting/screens at the periphery of all slabs and at all openings, shafts, ducts and stairwells and/or canopies to prevent any rubbish or material falling over or into such areas and endangering the safety of the persons working below. Should the Contractor fail to provide such safety measures and to take other necessary precautions in accidents that may occur, he shall bear all costs and damages as decided by Construction Manager in connection therewith and as a consequence there of.

The Construction Manager shall have powers to withhold amounts from

payment certificates in case of Contractor's persistent noncompliance with provisions of this clause. Also the construction Manager is empowered to employ another agency at Contractor's cost after one week's notice to implement this Clause in case of Contractor's noncompliance with provisions of this Clause.

Space For Contractor's Construction Yard, Stores Etc.:

The Client shall provide adequate storage/office space to the contractor for his use. The space has to be maintained/constructed by the contractor as per his usage requirements.

All spaces allotted to the contractor, as described above shall be vacated and all structures removed from site at any time as and when required and directed by the relevant authorities or by the Client, unconditionally and without any reservation. The authorities or the Client will not be obliged to give any reason for such removal. Upon receiving instructions to vacate the space, the contractor shall immediately remove all his structures, materials, etc., from the spaces and clear and cleanup the site to the satisfaction of the Construction Manager.

It shall be the specific responsibility of the Contractor to safeguard the site and ensure that no illegal encroachments are made by outside elements within the area allotted to the Con tractor. Upon completion of the work or earlier as required by Client/Authorities, the Con tractor shall vacate the land totally without any reservations. Necessary Bond to this effect on a stamp paper shall be signed by the contractor in a prescribed form.

The Performance Bond and/or guarantees towards retention amount furnished by the Con tractor shall not be released until the spaces allotted to the contractor are fully vacated and handed over to the Client as per the instructions of the Client.

Carrying Out Work Beyond Normal Working Hours Or In Shifts

In order to achieve the milestone and completion dates and to keep pace with the approved construction programme, the Contractor shall be permitted to carry out his work beyond the normal working hours or in shifts. The Contractor shall be responsible for obtaining any necessary permission from the relevant authorities that may be required for him to carry out the work beyond the normal working hours or in shifts. Also, the Contractor shall give prior notice to and make arrangements with the Construction Manager for the supervision of work carried out beyond the normal working hours or in shifts. The Contractor shall make his own arrangements in respect of the provision of adequate lighting and any other facilities that may be required for carrying out the work beyond the normal working hours or in shifts. No extra payments shall be made to the Contractor for or in connection with any such overtime or shift work. The Contractor will not be required to bear the overtime expenses of the Construction Manager in respect of the supervision of such overtime or

shift work of the Contractor.

Period And Time Limit For Completion Of Works:

The period and time limit for Completion of the Works shall be as per client's requirement from the date of issue of Work Order to commence works or handing over of site in respect of the award of Contract. This time period shall be inclusive of the mobilization period and monsoon period.

Professional Integrity And Team Spirit:

It is the intent of the Client, Architect and Construction Manager that this project will be executed in a spirit of team and full professional integrity. Contractor is expected to cooperate with all the agencies involved in the project to fulfill this objective.

List Of Approved Makes:

Unless otherwise specified and expressly approved in writing by the Engineer in Charge/only material of makes and specifications as mentioned in the list of approved makes attached with the specification shall be used.

The contractor shall clearly indicate the list of materials proposed to be used by him & enclose the same with the tender.

On Instruction of Engineer in Charge the Contractor shall submit samples of materials proposed to be used in the works. Approved samples shall be kept in the office of the Engineer in Charge and returned to the Contractor at the appropriate time.

Before procurement, Contractor will discuss with Client for preferred makes.

Water and electricity shall be supplied at one point.

Reference Points:

Contractor shall provide permanent bench marks, flag tops and other reference points for the proper execution of works and these shall be preserved till the end of the work.

All such reference points shall be in relation to the levels and locations, given in the architectural and HVAC drawing.

Reference Drawings:

The Contractor shall maintain one set of all drawings issued to him as reference drawings. These shall not be used on Site. All important drawings shall be mounted on boards and placed in racks indexed, no

drawings shall be rolled.

All correction, deviations and changes made on the site shall be shown on these reference drawings for final incorporation in the completion drawings. All changes to be made shall be initialed by Engineer in Charge or Architect.

Vendor shall prepare Shop Drawings with all details after checking the feasibility at Site which shall be approved by the Consultants before execution. No work will be carried out without approval of Shop drawing by the Consultant.

Handing Over:

Contractor will be responsible for following:

Entire System shall be commissioned and tested as per design parameter is coordination with Client & consultant.

Complete certificate has to be obtained from the consultant to certify the quality of work and performance of the system.

Contractor has to hand over 4 sets of as Built Drawings duly approved by consultants along with 2 soft copy in CD's.

Contractor has to handover operator manual of the system with catalogue and Technical Data of equipment supplied.

General Provisions

Description

The scope of works for all HVAC works and system comprises supply, installation, testing and commissioning, handover, training, maintenance as described or reasonably implied.

Contractor is obliged to provide fully functioning works and systems in conformance with the requirements of the Contract. In the event certain items are not fully described or indicated in the Contract, but deemed essential by the Engineer's Representative (in all reason ableness) for the performance of the works and systems, then the provision of such items shall form part of the Contractors scope of works at no additional cost to the Employer.

Contractor shall be responsible to coordinate the equipment and services with all other discipline and shall produce properly coordinated shop drawings to demonstrate the installation & comply with the performance requirement with shop drawing, calculations and de tails.

Shop drawings shall take into account actual measurement and setting out dimensions/levels obtained and determined by the Contractor on

site, actual equipment/material used, actual routing of services, coordination with all installation, and site conditions/constraints.

2 WATER COOLED SCREW CHILLER WITH VFD (AHRI Certified)

General

System Description

Microprocessor controlled water cooled chiller utilizing a mono / twin rotor, 2960 rpm (50 HZ), direct drive semi hermetic, one or multiple screw compressor using refrigerant 134A.

Quality assurance

Unit shall be rated in accordance with ARI / Eurovent standard.

Unit construction shall comply with European directives
Machinery directive 98/37/EC, modified.
Low voltage directive 73/23/EEC, modified.
Electromagnetic compatibility directive 89/336/EEC, modified, and the applicable recommendation of European standard.
Machine safety electrical equipment in machines, general regulations, EN 602041.
Electromagnetic emission EN 500812.
Electromagnetic immunity EN 500822.

Unit shall be designed, manufactured and tested in a facility with a quality assurance system certified ISO 9001.

Unit shall be manufactured in a facility with an environment management system certified ISO 14001. Unit shall be tested at the factory.

Delivery, storage and handling

Unit controls shall be capable of withstanding 55°C storage temperatures in the control compartment.

Products
Equipment
General

Factory assembled, single piece, air cooled liquid chiller contained within the unit cabinet shall be all factory wiring, piping, controls, refrigerant charge (HFC – 134a), required prior to field startup.

Unit Cabinet

Frame shall be made of U steel beam and protected by three layers of paint.
The control box plates shall be steel with an oven baked polyester paint finish, and be capable of withstanding a 500hour salt spray test in accordance with the ASTM B117 standard (U. S. A.).

Compressors

Unit shall have semi hermetic mono / twin screw, gear driven compressors with internal muffler and check valve.
Each compressor shall be equipped with a discharge shutoff valve.
Capacity control shall be provided by pilot operated solenoid valve, capable of reducing unit capacity to 20% of full load. Compressor shall start in unloaded condition.
Motor cooling shall be provided by direct liquid injection and protected by internal overload thermistor.
Lube oil system shall include pre filter and internal filter capable of filtration to 3 microns.

Evaporator

Unit shall be equipped with a single evaporator.

Evaporator shall be tested and stamped in accordance with applicable European pressure code for a refrigerant side operating pressure of 1700 kPa (service des Mines units) and for a maximum waterside pressure of 1000 kPa.
Shall be mechanically cleanable shell and tube type with removable heads.
Tubes shall be internally enhanced, seamless copper type, and shall be rolled into tube sheets.
Shall be equipped with Victaulic water connections (accessory flanges on request).
Shell shall be insulated with 19 mm closed cell, polyvinylchloride foam with a maximum K factor of 0.28.
Shall incorporate two independent refrigerant circuits.
Shall have an evaporator drain and vent.
Shall incorporate a refrigerant level control system.

Condenser

Coil shall be Water cooled with integral sub cooler and shall be constructed of aluminium fins mechanically bonded to internally finned copper tubes. The tubes are then cleaned, dehydrated and sealed.
Condenser tubes shall be leak tested and shall be pressure tested at 3400 kPa.

Refrigeration Circuits

Refrigeration circuit components shall include oil separators, high and low side pressure relief devices (according to applicable standards), discharge and liquid line shutoff valves, filter driers, moisture indicating sight glasses, electronic expansion devices, refrigerant economizers and complete operating charges of both refrigerant and compressor oil.

Controls, Safeties and Diagnostics

Controls

Unit controls shall include as a minimum; the microprocessor board, and a 6digit diagnostic display with keypad.

Shall be capable of performing the following functions

Automatic changeover between compressors.
Capacity control based on leaving chilled fluid temperature with return fluid temperature sensing.

Limiting the chilled fluid temperature pulldown rate at startup an adjustable range of 0.1°C to 1.1°C per minute to prevent excessive demand spikes at startup.

Enable adjustment of leaving chilled water temperature according to the return water temperature or by means of a 0 – 10 V signal to the outdoor temperature.

Provide a dual set point for the leaving chilled water temperature activated by a remote contact closure signal.

Enable a 2level demand limit control (between 0 and 100%), activated by a remote contact closure signal.

Control water pump(s) operation.
Enable automatic lead lag of two chillers in a single system.

Diagnostics

Display module shall be capable of displaying set points, system status (including temperatures, pressures, run time and percent loading), and any alarm or alert conditions.

Control Module, in conjunction with the microprocessor, shall be capable of displaying the output of a full load run test to verify operation of every switch, sensor, fan and compressor before the chiller is started, and carrying out a diagnosis and preventive maintenance (incorrect water loop, oil filter dirty etc.)

Safeties

Unit shall be equipped with all necessary components and in conjunction with the control system shall provide the unit with protection against the following

Loss of refrigerant charge.
Reverse rotation.

Low chilled water temperature.
Low oil pressure (per compressor).
Current imbalance.
Thermal overload.
High pressure.
Electrical overload.
Loss of phase.

Fan motors shall be individually protected by a circuit breaker.
Control shall provide general alarm remote indication for each refrigerant circuit. Control system shall have a RS485 serial output port (option and accessory).

Operating characteristics

Unit shall be capable of starting and running at full load at outdoor ambient temperatures from 0°C to 46°C.
Unit shall be capable of starting up with 25°C entering fluid temperature to the evaporator.

Electrical characteristics

Unit electrical power supply shall enter the unit at one or two locations.
Unit shall operate on 3phase power supply without neutral.
Control voltage shall be supplied by a factory installed transformer.
Unit shall be supplied with factory installed electrical disconnect switch / circuit breaker.

Finishing

Electrical cabinet colour – as per manufacturer. Compressor / heat exchanger colour – as per manufacturer

Low voltage unit mounted starter

A reducer voltage delta or double / solid state starter shall be supplied. The compressor motor starter shall be factory mounted, wired, and tested prior to shipment by the chiller manufacturer. Customer electrical connection for compressor motor power shall be limited to main starter power connection only.

Solid state starter shall provide stepless compressor motor accelerating and limit motor in rush current to 150 300% of compressor motor RLA. The starter shall include 6 Silicon Control Rectifiers (SCR) with integrally mounted bypass contactors to provide SCR by pass once the motor has achieved full voltage and speed. The starter shall also include automatic acceleration kick circuitry which monitors motor current subsides and automatically ramps voltage up at a faster rate to eliminate the instability that occurs at the break away torque point.

Starter shall be UL and CSA approved and shall include

- NEMA 1 enclosure with integral fan cooling and lockable hinged doors.
- Main power disconnects (non fused type)
- solid state 3phase over load relay with manual reset.
- 2 KVA control / oil heater transformer
- Branch circuit breaker for control power and oil heater
- 5 pilot relays for control of chilled water pump. Condenser water pump, tower fan, customer remote alarm, shunt trip, and main power disconnect. The shut trip shall be energized by the SMM during unauthorized operation (such as loss of communication) between the SSM (Starter Management Module) and PSIO (Processor Sensor Input / Output Module).

Solid state starters also include the following standard features

- Current imbalance detector which monitors 3 phase motor current to provide the following protection

  Phase loss
  Phase reversal
  Phase imbalance
  Ground fault
  Shorted SCR
  Current flow while stopped protection

- Diagnostic LED's shall be provided to indicate:

  Starter on
  Run (up to voltage)
  Phase correct
  Over temperature fault
  SCR gates energized
  Ground fault
  Current imbalance fault
  Shorted SCR.

I^2T fuses the solid state circuitry at 200,000 amp interrupting capacity.

Electrical requirements

The contractor shall supply and install main electrical power line, disconnect switches, circuit breakers, electrical protection devices per local code requirements and as indicated necessary by the chiller manufacturer.

The contractor shall wire the water flow switches to the chiller control circuit to ensure that chiller will not operate until flows are established & maintained as per contractor's / consultant's specifications.

The contractor shall supply and install electrical wiring and devices required to interface the chiller controls.

Piping requirements – instrumentation and safeties

The contractor shall supply and install pressure gages in readily accessible locations in piping adjacent to the chiller such that they can be easily read from a standing position on the floor. Gages shall be very accurate. Scale range shall be such that design valves shall be indicated at approximately midscale.

Gauges shall be installed in the entering and leaving water lines of the cooler and condenser.

HVAC contractor shall supply & install flow detection devices in chilled water and condenser water piping. Switches shall make contact when flow is established. Flow switches shall be installed in horizontal runs at least 5 pipe diameters downstream from any bend or tee.

Insulation

Chilled water piping and cooler water boxes shall be installed by the HVAC contractor.

Chiller shall be insulated at factory. Final layer of insulation shall be installed at the job site by the HVAC contractor along with cladding.

Chiller insulation shall confirm to UL standard 94, classification 94 HBF and should be suitable for positive temperature operation.

Vibration isolation

Chiller manufacturer shall furnish neoprene isolator pads for mounting equipment on a level concrete surface.

Startup

The manufacturer shall provide a factory trained representative, employed by the chiller manufacturer, to perform the startup, operation and maintenance manual provided by the chiller manufacturer.

After the above services have been performed, the same factory trained, representative shall be available for a period of class room instruction (not to exceed 4 hours) to instruct the chiller owner's personnel in the proper operation and maintenance of the chiller.

Manufacturer shall supply the following literature

a. Startup, operation and Maintenance Instructions.
b. Installation Instructions
c. Field Wiring Diagrams
d. Maintenance manual showing maintenance based on calendar

basis and hourly basis.

Quality Assurance

Chiller performance shall be rated in accordance with AHRI Standard 550/590/ Euroven Standard, latest edition.
Equipment and installation shall be in compliance with ANSI/ASHRAE 15 (latest edition).
Cooler and condenser shall be ASME "U" stamped and nameplate certifying compliance with ASME Section VIII code for unfired pressure vessels.
Centrifugal compressor impellers shall be dynamically balanced and over speed tested by the manufacturer at a minimum of 120% design operating speed. Each compressor assembly shall undergo a mechanical run in test to verify vibration levels, oil pressures, and temperatures are within acceptable limits.
Each compressor assembly shall be proof tested at a minimum 204 psig (1406 kPa) and leak tested at 185 psig (1276 kPa) with a tracer gas mixture.
Entire chiller assembly shall be proof tested at 204 psig (1406 kPa) and leak tested at 185 psig (1276 kPa) with a tracer gas mixture on the refrigerant side. The water side of each heat exchanger shall be hydrostatically tested at 1.5 times maximum working pressure.
Prior to shipment, the chiller automated controls test shall be executed to check for proper wiring and ensure correct controls operation.
Factory testing

Capacity& Efficiency:

Factory Testing - 4-point load test shall be carried out in presence of representatives of department at factory at 100%, 75%, 50% & 25% for one chiller of same capacity at constant condenser water temperature (given below) to check stable operation and efficiency of chiller. 5th point load test shall be carried out at 100% load in AHRI condition to verify COP of chiller. Chiller manufacturer must have in-house AHRI certified test bed for above mentioned capacity chiller for testing at site condition & AHRI condition. Manufacturer must provide AHRI certificate.

Design Parameters:

- Ref. Capacity - 450 TR (Actual)
- Chilled Water O/I Temp - 7° / 11.14°C
- Cooling Water, I/O Temp - 32° / 36°C
- Fouling Factor Evap. - 0.00050 FPS
- Fouling Factor Cond - 0.001 FPS
- Chilled Water Flow - 1456 USGPM
- Condenser Water Flow - 1750 USGPM
- Maximum power consumed at 100% (Design) ≤ 280 KW
- Full load energy efficiency (AHRI COP) ≥ 6.3
- Full load energy efficiency (Design Condition COP) 5.9
- Part load energy efficiency (AHRI IPLV) ≥ 0.35 IK/TR

- Sound Pressure Level @ 1m - 85 db(A)
- Refrigerant - 134A
- Chiller Pr. drop - Not more than 32 feet
- Condenser pr. Drop - Not more than 25 feet
- Preferred Type of Compressor & motor & chiller: Semi hermetic
- Preferred Number of Compressors: One/Multi.

Note:

1) The contractor will select the performance parameters of the chiller in accordance with requirement of green building as specified.
2) Above performance parameters will be minimum.

AUTO TUBE CLEANING SYSTEM, DEDICATED OR CENTRALIZED SYSTEM FOR CONDENSERS

Ball Trape

The ball shall be mounted between two flanges - (BS Table 10 E) Grade B, 15 days 100 lbs capacity, at the outlet line of the condenser. The casing shall be made from a MS material of IS2062 Grade B. The Ball trap shall be galvanized & have epoxy based finished paint. The screen inside is made from stainless steel SS304L perforated metal sheet.

The Ball Trap should have pressure drop of less than 800 mm of WC. The body of the Ball trap shall be of size as nozzle or 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 10 inches. The Ball Trap shall have Race Face Flange with gasket on only inner dial of pipe and should not be on the entire flange dia to avoid leakage.

Ball Collector

The Ball 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 galvanized & have epoxy based finished paint. The Ball Collector should have a sight glass for monitoring the balls. Toughened glass should be used and should be mounted by Allen key fasteners or SS nut bolt.

Skid with Pump and Valve

The skid should have pipe and flanges of MS material IS2062 Grade B and should be galvanized. 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 with minimum IP54 protection and less tan10s running time for open or close function with NEMA –II protection. The valve should be suitable to work in high humid environment up to 95% (Non-condensing) RH. All fasteners shall

be of high-tension grade 9.8, 10.9, 12.9. Pumps shall be from reputed makes like Grundfos/Xylem/Amstrong. Motorized Valves shall be from reputed makes like Belimo/Siemens/Honeywell.

Control Panel

Control Panel should be PLC based with LCD depiction of injection and collection cycle. The touch 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. Display must be Touch type, graphical presentation, and with multi-level security passwords with defined functional authorities. The HMI shall be from reputed makes like Delta/ABB/Honeywell.

Work 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 at least 2bar 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.

Step-01

PLC shall activate the cleaning process by detecting the on/off status of the corresponding chiller (or condensing water isolating valve). 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 location as 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.

Step-02

The ejection 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.

Step-03

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.

Step-04

After 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 the next injection cycle. The time of the collection cycle is normally pre-set at 27 minutes.

5. A single pump should be on skid and shall be running during injection and collection cycles.
6. The pressure drop across ball trap shall not be more than 800mm.

7. The Valves shall give feedback to Control PLC of functioning.

8. The Control PLC shall raise an alarm in case of any malfunctioning of system

9. The total time of the whole cycle (injection and collection cycle) shall be 3 - 4 minutes.

10. A maximum number of 4 Condensers should be controlled by single skid / multi 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.

CHILLER PLANT OPTIMISER

Set of Hardware and software tools, integrated and programmed to optimize the total chiller plant room operation". The prime function of a Chiller Plant manager is to optimize the operation of Chillers, Chilled water pumps, cooling water pumps and cooling tower, to exactly meet Building load during operation with minimum energy consumption. For Seamless integration between the Chillers and CPO system, Chiller manufacturer only shall take responsibility of ensuring it is set right and programmed in order to meet best efficiency. This shall also have 3rd party interface on BMS (Bacnet IP / Modbus) freely available. Also, Hardware and software combination shall be such that sufficient graphics, reporting, dashboards along with auto data storage can be employed. The data transfer shall be faster and less loss of data during physical data transfer. Chiller plant manager shall essentially be able to perform the functions as described in schedule of work.

DATA POINT SUMMARY FORC HILLER PLANT OPTIMIZER								
(IO Points s required)								
Sr. No	Description	Qt	Total Points					Required Signal
			DI	DO	AI	AO	SW	
A	Chiller Plant(Water Cooler chiller))							
1	Chiller On/Off command							Software Integration signal
2	Chiller Run status							Software Integration signal
3	Chiller Fault/Alarm status							Software Integration signal
4	Chiller CHW Temperature Reset Set point							Software Integration signal
5	Chiller Current Limit Set point							Software Integration signal
6	Chiller inlet isolation valve							NO/NC Relay Command
7	Chiller inlet isolation valve							NO/NC Potential free Contact rom Valve
8	CW inlet isolation valve Open/Close command							NO/NC Relay Command
9	CW inlet isolation valve Open/							NO/NC Potential free Contact from Valve
10	Common CHW supply header temperature							TE-632AM-1+WZ1000-5
11	Common CHW return header temperature							TE-632AM-1+WZ1000-5
12	Flow transmitter							0-10VDCor 4-20mAfrom Flow Meter
13	Supply/return header Bypass valve cmd							NO/NC Relay Command to Valve
14	Diff. pressure							0-10V DC from Press. Sensor(P499VAP-
15	Outside Air Temp/Humidity							0-10VDCfromRHcum Temp sensor(HE-67N3-

#	Total points for Chiller Plant							
	Condenser Water							
1	Pump Auto/Manual							Software Integration
2	Pump On/Off command							Software Integration
3	Pump run status							Software Integration
4	Pump trip status							Software Integration
	Total points for							
E	Cooling Tower (CT)							
1	Fan Auto/Manual							Software Integration
2	Fan On/Off Command							Software Integration
3	Fan Run status							Software Integration
4	Fan Trip status							Software Integration
5	CT inlet/outlet							NO/NC Relay
6	CT inlet/outlet							NO/NC Potential free
7	Common CW							TE-632AM-1+WZ
8	Common CW							TE-632AM-1+WZ
9	CT VFD command							Software Integration
10	CT VFD feedback							Software Integration
#	Total points for Cooling							
G	Chiller Diagnostic							
1	Leaving chilled liquid -							
2	Motor current limit -							
3	Leaving chilled liquid -							
4	Entering chilled liquid -							
5	Leaving condenser							
6	Entering condenser							
7	Evaporator pressure							
8	Condenser pressure							
9	Oil – low differential							
12	Motor FLA current							
13	Discharge pressure							
14	Operating hours							
15	Unit safety fault code							
16	Unit cycling fault code							
17	Operation code							
18	Evaporator – low							
19	Evaporator – low-							
20	Evaporator –							
21	Condenser – high							
22	Condenser – pressure							
23	Discharge – low							
24	Oil – high temperature							
25	Oil – low differential							

26	Oil – clogged filter							
27	Motor controller – loss							
28	Oil – high pressure							
29	Oil – separator – low							
30	Leaving chilled liquid –							
31	Motor controller – loss							
32	Sys Oil Temperature							
33	Sys Oil Pressure							
34	Sys Oil Filter Pressure							
35	Slide Valve Position							
36	Sys Discharge Temp							
37	SYS.EVAPORATOR							
38	SYS.EVAPORATOR SUB							
39	SYS.CONDENSER							
40	EVAPORATOR							
41	EVAPORATOR SMALL							
42	CONDENSER SMALL							
43	SYS. START TIMES							
	Total diagnostic points							

3 PUMPS SYSTEM

GENERAL

The various items of the water circulating system shall be complete in all respects and comply with the specification given below. The total sound intensity with all fans in operation shall not practically exceed 60 DB at a distance of 50 meters.

PUMP SETS

Pumps capacity shall be as per detail design requirement.

Primary and Condenser water Pumps

Scope:

This specification covers the design, materials of construction, features, performance and testing of the Water Pumps of side suction, Top discharge with back pull out Horizontal End Suction Centrifugal single stage pumps. Pump shall be suitable for the purpose they are intended.

Codes and Standards:

The design, material, construction, manufacture, inspection, testing and performance of vertical Inline Pumps shall comply with all currently applicable statutes, regulations and safety codes in the Locality where the Equipment will be installed. The Equipment supplied com plies with the latest Applicable Indian, American or equivalent Standards.

General:

The pumps shall be single stage, close coupled, inline suction and discharge ports of identical Diameter with top pullout design. Hence, the rotating unit can be removed and serviced without disconnecting the suction and discharge piping.

The pump and motor shall be factory assembled at the pump manufacturer's facility.

Installation instructions shall be included with pump at time of shipment. The pump manufacturer shall have complete unit responsibility.

Features of Construction:

a.) Pump Casing:

Pump spiral volute casing shall be of inline design robust construction with integrally cast base at bottom in order to transmit pipe load to the base and foundation (Small pumps can be without base). Liquid passages in the casing shall be smooth finish to ensure high Efficiency.

Pump casing shall capable of withstanding 1.5 times the design pressure.

Pump casing shall be of Cast Iron and capable of withstanding to the maxi mum pressure developed by the pump.

Flange dimensions are in accordance with EN 10922 or ISO 70052.Pump casing shall be fitted with bronze wear ring.

b.) Impeller:

The impeller shall be having cast bronze enclosed type with smooth surface finish for minimum frictional loss. This ensures high Efficiency. Impeller shall be keyed to the shaft and secured by impeller lock nut.

All impellers are dynamically balanced to ISO 19401: Grade G6.3. The thrust balancing can be of Balancing holes or back vanes.

The direction of rotation of the impeller shall be clockwise when viewed from the drive end.

c.) Shaft:

Pump shaft shall be Austenitic stainless steels according to EN 1.4301 / AISI 304 stub shaft and the same shall be, ground and polished to final dimensions and be adequately sized to with stand all stresses, hydraulic loads, vibrations and torques coming in during operation.

Shaft run out shall be limited at the seal face and at the impeller to 0.05 mm. Shaft shall be provided with Mechanical seal as default fitment to provide leak free operation.

d.) Wear Rings:

A renewable type bronze wearing ring shall be provided in the pump casing to maintain close Running clearance and to minimize leakage and recirculation losses and to ensure high pump efficiency.

e.) Mechanical Seals:

The stuffing box cavity shall be sealed off at the pump shaft by an internally or externally flushed Mechanical seal with carbon / Silicon carbide face material, suitable for continuous operation up to140 Deg C.

f.) Bearings:

As radial and axial forces are absorbed by the fixed bearing in the motor drive end, the pump requires no bearing. Bearing shall be effectively sealed to prevent loss of lubricant or entry of dust or water.

g.) Coupling:

The pump coupling should be of close coupled type with stub shaft.

h.) Motors:

Motor shall be a flange mounted, totally enclosed fan cooled motors with main dimensions according to IEC standards. Electrical tolerances are to IEC

60034. Motor shall be IE2motor for normal mode & fir mode equipment's with IE2 motor. Motor shall be to with IP 55 enclosure. The class of insulation shall be F with temperature rise limited to Class B.

Motor shall be suitable for operation on a 415 V (± 10% variation), 50Hz ± 5%, and 3phase AC supply. Pump and motor shall be factory aligned, and shall be realigned by the contractor as per factory recommendations after installation.

i.) Name plates:

Each pump shall be provided with a name plate indicating the following de tails:

Pump type designation
Pump Model
Rated flow
Rated head
Pressure rating/max temperature
Rated speed

j.) Working pressure:

Maximum allowable working pressure for all the pressure containing parts shall in no case be less than the maximum discharge pressure produced by the pump at shut off (including tolerances), at the max suction pressure, for the maximum impeller diameter and the maximum continuous speed. Pump shall be rated at actual required working pressure but not less than 16 bar working pressure.
Cast Iron with PN16 flanges for working pressure to 12bar at 65°C and Ductile Iron with PN25 flanges for working pressures to 25 bar at 65°C. Pumps for working pressure higher than 16 bar shall be PN25 with ductile iron flanges for working pressure up to 25 bar at 65°C, if called for Suction and discharge connections shall be flanged and the same size and shall be drilled and tapped for seal flush and gauge connections.

k.) Vibration:

The pump(s) vibration limits shall conform to Hydraulic Institute ANSI/HI 1.1 1.51994 or ISO 10816.

Painting:

The equipment shall be thoroughly cleaned and greased. All rust sharp edges and scales shall be removed. All external and exposed cast iron parts of pumps have an epoxy based coating made in a cathodic electrode position (CED) process which is high quality dip painting process and which would prevent rusting and corrosion. The color code for the finished product is NCS 9000/RAL 9005. The pump shaft shall not be painted.

PUMP & MOTOR SELECTION:

The pumps shall be factory manufactured, assembled and hydrostatically tested as per Hydraulic Institute standards in an ISO 9001 approved facility. Motor should be of variable Frequency drive compatible. Motor should be selected as no overloading type.

Inspection & Testing of Various Items:

Following inspections and tests as per relevant ISO/IS/HI standards shall be carried out.

1. Hydrostatic Testing
2. Performance Test (Single point / Duty point)
3. Dynamic balancing for pump impeller.

Tender Drawings:

The following drawings shall be submitted by the Contractor:

Preliminary outline dimensional drawing of pump and motor (Suction and discharge Connections).

Performance curves (capacity Vs total head, efficiency, NPSH and KW requirement) ranging from zero to maximum capacity.

Technical Data sheet for Pumps.

Variable Speed Pumping System For Primary CHW Pumps:

Variable speed pump should provide stable and predictable flow rate over a wide variation of head pressure including the following:

The control system shall include programmable logic pump controller, adjustable frequency drive(s) and Differential pressure transmitters as indicated in the design. Provide additional items as specified or as required to properly execute the sequence of operation.

The variable speed pump logic controller, adjustable frequency drives(s), AFD by pass and re mote sensor/ transmitter(s) shall ship as individual components to the job site.

Pump logic controller, adjustable frequency drives, sensor / transmitters and related equipment shall be installed by the HVAC contractor as shown on the drawing.

Line voltage power wiring shall be installed by the HVAC contractor as shown on the field connection drawings and wiring diagrams supplied with the pumping package.

Low voltage (24V DC and 110V AC) wiring shall be installed by the BMS contractor as shown on the field connection drawings and wiring diagrams supplied with the pumping package.

COMPONENTS

Pump Logic Controller

The Technologic pump logic controller assembly shall be listed by and bear the label of underwriters Laboratory, Inc. (UL). The controller shall meet part 15 of FCC regulations pertaining to class A computing devices. The controller shall be specifically designed for variable speed pumping application.

The controller shall function to a proven program those safeguards against damaging hydraulic conditions including:

Motor overload Pump flow surges Hunting
End of Curve

The pump logic controller shall be capable of receiving up to 7 remote process variable signals. It will then select the analogue signal that has deviated the greatest amount from its set point. This selected signal will be used as the commend feedback input for a hydraulic stabilizing 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 two pumps in parallel.

The pump logic controller shall have an additional analog input for a flow sensor. This input shall serve as the criteria for the end of curve protection algorithm.

The hydraulic stabilizer program shall utilize a proportional integral derivation control function. The proportional, integral and derivative values shall be uses adjustable over an infinite range.

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.
- On screen help functions
- LED pilot lights and switches.

- Soft touch membrane keypad switches.

The readout shall be two lines of forty 0.25" backlit LCD super twist characters capable of displaying the following values:

- Differential pressure in PSIG
- Pressure in PSIG
- Flow in GPM
- Temperature in degrees F or C
- Differential temperature in degree F or C

The following communication features shall be provided to the BAS:

- Remote system start/stop
- Failure of any system component
- Process variable
- AFD Speed
- Equipment's/ Controllers shall be compatible with existing BMS

ADJUSTABLE FREQUENCY DRIVE.

The adjustable frequency drive (s) shall be pulse width modulation (PWM) type, microprocessor controlled design.

The AFD including all factory installed options shall have CSA approval.

Enclosure shall be NEMA 1 ventilated for installation as a wall mounted of free standing unit, depending on the amp rating. A hand off auto switch and speed potentiometer shall be function via AFD key pad.

AFD shall utilize a diode bridge rectifier to convert three phase AC to a fixed DC voltage. Power factor shall remain above 0.98 regardless of speed or load. AFDs employing power factor correction capacitors shall not be acceptable.

Insulated gate bipolar transistors shall be used in the inverter section to convert the fixed DC voltage to a three phase, adjustable frequency, AC output. An internal line reactor shall be provided to lower harmonic distortion of the power line to increase the fundamental power factor.

The following customer modifiable adjustments shall be provided:

- Accel time: 0.1 to 1800 seconds
- Decel time: 0.1 to 1800 seconds
- Minimum frequency: 0 HZ
- Analog input filter: 0.1 to 10 seconds
- Analog outputs: 10 to 1 gain

Speed reference signal shall be customer selectable for 010VDC or 420 mA.

The AFD shall be suitable for elevations to 3300 feet above sea level without derating. Maximum operating ambient temperature shall not be less than 104 degrees F.AFD shall be suitable for operation in environments up to 95% non condensing humidity.

The AFD shall be capable of displaying the following information in plain English via a 40-character alphanumeric display:

- Frequency
- Voltage
- Current
- Kilowatts per hour
- Fault identification
- Percent torque
- Percent power
- RPM

SENSOR/TRANSMITTERS:

Provide adequate Nos. field mounted differential pressure sensor transmitter(s) as required at site. Unit shall transmit an isolated 420A 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 1electrical enclosure capable of withstanding 450 PSI static pressure. Accuracy shall be within 0.5% of full span.

SEQUENCE OF OPERATION

The system shall consist of a technologic pump logic controller, one duty pump /AFD set; with duty standby pump selection, automatic alternation and automatic transfer to the standby pump.

The pumping system shall start upon the closure of customer's contact when the 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, the pumping system shall operate automatically. Sensor/transmitters shall be provided as indicated on the plans.

Each sensor/transmitter shall send a 420mA signal to the technologic pump logic controller, indicative of process variable condition.

The Technologic 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 technologic pump logic controller shall continuously scan and compare each process variable to its individual set point and control to

the least satisfied zone.

As the worst case zone deviates from set point, the pump logic controller shall send the appropriate analog signal to the AFD to speed up or slow down the pump/motor.

The redundant variable speed system shall be started through the pump logic controller.

In the event of a system differential pressure failure due to a pump or AFD fault, the pump logic controller automatically initiates a times sequence of operation to start the redundant pump/AFD set in the variable speed mode.

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.

The zone number corresponding to the failed sensor/ transmitter shall be displayed on the operator interface of the pump logic controller.

In the event of failure to receive all zone process variable signals, the AFD shall maintain 100% speed; reset shall be automatic upon correction of the zone failure.

Pump or AFD fault shall be continuously scrolled through the display on the operator interface of the pump logic controller until the fault has been corrected and the controller has been manually reset.

Manual override arrangement for all control system to be provided.

PUMPS SUITABLE FOR VARIABLE SPEED

Pumps shall be single stage, end suction design with a foot mounted volute to allow servicing of the impeller and bearing assembly without disturbing piping connections.

Pump volute shall be class 30 cast iron with integrally cast pedestal support feet. The impeller shall be cast bronze enclosed type, dynamically balanced keyed to the shaft and secured by a locking cap screw.

The liquid cavity shall be sealed off at the pump shaft by an internally flushed mechanical seal with ceramic seal seat and carbon seal ring, suitable for continuous operation at 225o F.A. replaceable bronze shaft sleeve shall completely cover the wetted area under the seal.

Pump shall be rated for minimum of 16 bar working pressure. Volute shall have gauge tapings at the suction and discharge nozzles and vent and drain tapings at the top and bottom.

Base plate shall be structural steel or fabricated steel channel with fully enclosed sides and ends, and securely welded cross members. Grouting area shall be fully opened. A flexible type, center drop put design coupler, capable of absorbing torsional vibration shall be employed between the pump and motor. Coupler shall be shielded by a coupler guard securely fastened to the base.

Motor shall be energy efficient, totally enclosed fan cooled, class 'F' insulation and suitable for operation on AFD (only for secondary side).

Motor shall be specially designed for quite operation and its speed shall not exceed 1450 RPM. The motor rating shall be such as to ensure non over loading of the motor throughout its capacity range. Motor shall be suitable for 415 ± 10% volts, 3 phase, 50 cycles AC power supply.

Suction Guides

Furnish and install on the suction of each pump Suction Guide, with Outlet Flow Stabilizing Guide Vanes, removable Stainless-Steel Strainer and Fine Mesh Start-up Strainer. Supply suction guide with Ductile Iron body, with BSPT inlet and PN16 outlet connections. The mechanical contractor shall inspect the strainer prior to activating the pump and, further, shall remove the Fine Mesh Start-up Strainer after a short running period. (24 hours maximum). Space shall be provided for removal of the Strainer and connection of a Blow-down Valve.

4 VARIABLE FREQUENCY DRIVES

PART 1: GENERAL REQUIREMENTS

This specification covers complete variable frequency drives (VFDs) designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD.

The frequency converter shall not be a general purpose product, but a dedicated HVAC engineered design.

The VFD and its options shall be factory mounted and tested as a single unit under full load before dispatch.

The VFD shall be tested to UL 508C. The appropriate UL label shall be applied. VFD shall be manufactured in ISO 9000, 2000 certified facilities.

The VFD shall be CE marked and conform to the European Union Electro Magnetic Compatibility directive.

The VFD shall be UL listed for a short circuit current rating of 100 kA and labeled with this rating.

The frequency converter shall be supported locally by the manufacturer who will provide full technical support, spares holding and troubleshooting capability from their own local facility. A training course shall be provided by the manufacturer to the Engineer in Charge / contractor / maintenance engineers.

PART 2: TECHNICAL REQUIREMENTS

The VFD shall convert incoming fixed frequency three phase AC power into an adjustable frequency and voltage for controlling the speed of three phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor derating when properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.

The VFD shall convert incoming fixed frequency three phase AC power into an adjustable frequency and voltage for controlling the speed of three phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor derating.

When properly sized, the VFD shall allow the motor to produce full rated

power at rated motor voltage, current, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.

The VFD shall include an input full wave bridge rectifier and maintain a fundamental (displacement) power factor near unity regardless of speed or load.

The VFD shall have a dual 5% impedance DC link reactor (harmonic filters) on the positive and negative rails of the DC bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating. Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable.

VFDs with saturating (nonlinear) DC link reactors shall require an additional 5% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.

IEEE519, 1992 recommendations shall be used for the basis of calculation of total harmonic distortion (THD) at the point of common coupling (PCC). On request VFD manufacturer shall provide THD figures for the total connected load. The contractor shall provide details of supply transformer rating, impedance, short circuit current, short circuit impedance etc. to allow this calculation to be made.

All VFDs upto 90 KW shall contain integral EMC Filters to attenuate Radio Frequency Interference conducted to the AC power line. The VFDs shall comply with the emission and immunity requirements of IEC 618003: 2004, Category C1 with 50meter. The suppliers of VFDs shall include additional EMC filters if required to meet compliance to this requirement.

The VFD’s full load output current rating shall meet or exceed the normal rated currents of standard IEC induction motors. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 120% of rated torque for up to 0.5 second while starting.

The VFD shall provide full motor torque at any selected frequency from 20 Hz to base speed while providing a variable torque V/Hz output at reduced speed. This is to allow driving direct drive fans without high speed derating or low speed excessive magnetization, as would occur if a constant torque V/Hz curve was used at reduced speeds. Breakaway current of 160% shall be available.

A programmable automatic energy optimization selection feature shall be provided as standard in the VFD. This feature shall automatically and continuously monitor the motor’s speed and load to adjust the applied voltage to maximize energy savings.

The VFD must be able to produce full torque at low speed to operate direct driven fans.

Output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD.

An Automatic Motor Adaptation algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or decouple the motor from the load to perform the test.

Galvanic isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog I/O and discrete digital I/O shall include additional isolation modules.

VFD shall minimize the audible motor noise through the used of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise. VFDs with fixed carrier frequency are not acceptable.

The VFD shall allow up to at least 100 meters of SWA (Single Wire Armour) cable to be used between the FC and the motor and allow the use of MICS (Mineral Insulated Copper Sheath) cable in the motor circuit for fire locations.

PART 3: PROTECTIVE FEATURES

A minimum of Class 20 I2t electronic motor overload protection for single motor applications shall be provided. Overload protection shall automatically compensate for changes in motor speed.

Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over voltage, under voltage, VFD over temperature and motor over temperature. The VFD shall display all faults in plain language. Codes are not acceptable.

Protect VFD from input phase loss. The VFD should be able to protect itself from damage and indicate the phase loss condition. During an input phase loss condition, the VFD shall be able to be programmed to either trip off while displaying an alarm, issue a warning while running at reduced output capacity, or issue a warning while running at full commanded speed. This function is independent of which input power phase is lost.

Protect from under voltage. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output, without faulting, with an input voltage as

low as 70% of the nominal voltage.

VFD shall include current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload. If an output phase loss is detected, the VFD will trip off and identify which of the output phases is low or lost.

If the temperature of the VFD's heat sink rises to 80°C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. It shall also be possible to program the VFD so that it reduces its output current limit value if the VFD's temperature becomes too high.

In order to ensure operation during periods of overload, it must be possible to program the VFD to automatically reduce its output current to a programmed value during periods of excessive load. This allows the VFD to continue to run the load without tripping.

The VFD shall have temperature controlled cooling fan(s) for quiet operation, minimized losses, and increased fan life. At low loads or low ambient temperatures, the fan(s) may be off even when the VFD is running.

The VFD shall store in memory the last 10 alarms. A description of the alarm, and the date and time of the alarm shall be recorded.

when used with a pumping system, the VFD shall be able to detect noflow situations, dry pump conditions, and operation off the end of the pump curve. It shall be programmable to take appropriate protective action when one of the above situations is detected.

PART 4: INTERFACE FEATURES

Hand Off and Auto keys shall be provided on the control panel to start and stop the VFD and determine the source of the speed reference. It shall be possible to either disable these keys or passwords protect them from undesired operation.

There shall be an "Info" key on the keypad. The Info key shall include "online" context sensitive assistance for programming and troubleshooting.

The VFD shall be programmable to provide a digital output signal to indicate whether the VFD is in Hand or Auto mode. This is to alert the Building Automation System whether the VFD is being controlled locally or by the Building Automation System.

Password protected keypad with alphanumeric, graphical, backlit display can be remotely mounted. Two levels of password protection shall be provided to guard against unauthorized parameter changes.

All VFDs shall have the same customer interface. The keypad and display shall be identical and interchangeable for all sizes of VFDs.

To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD's keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters. Keypad shall provide visual indication of copy status.

Display shall be programmable to communicate in multiple languages including English.

A red FAULT light, a yellow WARNING light and a green POWERON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.

A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD.

A three feedback PID controller to control the speed of the VFD shall be standard.

This controller shall accept up to three feedback signals. It shall be programmable to compare the feedback signals to a common set point or to individual set points and to automatically select either the maximum or minimum deviating signal as the controlling signal. It shall also be possible to calculate the controlling feedback signal as the average of all feedback signals or the difference between a pair of feedback signals.

The VFD shall be able to apply individual scaling to each feedback signal.

For fan flow tracking applications, the VFD shall be able to calculate the square root of any or all individual feedback signals so that a pressure sensor can be used to measure air flow.

The VFD's PID controller shall be able to actively adjust its set point based on flow. This allows the VFD to compensate for a pressure feedback sensor which is located near the output of the pump rather than out in the controlled system.

The VFD shall have three additional PID controllers which can be used to control damper and valve positions in the system and to provide set point reset.

Floating point control interface shall be provided to increase/decrease speed in response to contact closures.

Five simultaneous meter displays shall be available. They shall be selectable from (at a minimum), frequency, motor current, motor voltage,

VFD output power, VFD output energy, VFD temperature in degrees, feedback signals in their own units, among others.

Programmable Sleep Mode shall be able to stop the VFD. When its output frequency drops below set "sleep" level for a specified time, when an external contact commands that the VFD go into Sleep Mode, or when the VFD detects a noflow situation, the VFD may be programmed to stop. When the VFD's speed is being controlled by its PID controller, it shall be possible to program a "wakeup" feedback value that will cause the VFD to start. To avoid excessive starting and stopping of the driven equipment, it shall be possible to program a minimum run time before sleep mode can be initiated and a minimum sleep time for the VFD.

A run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of initiating an output "run request" signal to indicate to the external equipment that the VFD has received a request to run.

VFD shall be programmable to display feedback signals in appropriate units, such as inches of water column (inwg), pressure per square inch (psi) or temperature (°F). Examples can be room temperature in 0C, return air temperature in 0C, supply air temperature in 0C, CO^2 concentration in ppm, pressure in bar, differential pressure in PSI etc.

VFD shall be programmable to sense the loss of load. The VFD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. To ensure against nuisance indications, this feature must be based on motor torque, not current, and must include a proof timer to keep brief periods of no load from falsely triggering this indication.

Standard Control and Monitoring Inputs and Outputs

Four dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.

Two terminals shall be programmable to act as either as digital outputs or additional digital inputs.

Two programmable relay outputs, Form C 240 V AC, 2 A, shall be provided for remote indication of VFD status.

Each relay shall have an adjustable on delay / off delay time.

Two programmable analog inputs shall be provided that can be either director reverse acting.

Each shall be independently selectable to be used with either an analog voltage or current signal.

The maximum and minimum range of each shall be able to be independently scalable from 0 to 10 V dc and 0 to 20 mA.

A programmable low pass filter for either or both of the analog inputs must be included to compensate for noise.

The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system setup and troubleshooting,

One programmable analog current output (0/4 to 20 mA) shall be provided for indication of VFD status. This output shall be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power. It shall be possible to scale the minimum and maximum values of this output.

It shall be possible to read the status of all analog and digital inputs of the VFD through serial bus communications.

It shall be possible to command all digital and analog output through the serial communication bus.

Optional Control and Monitoring Inputs and Outputs

It shall be possible to add optional modules to the VFD in the field to expand its analog and digital inputs and outputs.

These modules shall use rigid connectors to plug into the VFD's control card.

The VFD shall automatically recognize the option module after it is powered up. There shall be
no need to manually configure the module. Modules may include such items as:
Additional digital outputs, including relay outputs Additional digital inputs
Additional analog outputs

Additional analog inputs, including Ni or Pt temperature sensor inputs

It shall be possible through serial bus communications to control the status of all optional analog and digital outputs of the VFD.

Standard programmable firefighter's override mode allows a digital input to control the VFD and override all other local or remote commands. It shall be possible to program the VFD so that it will ignore most normal VFD safety circuits including motor overload. The VFD shall display FIREMODE whenever in firefighter's override mode. Fire mode shall allow selection of forward or reverse operation and the selection of a speed source or preset speed, as required to accommodate local fire codes,

standards and conditions.

A real time clock shall be an integral part of the VFD.

It shall be possible to use this to display the current date and time on the VFD's display.

Ten programmable time periods, with individually selectable ON and OFF functions shall be available. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter set points and output relays. Is shall be possible to program unique events that occur only during normal work days, others that occur only on nonwork days, and others that occur on specific days or dates. The manufacturer shall provide free PC based software to set up the calendar for this schedule.

All VFD faults shall be time stamped to aid troubleshooting.

It shall be possible to program maintenance reminders based on date and time, VFD running hours, or VFD operating hours.

The realtime clock shall be able to time and date stamp all faults recorded in the VFD fault log.

The VFD shall be able to store load profile data to assist in analyzing the system demand and energy consumption over time.

The VFD shall include a sequential logic controller to provide advanced control interface capabilities. This shall include:

Comparators for comparing VFD analog values to programmed trigger values Logic operators to combine up to three logic expressions using Boolean algebra Delay timersA 20step programmable structure

PART 5: SERIAL COMMUNICATIONS

The VFD shall include a standard EIA485 communications port and capabilities to be connected to the following serial communication protocols at no additional cost and without a need to install any additional hardware or software in the VFD:

Modbus/ Bacnet/RTU

VFD shall have standard USB port for direct connection of Personal Computer (PC) to the VFD. The manufacturer shall provide no charge PC software to allow complete setup and access of the VFD and logs of VFD operation through the USB port. It shall be possible to communicate to the VFD through this USB port without interrupting VFD communications to the building management system.

The VFD shall have provisions for an optional 24 V DC backup power

interface to power the VFD's control card. This is to allow the VFD to continue to communicate to the building automation system even if power to the VFD is lost.

PART 6: ADJUSTMENTS

The VFD shall have a manually adjustable carrier frequency that can be adjusted in 0.5 kHz increments to allow the user to select the desired operating characteristics. The VFD shall also be programmable to automatically reduce its carrier frequency to avoid tripping due to thermal loading.

Four independent setups shall be provided.
Four preset speeds per setup shall be provided for a total of 16.

Each setup shall have two programmable ramp up and ramp down times. Acceleration and deceleration ramp times shall be adjustable over the range from 1 to 3,600 seconds.

Each setup shall be programmable for a unique current limit value. If the output current from the VFD reaches this value, any further attempt to increase the current produced by the VFD will cause the VFD to reduce its output frequency to reduce the load on the VFD. If desired, it shall be possible to program a timer which will cause the VFD to trip off after a programmed time period.

If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: external interlock, under voltage, overvoltage, current limit, over temperature, and VFD overload.

The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.

An automatic "start delay" may be selected from 0 to 120 seconds. During this delay time, the VFD shall be programmable to either apply no voltage to the motor or apply DC braking current if desired.

Four programmable critical frequency lockout ranges to prevent the VFD from operating the load at a speed that causes vibration in the driven equipment shall be provided. Semiautomatic setting of lockout ranges shall simplify the setup.

PART 7: OPTIONAL FEATURES

7.1 All optional features shall be built and mounted by VFD manufacturer as an inbuilt factory solution. All optional features shall be UL listed by the VFD manufacturer as a complete assembly and carry a UL label.

PART 8: SERVICE CONDITIONS

Ambient temperature at full speed, full load operation with continuous drive rated output current:

10 to 45°C for ratings upto 90 kW without derating

10 to 40°C for ratings 110 kW and higher without derating

Relative Humidity: 0 to 95%, noncondensing.

Elevation: Up to 3,300 feet without derating.

AC line voltage variation: + 10% of nominal with full output.

VFDs upto 90 KW rating Enclosure protection: IP 55, integral, with Mains Disconnect with no additional cabinets.

Side Clearances: No side clearance shall be required for cooling.

All power and control wiring shall be done from the bottom.

All VFDs shall be plenum rated.

PART 9: QUALITY ASSURANCE

To ensure quality, the complete VFD shall be tested by the manufacturer. The VFD shall drive a motor connected to a dynamometer at full load and speed and shall be cycled during the automated test procedure.

All optional features shall be functionally tested at the factory for proper operation.

5 COOLING TOWER

GENERAL DESCRIPTION

The specifications to follow cover general requirements of design, preparation of detailed drawings, supply of material, manufacture, testing, inspection, packing, forwarding, transportation, transit insurance, and delivery at site, installation, testing and commissioning at site and carrying out acceptance test of the equipment, materials and services as per enclosed documents.

SCOPE OF WORK

The scope shall include development of a total system and design of their sub-systems as per concepts and parameters given herein, providing engineering drawings and data for approval by Customer / Consultants.

This will consist of supply, installation, balancing, testing & commissioning of the following in conformity with the tender, General Terms & Conditions, Special Conditions, Specifications, Bill of Quantities, attached drawings, drawings to be submitted by the Contractor and approved by the Consultant. The Contractor shall carry out the said work under the Contract in every respect in conformity with the Contract documents and with the directions of and to the satisfaction of the supervisor. The Contractor shall furnish all labour, materials and equipment (except those to be supplied by the owner) as listed under 'schedule of quantities' and specified otherwise, transportation etc., for supply, installation, testing and commissioning of complete HVAC system as described in specifications and shown on drawings. This also includes any material, equipment, work not specifically mentioned in the drawings / documents but which are necessary to make a complete installation. Additionally:

1. Scope shall be inclusive of approval from Authority for required statutory approval required for Works.
2. Contractor will need to submit technical data sheet of each and every equipment and ancillaries to MEP Consultant & get approval prior to procurement
3. All Equipment shall be factory inspected by MEP Consultant and Client Representative prior to dispatch on site.
4. All necessary site housekeeping, material security, site construction lighting etc. required for site work shall be inclusive in the scope of vendor.

COOLING TOWER SPECIFICATIONS

SCOPE

This section covers the supply, installation, testing and commissioning of **Induced draught cooling towers** in accordance with the approved drawings and 'Schedule of Quantities'.

CODES AND STANDARDS

The design, manufacture, testing and performance of the cooling tower shall comply with all currently applicable statues, regulations and safety codes in the locality where it is to be installed. The cooling tower shall also conform to the latest applicable Indian Standards and Publications of the cooling Tower Institute. Nothing in this specification shall be construed to relieve the contractor of his responsibility.

TYPE

The cooling tower shall be of Mechanical draft type. Fan on Mechanical draft towers may be on the inlet air side or exit air side. In case of former it is called forced draft type and in case of later it is called Induced draft type. On the basis of direction of air flow and water flow, Mechanical draft cooling tower can be counter flow or cross flow type as per the manufacturer design.

This may be of any of the following construction as may be specified in the tender specifications: -

a) In wooden construction with wood or PVC fill and RCC basin,
b) In fibre glass reinforced plastic (FRP) construction with PVC fill and FRP basin,
c) In masonry construction.

The mechanical draft cooling towers of wooden construction and masonry construction, being un-common now, have been excluded from the scope of these specifications.

Cooling tower shall be fiberglass – reinforced plastic type suitable for outdoor installation. Tower shall be **Induced draught type**, vertical, counter / cross flow type in fiberglass reinforcement plastic construction complete with fan, motor, eliminators, steel supports, HDG ladder etc.

DESIGN:

Rating: The cooling tower shall be rated for the heat rejection capacity specified in the tender specifications. **All cooling towers shall be certified by CTI (Cooling Tower Institute).**

Range: The Cooling tower shall be designed to cool the requisite quantity of water through 7.0-degree C or as specified in the tender specifications, against the prevailing wet bulb temperature.

Wet Bulb approach: The cooling tower shall be selected for a wet bulb approach of not more than 5.0-degree C.

Outlet temperature: The cold water temperature from the cooling tower shall match the entering temperature for which the condenser selection is

made.

Flow rate: The water flow rate through the cooling tower shall match that through the condenser.

Multi cell design: The induced draft cooling tower shall be of one or more cells.

Drive Motor: The fan motor shall be premium efficiency IE3 class, as per IS 12615.

MATERIAL

STRUCTURE

The structural framework of the cooling tower including all members shall be designed for the load encountered during the normal operation of the cooling tower and its maintenance. The structure shall be rugged and rigid to prevent distortion and shall include tie arrangements as may be necessary.
The supporting framework for the tower casing and the water basin shall be made of hot dip galvanized steel and it shall be further protected with epoxy painting.

SIDE CASING

The side casing shall be made of FRP with smooth surface for minimum resistance to airflow. It should have sufficient structural strength to withstand high wind velocity and vibrations. The casing shall be installed in the fiberglass-reinforced basin. The tower supporting structure shall be made out of hot dipped galvanized frame. The tower shall have FRP panels reinforced with embedded steel frame.

AIR INTAKE

The air intake shall be from openings all along the circumference of the casing near its base in case of circular shape. Air Intake shall be along the sides in case of square or octagonal/ rectangular cooling tower. These openings shall be covered with hot dip galvanized expanded metal mesh screens.

COLD WATER BASIN

Basin shall be FRP on which cooling tower structure shall be supported and shall be complete with following: -

- ✓ Bottom outlet
- ✓ Suction screen
- ✓ Drain outlet
- ✓ Over flow
- ✓ Make up water connection with ball valve & float valve

- ✓ Equalizer connection where required
- ✓ Quick fill.
- ✓ The basin shall be watertight without the use of any fillets, paints or sealing compounds

The basin shall have a holding capacity adequate for operation for at least 30 minutes without addition of make-up water to the basin. The construction should be such as to eliminate the danger of drawing air into the pump when operating with minimum water in the basin.

Suitable provision shall be made in the tower for cable supports and for fixing galvanized steel flats as earthing and lightning protection.

DISTRIBUTION SYSTEM

Distribution system shall be thru self-rotating or fixed type nozzles or thru balancing, sub balancing and spread thru ensuring uniform water loading and distribution. The water distribution may be either through self-rotating or fixed type sprinklers or through balancing, sub balancing and spreader troughs (unpressurised system) open gravity type with polypropylene nozzle, ensuring uniform water loading and distribution of water over the fill. All pipes and fittings shall be of PVC. The sprinklers shall operate from the residual velocity head at the headers. Due care shall be taken with regard to corrosive effects and maintainability in the design of the water distribution system.

FILLINGS

The filling shall be of PVC. Thickness of PVC fills shall not be less than 0.2mm. Fillings shall be made of corrosion proof and rigid film in cross-fluted design and arranged in square/rectangular form and shall be elevated from 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 airflow and to eliminate backwater 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 eliminators shall be of high efficiency. Drift eliminators of PVC shall be provided for maximum removal of entrained water droplets. The spacers and tie rods used shall be of plastic material.

MECHANICAL EQUIPMENT

Fan shall be made of cast aluminum alloy and propeller type lightweight rotor fitted with multiple aerofoil blades. The entire fan assembly shall be statically balanced fan shall be direct driven by motor suitable for 415 ± 10% Volts, 3 phase, 50 cycle per second AC supply, TEAO, weather proof construction (IP:56) designed to operate in humid air stream fan shall be protected by fan guard and shall be easily accessible for inspection and maintenance. A service ladder fabricated out of hot dipped galvanized material shall be provided. The mechanical equipment assembly shall be supported on a rugged steel base welded to tubular support for vibration

free support. Fan shall be provided to prevent birds from nesting during idling periods. All fans shall be direct driven with low RPM motor. The fan drive shall be from a three phase induction motor of efficiency class IE3 as per IS 12615. The entire drive arrangement shall be designed for a minimum noise and it shall be rigidly supported to the tower structure.
Tower from 175 TR onwards shall have twin fans with low RPM motors of 720/600 RPM suitable for low noise application. Maximum noise level within One (1) meter of the source shall not exceed 75 dBA.

OTHER ACCESSORIES

To ensure safety of personnel at the time of working on cooling tower a steel ladder shall be provided in such a manner and location as necessary to give safe and complete access to all the parts of the cooling tower requiring inspection or adjustments. The ladder shall be bolted to the tower at the top and grouted in masonry at the bottom end.

INSTALLATION

The cooling tower shall be installed on M.S. girders fixed in masonry foundations with cement concrete footing. Second class brick work and cement mortar having one part cement & six parts sand shall be used for the masonry work. 12mm sand cement plaster shall be provided over the brickwork.

These may be located at a well-ventilated place either at ground level and contiguous to the plant room, or on the terrace of the building in consultation with the Architect. In case the cooling towers are located on the terrace of the building, the structural loading of the terrace shall be considered. For this respective columns are to be raised by two feet at the terrace. Cooling towers shall be installed in such a way that their load is transferred directly to the columns for which necessary Mild steel-I sections shall be provided by the air- conditioning contractor. The cooling towers shall be rested on Mild Steel-I sections & not on terrace slab. Sufficient free space shall be left all around for efficient operation of the cooling tower.

Cooling tower shall be not less than 75cm above the ground/ floor level unless otherwise stated in the tender specifications. 6mm neoprene pads shall be placed between the tower and the girder for vibration isolation whereas directed by the Engineer-in-charge. Guy-wires of suitable sized shall be used to secure firmly to its base wherever necessary.

PAINTING

The cooling tower shall be procured of colour strictly in accordance with written approval of Architect/Consultants. All exposed surfaces shall be given three (3) coats of epoxy paint and colour finish as per standards.

ACCESSORIES

a) Cold-water basin common outlet header shall have pot strainer. The strainer shall have handles for easy removal.

b) The cooling tower basin shall have automatic float valve with a stop valve for continuous Make up water flow, quick fill arrangement with stop valve, over flow and drain connections with stop valves.

c) A hot water bleed connection to drain line through a stop valve shall be provided and shall be connected to drain line below the drain stop valve.

d) Hot dipped galvanized steel ladder made of 40mm x 40mm x 6mm HDG angle sides and
e) 16mm HDG straps shall be provided for complete access to tower. The ladder shall be bolted to tower on top and grouted in masonry at bottom side.

f) Hot dipped galvanized bird-screen shall be fixed on top to prevent any bird entering into
g) Cooling tower.

h) All hardware used inside the cooling tower shall be of stainless steel. All pipe
i) Connections shall be hot dipped galvanized and double flanged.

j) Equalizer line to be provided for cooling towers.

TESTING

Complete performance ratings and power consumption at varying outdoor wet bulb temperature shall be submitted and verified at the time of testing and commissioning of the installation. Capacity of the cooling tower shall be computed from the measurements of water flow, incoming/outgoing water temperature 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 induced draft cooling towers shall be computed from measurements of incoming voltage and input current.

6 AIR HANDLING UNITS (AHUS)

GENERAL

The scope of this section comprises the supply, erection, testing and commissioning of double construction air handling units, conforming to these specifications and in accordance with requirements.

FLOOR MOUNTED AIR HANDLING UNITS

The air handling units shall be double skin construction, draw thru type comprising of various sections such as pre-filter section, coil section and fan section.

CAPACITY

The air handling capacities, maximum motor horsepower and static pressure shall be as per requirements.

CASING

Frame work shall be of Hollow extruded aluminum profile/thermal break extruded aluminum profile as per application & location of AHU to be placed. AHUs Panels shall be double skinned panel fabricated with anodized extruded aluminum construction section framework bolted together with sandwich panel having 22/20 gauge pre plasticized outer skin and 22/20 gauge plain GI inner skin injected with 25/43 mm thick CFC free PU foam insulation as per application & location having density not less than 40 + 2 kg/ m3 to ensure mechanical strength as per class D1 of EN 1886, air leakage as per class L1 of EN 1886,thermal bridging of minimum TB2 class and thermal transmittance of minimum T2 class as per EN 1886. For floor mounted AHU the entire frame shall be mounted on a sheet steel channel base of 100 mm height. The panels shall be sealed to the framework by heavy duty `O' ring gaskets held captive in the framed extrusion.
The acoustic performance of the panels shall have been tested by an independent laboratory per ASTM C423, mounting Type A and E79593.

All panels shall be detachable or hinged. Hinges shall be made of die cast aluminum. Nylon plastic with stainless steel pivots, handles shall be made of hard nylon and be operational from both inside and outside of the unit. Units supplied with various sections shall be suitable for onsite assembly with continuous foam gasket. All fixing and gaskets shall be concealed.

Units shall have hinged quick opening access doors in the fan and filter section. Access doors shall also be double skin type.

Condensate drain pan shall be fabricated from 18-gauge stainless steel sheet. It shall be isolated from bottom floor panel through PU foam

insulation as per manufacturer standard.

AHU's such as TFA units, AHU with mixing box having return air ducted shall be provided with thermal break casing. Also these AHU's shall be provided with 43 + 2 mm thick panel.

MOTOR AND DRIVE

Fan motors shall be energy efficient and shall be 415±10% volts, 50 cycles, three phases, totally enclosed fan cooled class F and shall have premium efficiency i.e. Minimum **IE-3**, with IP55 protection. Motors shall be especially designed for quiet. Drive to fan shall be provided through direct drive arrangement. Frequency converter (VFD) for energy saving, shall be supplied by the AHU manufacturer for all AHUs with direct driven fans.

FAN

EC 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 for high efficiency and favorable acoustic behavior.

Impeller: The high efficiency backward curved impeller made of welded aluminum sheet or high performing composite material with external rotor motor balanced together statically and dynamically according to ISO 1940. The EC fan should be capable of being fitted in horizontal position in the AHU.

Motor: The minimum efficiency class of the motor shall be IE-/4.The motor shall be permanent magnet external rotor motor with integrated electronics and suitable for continuous operation. The speed of the motor shall be varied with an external 0-10V/ PWM control signal. The fan in totality shall be of most efficient type so that the power consumption and noise level is minimal. The motor shall be minimum IP54 protection class.

Direct Driven Plug Fan

Fans shall be backward curved Plenum plug fan with aero-foil design blades so as to give maximum efficiency for given duty condition. In case of Plug fan, the AHU will be certified by a reputed 3rd party internationally acclaimed certifying body like Eurovent / AHRI, and the entire Fan + Motor assembly will be balanced at supplier's works before dispatch. Fans driven by variable frequency drive shall be backward inclined irrespective of static pressure value. Fans shall be selected for minimum efficiency of 70%. Fan wheels shall be made of MS epoxy coated/composite material in case of plug fans. Fan array with multiple fans should be used for capacities more than 15000 CMH. Plug fans in fan array shall have individual VFDs for

every motor fan set. Certified Computerized selection for AHU shall be with fan selection and sound level spectrum. Complete AHU sound level should be given in computerized selection sheet instead of sound level of bare fan.

Motors shall be mounted inside the AHU casing on rigid frame/ slide rails for alignment, and be totally enclosed, fan cooled, to be class `F' insulation and shall have premium efficiency i.e. minimum IE-3.

Heavy duty anti-vibration mounts shall be provided for isolating the unit casing. Fire retardant, waterproof silicone rubber impregnated flexible connection shall be provided at the fan inlet/ discharge.

COOLING COILS

CHW Cooling coils shall have 12mm dia. (O.D) tubes minimum 0.5 mm thick with sine wave aluminum fins firmly bonded to copper tubes assembled in zinc coated steel frame. Face and surface areas shall be such as to ensure rated capacity from each unit and such that the air velocity across the coil shall be around 155 meters per minute. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory-tested at 21 kg per sq. m air pressure underwater. Tubes shall be mechanically expanded for minimum thermal contact resistance with fins. Fin spacing shall be 4 - 5 fins per cm. No drop should be observed indicating any leaks.

The depth of the coil shall be such as to suit the requirements, viz. re-circulated air applications, or 100 % fresh air applications and the bypass factor required shall be specified in the tender specifications. The coil shall be 6 rows deep for normal/general area re-circulated air application and 8 rows deep for all critical/TFA and for outdoor air application, unless otherwise specified in the tender specifications. In case of 8 rows deep coils, it shall be made of 2x4 rows deep coils with a spacing of 200mm between the two coils, access door and independent drain pan.

In case of AHU/TFA has multiple coil stacked one above another, intermediate insulated condensate drain tray of SS 304 (18 gauge) shall be provided so that upper level of coil drains into this tray. Copper / SS 304 piping shall be provided from this tray up-to main bottom tray.

U bends shall be of copper, jointed to the tubes by brazing, soft soldering shall not be used.

Each section of the coil shall be fitted with flow and return headers to feed all the passes of the coil properly. The headers shall be of copper and shall be complete with water in/out connections, vent plug on top and drain at the bottom. The coil shall be designed to provide water velocity between 0.6 to 1.8 m/s in the tubes.

The fins shall be of aluminum. The minimum thickness of the fins shall be 0.15 mm nominal. The no. of fins shall not be less than 4.7 per cm length

of coil. Fins may be of either spiral or plate type. The tubes shall be mechanically expanded to ensure proper thermal contact between fins and tubes. The fins shall be evenly spaced and upright. The fins bent during installation shall be carefully realigned. For coastal areas fins shall be phenolic coated for re-circulated and 100% F.A. application fins shall be hydrophilic type.

The coil shall be suitable for use with the refrigerant specified or with water as specified in schedule of quantities. Refrigerating coils shall be designed for the maximum working pressure under the operating conditions. Water coils shall be designed for a maximum working pressure of 10 kg./sq.cm.

Shut off and regulating valves at the inlet and outlet of water shall be provided. In the case of DX coils, solenoid valve and expansion valves shall be provided at the inlet of coil.

Computerized cooling coil and Heating coil selection output shall be submitted. Coil rating shall be certified as per ARI-410/2006.

Certified Computerized selection for AHU/TFA shall be with coil selection.

UVGI FOR COIL AHU MOUNT ULTRA VIOLET GERMICIDAL IRRADIATION SYSTEM

UVGI system shall provide effective destruction and prevention of growth of bacteria, virus, mold, fungi and microbiological species on the cooling coil. Intensity of UVC rays shall envelope the entire surface area of the cooling coil within the high kill rate zone of the UV glow. Where specified by the Engineering Consultant, an additional UVGI Fixture or set of Fixtures along the width of the Cooling Coil shall be provided, and this shall be mounted near the base of Cooling Coil directed to destroy bacteria and mold in the drain pan.

The UVGI frame shall be installed in close proximity to cooling coil so as to provide effective bactericidal ability on the entire surface area of the cooling coil and large part of the drain pan.

Sufficient number of UVGI units shall be provided to cover the entire surface area of the Cooling Coil.

Each UVGI unit or fixture shall contain at least 2 lamps, to ensure UVC rays penetrate deep into the rows of the Cooling Coil to enable bacteria destruction in the inner rows of the Coil. Units or Fixtures with single lamp is not acceptable due to its limited ability to penetrate into the depth of the Cooling Coil.

The system shall comprise one or more number of individual units or fixtures, all mounted on factory provided metallic frame complete with vertical support channels. The vertical channels shall be telescopic to cover cooling coil of any height. All necessary materials for frame, top and bottom

mounting cups, pre drilled vertical telescopic channels, screws, and hardware shall be factory provided.

Each UVGI unit or fixture shall comprise at least two lamps, installed over a properly profiled aluminum reflector. The reflector shall be mirror surface specular reflectivity 86%. The enclosure shall be not less than 0.04 Inch (1 mm) thick Aluminum.

Interconnecting cable between the ballast and lamps shall be covered in UL Listed water proof and fire resistant sleeve to prevent exposure to moisture from Cooling Coil. The interconnect cable and protective sleeve shall be UL Listed. Cables and ballasts shall be fully enclosed in metallic case. No cable shall be exposed.

The lamps shall be high output type 425 mA each. Energy output of the lamp measured 3'3"(1M) from the Lamp shall not be less than 144 μwpercm². The lamps shall be rated for useful lamp life not less than 9,000 hours.

The lamps shall not operate at wave length 180 nM or lower, to ensure no uncontrolled ozone is put out by the lamps.

All electrical connections within the fixture shall be factory ready, ending on terminals. All fixtures within an AHU shall be daisy looped at site. All electrical cables shall be UL Listed. It shall be possible to connect all the UV fixtures within an AHU easily and quickly with minimum labor time, opening the terminal box alone, and without opening the fixtures.

The Ballast shall be electronic type, fully encapsulated, and confirm to the following;
UL Listed (Class P, Type 1, Outdoor)
Tested and certified to comply with fire and smoke safety to UL 2043
Sound Rated A
Compliance to FCC Part 18 (Class A) for EMI and RFI (non-consumer limits)
ANSI Standard C62.41

Each lamp shall be housed individually in a quartz sleeve equivalent to GE 214 to ensure high rate of transmission of UV intensity. The quartz sleeve shall cover the entire length of the lamp and lamp holders, with annular air gap of 1/8" (3 mm). The quartz sleeve is essential to ensure multiple beneficial features;
a. Prevent carry over moisture from Cooling Coil from contacting lamp surface.
b. Prevent dust particles settling on lamp surface
c. Ensure lamp surface is maintained at constant temperature and to prevent cooling of lamp surface due to passage of air and moisture over it.
d. Contain and hold mercury from spilling into the AHU section and ducts, in the event of breakage of lamp. This is required to ensure compliance to environmental codes.

Facilitate environmentally safe disposal of broken lamp. Installation of vertical telescopic support structure in AHU and mounting of UVGI Fixtures to the frame shall be easy and quick using minimum labor hours. All installation materials shall be factory supplied. No material shall be field supplied, except one power input cable for each AHU and inter connect cable between fixtures.

Installation of UV fixtures on vertical telescopic support structures shall allow easy movement of lamp fixtures as needed to cover the entire surface area of Cooling Coil and drain pan with UV radiation.

Final finished UV Fixture shall be Listed or Classified to UL1995.

Final finished UV Fixture shall be tested and certified by UL to comply with Fire and Smoke Safety to UL 2043.

DRAIN PAN :

Condensate drain pan shall be fabricated from 1.25mm thick SS304 stainless steel sheet and a minimum of 25mm deep with all corners welded. It shall be isolated from bottom floor panel through 10 mm thick closed cell Polyethylene foam insulation or elastomeric nitrile rubber or puff with necessary dual slope to facilitate fast removal of condensate. Necessary supports will be provided to slide the coil in the drain pan.

FILTER:

The air used in an air-conditioning system must be filtered to maintain a clean atmosphere in the conditioned space. The concentration of contaminants in the air and the degree of cleanliness required in the conditioned space will determine the type of filter or filters that must be used.

TYPES OF FILTERS:

PRE-FILTERS COMBINATION FILTER (MERV-5 & 7):

Cleanable metallic viscous type filter made out of aluminium wire mesh or of dry cleanable synthetic type minimum 50mm thick, shall be provided on the suction side of AHU as standard equipment with the unit. These filters shall have the efficiency of 90% down to 10 micron& 10micron particle size. When these filters become loaded or full of dirt, it is removed from service and replaced by another filter. The dirty filter can then be washed in a cleaning solution in a tank, dried and then given a bath of viscous oil. Face velocity across these filters shall not exceed 155 MPM.

DRY FABRIC (FINE) FILTER (MERV-3):

These filters shall have greater efficiency of 99% down to 3-micron particle size as per MERV-3 standard. When these filters become loaded or full of

dirt, it is removed from service and replaced by another filter. The dirty filter can then be washed in a cleaning solution in a tank, dried and then given a bath of viscous oil. Face velocity across these filters shall not exceed 155 MPM.

ABSOLUTE (HEPA) FILTERS: (MVRV-17)

These filters shall have efficiency of 99.99% up-to 0.3-micron particle size as per MERV-17 standard & are required for applications like operation theatre, PE, AII, Combined isolation room etc. These are also provided in the AHU after fan section or at terminal point and always must be backed by fine filters & pre filters as per tender documents. These filter after they become dirty, cannot be reused and have to be thrown away. Face velocity across these filters shall not exceed 25-35 MPM. These filters shall be separately measured & paid for.

General constructions of filters

Each AHU shall be provided with a factory assembled filter section containing pre-filters made of cleanable metal viscous filters made of corrugated aluminum wire mesh, or dry cleanable synthetic filters. These shall be minimum 50 mm thick with a frame work of aluminum.

The filter area shall be made up of panels of size convenient for handling. The filter panels shall be held snugly within suitable aluminum framework made out of minimum 1.6 mm aluminum sheet with sponge neoprene gaskets by sliding the panels between the sliding channels so as to avoid air leakage.
In order to indicate the condition of these filters while in operation, a manometer shall be provided to indicate the pressure drop across the fine filters and absolute filters.

Special filters, if any specified in the tender specifications shall be provided in addition to the above filters. In that event, the latter shall function as pre-filters.

Each fine and HEPA filter shall carry test certificate from manufacturer.

LIMITATIONS:

The air velocity across the cooing coil shall not exceed 155 MPM. The fan outlet velocity shall not exceed 610MPM. (Subject to Fan Noise Level not exceeding 75dBA at 2-meter distance from AHU/TFA etc.)
The air velocity across the filters shall not exceed 155MPM.

COIL AND FILTER SECTION:

The cooling coils, special and standard filters, etc., shall all be housed in a separate section of suitable size and length. The inspection doors shall have double synthetic rubber seals doors and locking arrangements. The gaps between filter frames and housing shall have synthetic rubber packing, to eliminate any air leakage. All filter frames shall be epoxy painted. The flat filter section shall be suitable for mounting filters vertically.

FRESH AIR INTAKES:

Fresh air dampers shall be of the interlocking, opposed-blade louver type. Blades shall be made of extruded aluminum construction and shall be rattle-free. Dampers shall be similar to those specified in "DAMPERS". Fresh air intakes shall be as per the requirements of Schedule of Quantities.

INSTRUMENTS AND VALVES:

The following instruments shall be provided at the specified locations in the AHUs for the chilled water / hot water system: -
Pressure gauges at the inlet and outlet of the coil with tubing and gauge cock.
Stem type thermometers at the inlet & outlet of coil with tubing & gauge cock.
Butterfly / Ball Valve at inlet and outlet of coil.
Y-Strainer at the inlet of coil.
2-Way PIBCV valve along with proportionate thermostat with bypass Butterfly/ Ball valve.

VIBRATION ISOLATORS:

Vibration isolators shall be provided with all air handling units. Vibration isolators shall be cushy foot mounting type.

NOISE LEVEL:

Noise level of air handing should be as follows:

For Floor mounted AHU: Not more than 75 dBA at 2 Mtr. Distance
For Ceiling suspended AHU: Not more than 55 db at 1 Mtr. Distance

ACCESSORIES:

Each air handling unit shall be complete with the following as part of AHU price.

Flexible connection between the fan outlet and duct.
Vibration isolators of 90% efficiency.
Opposed blade damper at supply air, return air & fresh air point in AHU/TFA section.

MIXING BOX

AHU's requiring mixing boxes shall be made of same construction as of AHU, complete with fresh and return air dampers.

DAMPER

Dampers shall be opposed blade type. Blades shall be made of double skinned aero foil aluminum sections with integral gasket and assembled within a rigid extruded aluminum alloy frame. All linkages and supporting spindles shall be made of aluminum or nylon, turning in Teflon bushes. Manual dampers shall be provided with a Bakelite knob for locking the damper blades in position. Linkages shall be extended wherever specified for motorized operation. Damper frames shall be sectionalized to minimize blade warping. Air leakage through dampers when in the closed position shall not exceed 1.5% of the maximum design air volume flow rate at the maximum design air total pressure.

ACCESSORIES

Each air handling unit shall be provided with manual air vent at high point in the cooling coil and drain plug in the bottom of the coil.

Water resistance IP 68 light with power cabling & limit switch.

Fire retardant flexible canvass connections at the connection ends.

ISOLATORS

Vibration isolators shall be provided with all air handling units. Vibration isolators shall be ribbed rubber pads.

All ceiling suspended air handlers shall have additional vibration isolators (In addition to the fan isolator in the AHU casing), on the suspenders.

SAFETY FEATURES

The Fan access door shall be equipped with micro switch inter locked with fan motor to enable switching of the fan motor automatically in the event of door opening.
The access door shall have further wire mesh screen as an added safety feature bolted on the unit frame.
All the screw used for panel fixing shall be covered with PVC caps to avoid human injury.
Fan & motor should be properly earthed.

FRESH AIR INTAKES

Extruded aluminum construction duly anodized (20microns and above) fresh air louvers with bird screen and dampers shall be provided in the clear openings in masonry walls of the air handling unit room shaving atleast one external wall. Louvers, damper, prefilters, duct sand fresh air fan with speed regulator shall be provided as shown on Drawings and in Schedule of Quantities. Fresh air dampers shall be of the interlocking,

opposed blade louver type. Blades shall be made of extruded aluminum construction and shall be rattle free. Dampers shall be similar to those specified in "Air Distribution". Fresh air fans and fresh air intakes shall be as per the requirements of Schedule of Quantities.

PAINTING

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 paint to match the finish over the adjoining shop painted surface.

PERFORMANCE DATA

Air handling unit shall be selected for the lowest operating noise level as per ASHRAE standard (Sound and Vibration Control) of the equipment. Fan performance rating and power consumption data, with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of the installation. Computerized selection for air handling units shall be provided through 3rd party certified software for all the Floor Mounted AHUs.

TESTING

Cooling capacity of various air handling unit models be computed from the measurements of air flow and dry and wet bulb temperatures of air entering and leaving the coil. Flow measurements shall be by an anemometer and temperature measurements by accurately calibrated mercury in glass thermometers. Computed results shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

LIMITATIONS

The air velocity across the coil shall not exceed 50mtr/minute. The fan outlet velocity shall not exceed 600 mtr / minute.

FAN COIL UNITS

SCOPE

This section covers the technical requirements for manufacture, testing at works, and delivering at site, testing after installation, commissioning of fan coil units conforming to these specifications and in accordance with the requirement of the drawings and 'Schedule of Quantities'.

TYPE

The fan coil unit shall be suitable for chilled water application,

horizontal Powder coated type to be mounted within ceiling space. The units shall have horizontal discharge and complete with chilled water coil, one or more centrifugal fans and motors, synthetic cleanable pre-filters, double skin insulated (CFC & HCFC FREE) condensate drain pan. Horizontal fan coil units shall be provided with auxiliary secondary condensate drain pan.

CAPACITY

The air moving and coil capacities shall be as shown on Drawings and indicated in Schedule of Quantities.

CABINETS

Cabinets shall be constructed of 18gauge die-formed cold-rolled galvanized sheet steel, bowdlerized and painted with approved shade of powder coating finish and shall have access doors to piping and controls. Access panels shall have positive locking fasteners for easy removal. Horizontal furred-in type units mounted within ceiling space shall be provided with a cabinet housing, the coil and fan section with provision to mount filters within the fan section.

INTERIOR CHASSIS

The interior chassis shall be constructed of not less than 16 gauge cold rolled galvanized sheet steel bowdlerized and painted with approved shade of powder coating finish. All ceiling suspended fan coil units shall be securely mounted from the building structure with top panel set dead level in both directions. In case of ceiling suspended horizontal units, fan deck and cooling coil shall be easily removable from FCU without lowering down of the FCU or disturbing the other installation.

FAN SECTION

This shall consist of two lightweight aluminum impellers of forward curved type, both statically and dynamically balanced, along with properly designed GI sheet casings.
The two impellers shall be directly mounted on to a double shaft, single phase multiple winding motor capable of running at three speeds.
Powder coated GI flange of 25 mm wide face shall be fitted to the FCU mouth outlet for fixing 45-degree Al. Extruded supply air grill.

COOLING COIL

The coil shall be of seamless copper tube with aluminum fins of minimum 10 mm OD and wall thickness shall be minimum 0.5 mm. All bends and joints shall be enclosed within insulated end sections of the base unit for protection against sweating. Each coil shall be provided with air vent. All coils shall be factory tested at 21 kg per sq.cm. (300psig) air pressure when submerged in water. Fin spacing shall be 4

to 5 fins per cm. Tubes shall be mechanically/ hydraulically expanded for minimum thermal contact resistance with fins. Air vent shall be provided in headers at a level higher than coils. The cooling coil shall be easily removable from backside of FCU without disturbing the other installations. The copper tube or pipe should not be manufactured from reprocessed or recycled copper. The coil circuit should be sized for adequate water velocity but not exceeding 1.8 m/s. The air velocity across the coil shall not exceed 155 m/min.

DRAIN PANS

Primary drain pan shall be of double skin construction fabricated from 18 gauge stainless steel-304 with all corners enclosed. An additional inner bottom panel of 18 G thick stainless steel sheet shall be provided to prevent damage to insulation. The pan shall be insulated with minimum 15mm thick expanded polyethylene insulation sandwiched between top and bottom panels to prevent condensation. The pan shall be of sufficient size to accommodate cooling coil supply and return water header and bends and control valves.

The auxiliary condensate drain pan shall be similar in construction to primary drain pan and size larger than primary drain pan to catch all overflows in case primary drain pan gets choked. Drain from auxiliary drain pan shall be connected to drain from primary drain pan through a tee connection and piped to vertical risers.

MOTOR

Motor shall be 220 ± 6% volts, 50 cycle, single phase, six poles, shaded pole type, rpm not exceeding 1000 at maximum airflow. Motor shall have three speed windings and shall be factory wired to a terminal block mounted within the fan section. Motors shall have extended shaft on both sides.

SPEED CONTROL

A sturdy switch shall be provided with the unit complete with wiring, for ON/OFF operation and with minimum three speed control of the fan.

AIR FILTER

The filter shall be cleanable type 15mm thick with 90% efficiency down to 10 micron of dry cleanable synthetic type AL. wire mesh and mounted behind the pan in a filter plenum of GI sheet.

WATER CONNECTIONS

The water lines shall be finally connected to the coil of the fan coil unit, by at least 300mm long, type `L' seamless solid drawn copper tubing, with flare fittings and connections.

PAINTING

The fan coil units shall be powder coated in approved color.

CONTROLS

All units shall be complete with following controls as a part of unit supply WITH FACTORY FITTED ASSEMBLY with minimum PN16 Rating:
Entire valve package including all 2 way control valve (Spring return type) of PN16 rating complete with motor 220/230 volt of actuator of suitable torque
Control valves, Brass Ball valves with brass made 'Y' strainer, ball valve& Air vent to be supplied along with FCU.
Wall mounted Digital thermostat containing three speed and on/off control for fan, speed and temperature control for summer/ winter air conditioning. The valve should be IEC 534 compliant and should have 20 mm stroke.

PERFORMANCE DATA

Fan coil units shall be selected for the lowest operating noise level having standard sound level rating of NC 30 at low speed and NC 35 at medium / high speed. Fan performance rating and power consumption data, with operating points clearly indicated, shall be submitted by the Contractor and verified at the time of testing and commissioning of the installation.

TESTING

Cooling capacity of various fan coil unit models shall be computed from the measurements of airflow and dry and wet bulb temperatures of entering and leaving the coil. Flow measurements shall be by anemometer and temperature measurements by accurately calibrated mercury -in-glass thermometers. Computed ratings shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage.

GENERAL

Scope shall be inclusive of approval from Authority for required statutory approval required for Works
Contractor will need to submit technical data sheet of each and every equipment and ancillaries to MEP Consultant & get approval prior to procurement
All Equipment shall be factory inspected by MEP Consultant and Client Representative prior to dispatch on site.
All necessary site housekeeping, material security, site construction lighting etc. required for site work shall be inclusive in the scope of

vendor.

CO SENSOR & DETECTORS

'CO' sensor shall be designed to detect Carbon Monoxide gas in the air. The sensor should have high accuracy even at low concentration.
It should be suitable for installation in a parking lot, underground basements, tunnels &underground spaces.
The model shall be compact in size and shall offer ease of installation.
The device should be a solid-state semi-conductor type sensor, high sensitivity and selectivity to carbon monoxide and low sensitivity to alcohol vapor.
Sensor should meet the minimum technical parameters as listed below:

Electrical	
Power supply	+16-29VDCwithreversepolaritydiodeprotection
Power consumption	22mAmax.(0.5VA@+24VDC)
Analog signal output	Linear proportional4-20Macurrentloop
Output load	≤500Ωfor current signal
Sensor Performance	
Sensor element type	Electrochemical(Ge Based Diffusion)
Detected gas	Carbon Monoxide(CO)
Measurement range	0-300ppm
Accuracy	±3ppm
Resolution	0.5ppm
Repeatability	< ±5%FS
t90Time	≤50seconds
Zero-point variation	±4ppm
Zero/Gain calibration drift	<±0.4%FSsignal/month
Sensor Life Time	>6 years(with recommended calibration interval)

Environmental and Physical Specifications:

Storage time	6months@5–30°C
Operating temperature range	-15 to+50°C
Humidity range(non-condensing)	10-95%RH
Pressure range	Atmospheric±20%
Wiring	2Wire
Wire Connection	Springloadedterminalmin.0.

	25mm^{2}tomax.2.5mm^2
Mounting	Wall mounting
Relative Gas Density	0.97(Air=1)
Mounting Height	1.5to1.8meter
Recommended Coverage Area	400m^{2}to750m^2,ideal condition assumed
Dimensions(sensor cartridge only)	38mm(L)xM25mountingdia meter
Weight(sensor cartridge only)	30g
Sensor Cartridge	PolycarbonateIP65
Optional Housings Specifications:	F:ABS,IP44,UL94:V0,weight :0.1KgD:Polycarbonate, IP65, UL94:V2, weight:0.15KgK:DHousingw ith DuctKit,weight:0.1Kg

Standards and Approval Compliance:

• EMC Directives2014/30/EU
• CE
• IP65/66 (EN60529 / DINVED–0470-1)
• Impact Resistant IK08 (DINEEN5012/VDE0470seg.100
• UL508 / CSA Certified C22.2 No.94.1-07-Enclosure for Electrical Equipment
• UL50 / CSA22.2 Certified Enclosure for Electrical Equipment

DEMAND CONTROL VENTILATION SYSTEM

VAQ station made out of heavy gauge extruded aluminum of 1.5 mm nominal thickness consists of low leakage extruded aluminum volume control damper; Rapid Average Pitot tube; Air Flow Straightener (Honeycomb patterned). The VAQ stations shall incorporate air pressure pickups mounted on station and shall control the minimum amount of outside air as recommended by National Building Code -2016.
Motorized assembly for dampers with programmable single space DCV controller complete with CO2 sensor; shall be able to control VFD, supply air damper; shall communicates on EIA- 485 through Modbus; differential pressure sensor; & step-down transformer of 24V & control cabling.

CO2 SENSORS & DETECTORS

TECHNICALSPECIFICATION:

Gas detected	Carbon Dioxide(CO2)
Sensing element	Non-Dispersive Infrared Detector (NDIR) , Gold Plated IR wave guide (Dual Beam Infra-Red)
Accuracyat25oC(77 oF), 2000ppm	±40ppm+3% reading
Stability	<2%of FS over life of sensor (15yr. typical)
Calibration interval	ABC Logic Self Calibration System (Automatic Background Calibration)
Response time	<2minutesfor90%step change24 hours(first time)
Warm uptime	10minutes(operation)
CO2 measuring range	0 ~ 2,000ppm(std.)/ 0 ~ 50,000ppm (std.) (opt:0 ~ 5,000ppm Or 0〜20,000ppm)selectable in orders
Power supply	24VAC/24VDC
Consumption	1.5Wmax.; 0.8Wavg.
Analog outputs	0~10VAC or4~20mAselectable by jumpers
Flow rates	80~ 120cc/min
Operation conditions	0~50oC(32~122oF);0~95%RH,non condensing
Storage conditions	-40~70oC(-40~158oF)
NDIR life	15 years

PHYSICALSPECIFICATIONS:

Net weight	180g
Dimensions	100mm×80mm×28mm
Installment standard	65mm×65mmor 2”×4”wirebox
Wiring Connection	Wiring terminals or the power plug(optional)
Standard Approval	CE-Approval

EXPANSION TANK AND AIR SEPERATOR:

Pressurized Cold water expansion tank (PN16) suitable for total volume of water in Cold water circuits along with necessary accessories such as pressurization unit etc. in order to keep Cold water system under (+) pressure and to prevent entrapment of pressure and to prevent entrapment of air in the system. The system shall also include a fully automatic pressurization unit with 2 pumps (1 Working + 1 Standby) with IP56 protection giving 2 CMH flow rate @ 25m with pressure switch/transmitter, flow meter, interconnecting piping, wiring & control panel completely assembled on skid with all necessary valves & manifolds. The tank shall be pre-charged steel expansion tank with replaceable heavy duty butyl rubber bladder. The tank shall have a system connection with isolation valve, drain connections with ball valves and charging valve connection to facilitate the onsite charging of the tank to meet system requirement. The expansion tank shall have pressure gauges fitted with isolation valves and high capacity auto air vents with isolation valves. The tank shall have safety valve, 50 mm system connection and 20 mm drain and charging valve connection to facilitate the onsite charging of the tank to meet system requirement. The tank shall be fitted with lifting rings and a floor mounting skirt for vertical installation. The tanks shall be coated with two coats of anti-corrosive paint (LOW VOC). Two coats of lag coating (Anti-fungal & vapour barrier -5590 standard). It shall be covered with Nitrile Rubber thermal insulation (density 45-60 kg/m3, CFC/HCFC FREE) with laminated one sided thick glass woven cloth with suitable adhesive. The Adhesive used for shall be of low volatile organic compound. Two coats of lag coating (Anti-fungal & vapour barrier -5590 standard).The contractor shall submit calculations for total system volume and tank sizing calculations and accordingly expansion tank capacity shall be finalized. The contractor shall furnish material test certificates of various components & performance test certificates carried out by manufacturer.

RETURN AIR RISER:

The Return Air Risers shall be comprising 18 G GI epoxy painted risers with EU filter, Powder coated Aluminum perforated sheet & damper. The riser should be have internally coving with step in fixing arrangement for filter and perforated sheet

Sr. No.	Description	Specification
1	Riser Type	Exposed/ Flush with wall
2	Return air riser MOC	GI Powder coated/ Epoxy painted unless otherwise specified.
3	Return air riser thickness	18 gauge unless otherwise specified.
4	Return air riser grill	Capsule shape 18 G perforated sheet unless otherwise specified.
5	MOC of return air grill	Aluminum
6	Return air grill location above the floor	150 mm / refer typical G.A drawing for details
7	Access door	SS 304 access door with knob wherever specified in the BOQ / drawing.
8	Filter	EU 4 filter, unless otherwise specified.
9	Return air damper	Unless otherwise specified it shall be removable type manual operated damper in GI construction fixed with riser and operated from service area side. / The area having non access ceiling should have bottom operated damper with SS knob.
10	Height of the riser above false ceiling	Refer general G.A drawing for details.
11	Air velocity across the riser	600 to 700 FPM
12	Air velocity across the riser Grille	350 FPM

7 HYDRONIC CHILLED WATER CASSETTE UNITS

GENERAL

The Cassette units shall be ceiling hung type. Ceiling hung units shall have 4 way directional air discharges. All units shall be complete with chilled water coil, fins centrifugal fans and motor, cleanable fabric filters, condensate drain pump, drain pan & grill.

CABINETS

Cabinets for Ceiling mounted cassette units shall be constructed of anticorrosive treated galvanized sheet steel, bonderized and insulated externally. The cabinets shall be of sufficient size to enclose centrifugal turbine fan with direct drive, cooling coil in all 4 directions, with insulated drain pan with condensate pump.

DRAIN PAN

Drain pan shall be fabricated from 20-gauge stainless steel with insulation.

COOLING COIL

All cooling coils shall be standard three row staggered seamless copper tube with aluminum fins. The coil shall be fitted with for connection with MS pipes. Tubes shall be minimum 9 mm OD of required thickness. Fin spacing shall be between 4 to 5 fins per cm. All bends and joints shall be enclosed within insulated end sections of the base unit for protection against sweating. Tubes shall be mechanically/hydraulically expanded for minimum thermal contact resistance with fins. The cooling coil shall be easily removable without disturbing the other Installations. The coil circuit should be sized for adequate water velocity but not exceeding 1.8 M/s. (6 F.P.S.). The fins shall be uniformly bounded to the tubes by hydraulic expansion of the tubes. The fins material shall be anticorrosive blue coted aluminum.

FANS

Fans shall be forward curved centrifugal type. There shall be one number fan only. The Fan should statically and dynamically balance to give the required air flow.

MOTOR

Motor shall be 220±5% volts, 50 cycles single phase, energy efficient, speed not exceeding 1000 rpm at maximum airflow. Motors shall have two speed windings and shall be factory wired to a terminal block mounted within the fan section.

INSTALLATION

Ceiling suspended units and units mounted within the ceiling mounting shall be hung through rubber in shear vibration isolator suspenders.

ACCESSORIES

All Cassette coil units shall be equipped with copper piping connections. In addition, the following accessories are required at coil units;

- LCD Wireless Controller
- Auto Restart

WATER CONNECTIONS

The water lines shall be finally connected to the coil of the fan coil unit, by at least 300mm long, type L seamless solid drawn copper tubing with flare fittings and connections.

8 PRECISION AIR CONDITIONING UNITS FOR SERVER ROOM

Indoor Condition to be maintained shall be 21 Deg C +/- 1 Deg C, 50% RH.

The room air-conditioning system shall be designed specifically for with high sensible heat ratio, such as Telecommunication and Computer rooms.

Each unit shall be capable of providing sensible cooling capacities at rated ambient temperatures with adequate airflow. The system shall be High Technology Scroll compressor, Evaporator, Condenser and electronic expansion valve all of which shall be contained within the cabinet of the unit.

SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of Precision Air Conditioning Units conforming to these specifications and in accordance with the requirements of Drawings and Schedule of Quantities.

TYPE

The precision Air Conditioning Unit shall be DX Air Cooled/ Chilled Water, dual fluid coil.

The Precision Air-conditioning Unit shall be complete with microprocessor controller and shall consist of hermetically sealed Scroll compressors, evaporator fan, motor, strip heaters, humidifier, integral refrigerant piping and control panel duly wired to compressor and air cooled condenser all mounted on a steel frame. Micro-processor panel shall be BMS Compatible with open protocol for software integration. The Air cooled condenser with fan duly mounted on a common frame shall be installed on the wall openings / terrace with suitable angle iron / channel frame to be provided by contractor. The suitable starters, switches, power control cabling between Indoor unit and outdoor unit shall be included by the contractor.

CAPACITY

The refrigeration capacity and air quantity for the unit shall be as shown in Drawings and Schedule of Quantities. Manufacturer shall submit unit capacity software selection as per tender design conditions.

CASING

The indoor & outdoor units shall be sectionalized / cabinet construction. Indoor units shall be consisting of fan section, coil section, heater and humidification section, filter section, and drain pan. Each

section shall be constructed of thick sheet steel all welded / bolted construction, adequately reinforced with structural members and provided with sufficient access panels for proper lubrication and maintenance. Base panel shall be constructed of fabricated steel structure provided with an under frame suitably braced. Drain pan shall extend under coil and fan sections with drain connections.

The indoor unit cabinet shall be of double skin sandwich panel construction (all four sides) with 25± 2 mm thick panel made of galvanized steel. The panels should be insulated with AO class insulation with Mineral wool of 32 Kg/CUM density, suitably treated for weather protection, corrosion resistant and shall be powder coated.

Units shall have hinged, quick opening access door in the fan & coil section and also in filter section where filters are not accessible from outside. Access doors shall be double skin type.

Outdoor unit shall consist of condenser coil and propeller type fan for air cooled unit.

Lugs shall be provided for lifting / easy handling of machines.

COMPRESSOR & MOTOR

The compressor shall be hermetic sealed type and suitable for operation on Eco-friendly refrigerant HFC-410a/HFC-407c. The compressor shall have dual pressure stat and an operating oil charge. The motor shall be suction gas cooled and shall be sealed against dirt and moisture.

The motor shall be suitable for 415± 10% V, 50 Hz, 3 Phases AC supply. The compressor shall be located in separate compartment isolated from air stream to permit servicing without shutting down the system. Compressor shall be installed on spring mounted floating platform / rubber pads or manufacturers recommended approved mounting. Suitable overload protection shall be provided in compressor. Isolating valves shall be provided at suction & discharge. Compressor shall be fitted with electrically operated oil heaters with built-in thermostats and the heaters shall be automatically actuated when the compressor is stopped. In built TIME DELAY shall be provided for restart of compressor.

The compressor shall be capable of operation of variable capacity by using brushless AC/DC inverter /digital scroll compressor.

EVAPORATOR SECTION

Evaporator coil shall be of fin and tube type having hydrophilic coated aluminium fins firmly bonded to copper tubes assembled in zinc coated steel frame. Face and surface areas shall be such as to ensure rated capacity from each unit and air velocity across each coil shall not exceed

500 FPM. The coil shall be minimum 3 row deep for DX coil.

For dual feed unit, chilled water coil shall be provided in addition to DX coil. Chilled water coil shall be minimum 4 rows deep. Coils shall be pitched in the unit casing for proper drainage. Each coil shall be factory-tested at 21 Kg. per sq.cm air pressure under water. Tube shall be mechanically / hydraulically expanded for minimum thermal contract resistance with fins. The number of fins per cm. shall be 4 to 5.

Chilled Water Coil shall be supplied with 2-way Motorized valve integrated with the unit, controlled for operation on chilled water circuit.

A condensate drip tray of stainless steel construction of minimum 18 SWG thick, duly insulated shall be provided.

Dehumidification shall be achieved by reducing the air flow of the EC fans which thereby would reduce the ADP of the cooling coil to achieve dehumidification.
The Microprocessor panel should be able to perform auto changeover from Chilled water to DX mode and vice versa as and when required due to start and stop of the chilled water. The controller should also be able to start unit on DX mode, in case the chilled water temperature rises and is unable to maintain inside conditions. Manual change over provision shall also be provided.

BLOWER SECTION

The unit shall be under floor / top discharge type and should be able to deliver between 550-600 CFM per ton. Total external static pressure shall be of minimum 5 mm of WG for top discharged units. Units with top discharge shall be designed for required static pressure as per actual ducting arrangement.

The units should be equipped with direct driven backward curved plug fans with electronically commutated brushless motors suitable for 415 ± 10% V, 3 Phase, 50 Hz AC supply. The motor's high efficiently should make for less energy absorption, especially at partial loads and during starting. The motor shall be of IP 54 grade. The fan shall be directly coupled having a maximum speed of 1400 R.P.M. The fan speed shall be controlled through microprocessor panel based on temperature & humidity set points. Fan motor assembly shall be statically and hydraulically balanced and designed for quite operation.

HUMIDIFIER & HEATERS

The humidifier and heaters shall be a built in feature in each machine individually. Humidification shall be provided by boiling water in steam generator/infrared humidifiers. The steam shall be evenly distributed into the supply air stream of the Air Conditioning Unit. The humidifier shall be self-cleaning and capable of delivering variable capacity steam

from 30 % to 100% of its total capacity with help of microprocessor. The humidifier shall be fully serviceable with replaceable electrodes. Waste water shall be flushed from the humidifier by initiation of water supply valve via U-trap. The microprocessor should be able to display the current drawn and actual steam output in the microprocessor.

Heater should be of minimum two stages & heating circuit shall include dual safety protection through loss of air and manual reset high temperature controls.

Electric strip heaters shall be of the low temperature totally enclosed strip type fitted with radiation fins and suitable for operating at black heat. If overheating occurs, a safety thermostat should cut off the voltage supply to the heaters and triggers an alarm. Microprocessor should be able to control the humidification and heating through suitable sensors.

FILTERS

Each unit shall be provided with a factory assembled filter section containing washable synthetic type air filters having anodized GI/aluminum frame. The media shall be supported with HDP mesh on one side and aluminum mesh on other side. Filter banks shall be easily accessible and designed for easy withdrawal and renewal of filter cells. Filter framework shall be fully sealed and constructed either from aluminum alloy or GI powder coated. Filter banks face velocities shall not exceed 150 Mt. / minute. The filter shall be suitable for high efficiency dust filtration of minimum MERV 8.

REFRIGERANT PIPING & CONTROLS

Refrigerant piping and fittings within the unit shall be of copper and valves shall be of brass / gunmetal construction. Piping thickness shall be designed based on type of refrigerant and superheated gas pressure at full load, corresponding to ambient dry bulb temperature of 45°C.

The refrigeration system shall be of the Single/Multiple circuit direct expansion type and incorporate hermetic scroll compressors. The system shall include a manual reset high pressure control; auto reset low pressure switch, safety valve, and charging/access ports in each circuit.

Each refrigerant circuit shall include the following items:

a. Electronic Expansion Valve with transducers to enable display of Discharge, Suction Pressures along with Superheat on the microprocessor.
b. Liquid line drier / filter.
c. Liquid Line Sight Glass with Moisture indicator.
d. Hand shut off valves / Shredder valves.
e. Liquid line receiver.

f. Liquid Line Solenoid Valve for interception of Liquid Refrigerant

The serviceable / removable components shall have union connection for easily removal / assembly.

All external pipe work shall be carried out with 18G refrigerant quality copper tube and where bends are required; the same shall be completed using either a proprietary bending tool or radius fittings.

AIR COOLED CONDENSER

Each condenser unit shall consist of a heat rejecting coil block constructed from copper tubes expanded on to straight aluminum fins. The coil shall be factory epoxy coated for protection against corrosive environment.

The fan shall be selected for low speed quiet operation. The fan shall be directly driven by a motor of speed not exceeding 1000 RPM and constructed from sheet and cast aluminum. When compressor stops condenser fan shall also stop after a suitable time delay.

The fan should be complete with an automatic step-less fan speed controller to maintain constant head under varying ambient conditions. The housing for fan speed controller & isolator shall be of IP 65 grade.

The condenser shall be flexible for mounting in both horizontal and vertical positions.

The entire assembly shall be supported by a corrosion treated frame having four legs.

ELECTRICAL SYSTEM

The electrical power system shall confirm to relevant IS standard. A main isolator (MCB) shall be provided by the side of each unit, sized to meet the system total power requirement.

Within the panel individual power loads shall be distributed equally across the three phases.

All individual wires shall be of cross linked polythene insulated; armoured Copper cabling, with a low smoke and flame sheath (XLPE) and colour coded or shall be numbered at their point of termination to facilitate servicing. Low voltage control wiring and power wiring shall be segregated from each other.

The following shall be incorporated:

a. Contactors for automatic Micro Processor Control
b. Single phase preventers

c. Separate over load preventer for all individual components.

SAFETY CONTROLS

Following minimum safety controls shall be provided for each unit:

High pressure trip - Manual reset (for each compressor)
Low pressure trip - Manual reset (for each compressor)

SAFETY INTERLOCKS

Operation of heaters & humidifier shall be possible only when blower fan is in operation.
Condenser fan shall stop after a suitable time delay on Compressor's stopping.

MICROPROCESSOR CONTROLS

Following information shall be available on the display on the units.

a. Room temperature and humidity.
b. Supply fan working status
c. Compressor working status
d. Condenser fans working status.
e. Electric heaters working status
f. Humidifier working status.
g. Manual / Auto unit status.
h. Clogged Filter status
i. Temperature set point.
j. Humidity set point.
k. Working hours of main component i.e. compressors, fans, humidifier etc.
l. Unit working hours.
m. Current date and time.
n. Type of alarm (with automatic reset or block)
o. The last 100 intervened alarms.

The microprocessor shall be able to perform following functions:

a. Testing of the working of display system.
b. Password for unit calibration values modification.
c. Automatic re-starts of program.
d. Cooling capacity control.
e. Compressor starting timer.
f. Humidifier capacity limitation.
g. Date and time of last 100 intervened alarms.
h. Start / Stop status storage.
i. Random starting of the unit.
j. Outlet for the connection to remote system.
k. Temperature and humidity set point calibration.

l. Delay of General Alarm activation.
m. Alarm calibration.

PAINTING

Units shall be factory finished with durable alkyd spray enamel. Shop coats of low VOC paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, then coated with enamel paint to match the finish over the adjoining shop-painted surface.

PERFORMANCE RATING

The unit shall be selected for the lowest operating noise level (65 dBA at 3m). Capacity rating and power consumption with operating points clearly indicated shall be submitted with the tenders and verified at the time of testing and commissioning of the installation. For site verification of working of humidification / dehumidification systems, set point RH shall be changed below / above (respectively) actual RH. Similar procedure shall be adopted for temperature control system. Test report shall indicated selected set point for RH and temperature and achieved values of these process variables after humidification / dehumidification cycles are activated.

9 VARIABLE REFRIGERANT VOLUME/FLOW SYSTEM

SCOPE

The scope of this section comprises the supply, erection testing and commissioning of 100 % **inverter based** Variable Refrigerant Flow System with hermetically sealed Scroll/ Rotary Compressor conforming to these specifications and in accordance with the requirements.

TYPE

Outdoor units shall be air cooled, variable refrigerant flow air conditioner of R410A gas based consisting of one outdoor unit and multiple indoor units. Each indoor units having capability to cool independently for the requirement of the rooms.

It shall be possible to connect minimum 20 indoor units on one refrigerant circuit. The indoor units on any circuit can be of different type and also controlled individually. Following type of indoor units shall be connected to the system:

- Ceiling mounted Four-way flow cassette type
- Ceiling mounted Ductable type
- Wall mounted type
- Dx type air handling unit

Compressor installed in outdoor unit shall be equipped with 100 % inverter compressor. The system shall be capable of changing the rotating speed of inverter compressor by inverter controller to follow variations in cooling and heating load.

Outdoor unit shall be suitable for mix match connection of all type of indoor units.

The refrigerant piping between indoor units and outdoor unit shall be extendable up to 165m actual piping length for outdoor unit with maximum 50m level difference without any oil traps and total piping length with 1000m.

Both indoor units and outdoor unit shall be factory assembled, tested and filled with first charge of refrigerant before delivering at site.

OUTDOOR UNIT

The outdoor unit shall be factory assembled unit housed in sturdy weather proof casing, constructed from heavy gauge mild steel panels and coated with baked enamel finish. The Unit should be completely factory wired tested with all necessary controls and switch gears:

All outdoor units above 8 HP shall have minimum two scroll/ rotary compressors and be able to operate even in case one of compressor is out of order.

In case of outdoor units above 14HP, the outdoor unit shall have at least 2 inverter compressors so that the operation is not disrupted with failure of any compressor.

All outdoor units must be equipped with optimized heat exchanger.

All outdoor units must be equipped with night time quite operation function which results in less sound level in night time operations of the outdoors. The nighttime quiet operation shall be with three modes automatic, manual and combined mode.

It should also be provided with duty cycling for switching starting sequence of multiple outdoor units.

The noise level shall not be more than 68 dB (A) at normal operation, measured horizontally 1m away and 1.5m above ground level.

The outdoor unit shall be modular in design and should be allowed for side by side installation.

The unit shall be provided with its own microprocessor control panel.

The outdoor units shall be complete with safety devices namely –high/ low pressure switch, fan driver overload protector, over current relay, inverter overload protector.

The oil mechanism shall be capable of oil film control by high thrust mechanism.

The heat transfer circuit should perform super cooling before the expansion process in the indoor units.

The outdoor unit's side panel and outer panel shall be alloyed hot dip zinc coated steel plate with powder polyester resin coating on the inner and outer surfaces in the thickness of 32 micron.

The outdoor unit's bottom frame shall be hot dip aluminum; zinc and silicone coated steel plate.

The outdoor unit should be fitted with low noise, aero spiral and aero asymmetrical design fan with multiple speed DC motor. The fan shall be coated with styrene acrylonitrile res in(glass fiber filled) The fan shall be covered with aero smooth grille which shall be three dimensional, integrated, soft woven steel covered with plastic coating. The fan protective net shall be coated with weather resistant polypropylene resin.

INVERTER COMPRESSOR

The compressor shall be highly efficient reluctance DC scroll/ rotary type with neodymium magnets and capable of inverter control. It shall change the speed in accordance to the var iation in cooling load requirement:

The inverter shall be IGBT type for efficient and quiet operation.

All outdoor units shall have step less of capacity control to meet load fluctuation and in door unit individual control. All parts of compressor shall be sufficiently lubricated. Forced lubrication may also be employed.

Oil heater shall be provided in the compressor casing.

HEAT EXCHANGER

The heat exchanger shall be constructed with copper tubes mechanically bonded to aluminum fins to form a cross fin coil.

The aluminum fins shall be covered **by anticorrosion resin** film of special acrylic resin. The coils shall be integrally coated with **Blygold PoluAl (Aluminum hydroxide, 2530 microns' thickness)** after fins stamping process or equivalent coating material asrecom mended by manufacturer. The Cu/Al metallic couple will wholly isolate from the corrosive atmosphere by aluminum coating to raise the ability of anticorrosion.

The unit shall be provided with necessary number of direct driven low noise level propeller type fans arranged for vertical discharge. Each fan shall have a safety guard.

REFRIGERANT CIRCUIT

The refrigerant circuit shall include liquid & gas shutoff valves and a solenoid valve at con denser end.

All necessary safety devices shall be provided to ensure the safe operation of the system.

SAFETY DEVICES

All necessary safety devices shall be provided to ensure safe operation of the system.

Following safety devices shall be part of outdoor unit; high pressure switch, low pressure switch, fuse, crankcase heater, fusible plugs, over load relay, protection for inverter, and short recycling guard timer.

OIL RECOVERY SYSTEM

Unit shall be equipped with an oil recovery system to ensure stable operation with long refrigeration piping.

INDOOR UNIT

This section deals with supply, installation, testing, commissioning of various type of indoor units confirming to general specification and suitable for the duty selected. The type, capacity and size of indoor units shall be in

GENERAL

Indoor units shall be either ceiling mounted cassette type, or ceiling mounted ductable type or wall mounted type. These units shall have electronic control valve to control refrigerant flow rate in response to load variations of the room.

a) The address of the indoor unit shall be set automatically in case of individual and group control

b) In case of centralized control, it shall be set by liquid crystal remote controller

c) The fan shall be dual suction, aerodynamically designed turbo, multi blade type, statically & dynamically balanced to ensure low noise and vibration free operation of the system. The fan shall be direct driven type, mounted directly on motor shaft having supported from housing.
The cooling coil shall be made out of seamless copper tubes and have continuous aluminum fins. The fins shall be spaced by collars forming an integral part. The tubes shall be staggered in the direction of airflow. The tubes shall be hydraulically/ mechanically expanded for minimum thermal contact resistance with fins. Each coil shall be factory tested at 21kg/sqm air pressure under water.

Noise level should not be more than 42 db at high speed for Hiwall unit.
Noise level should not be more than 40 db at high speed for cassette.
Noise level should not be more than 45 db at high speed for Ductable unit.

Unit shall have cleanable type filter fixed to an integrally molded plastic frame. The filter shall be slide away type and neatly inserted.

Each indoor unit shall have computerized PID control for maintaining design room temperature. Each unit shall be provided with microprocessor thermostat for cooling and heating.

Each unit shall be with wired LCD type remote controller. The remote controller shall memorize the latest malfunction code for easy maintenance. The controller shall have self-diagnostic features for easy

and quick maintenance and service. The controller shall be able to change fan speed and angle of swing flat individually as per requirement.

CEILING MOUNTED CASSETTE TYPE UNIT (FOUR WAY TYPE)

The unit shall be ceiling mounted type with four directional flow. The unit shall include pre filter, fan section and DX-coil section. The housing of the unit shall be powder coated Galvanized steel. The body shall be light in weight and shall be able to suspend from four corners.

Unit shall have an external attractive panel for supply and return air. Unit shall have four-way supply air grilles on sides and return air grille in center.

Each unit shall have high lift drain pump, fresh air intake provision (if necessary) Low gas detection system and very low operating sound.

All the indoor units regardless of their difference in capacity should have **same panel size** for harmonious aesthetic point of view. The sound absorbing thermal insulation material shall be polyurethane foam.

CONTROLS & ACCESSORIES

For connection with Dx-type AHU, necessary kit for connection to the VRV/VRF based refrigerant circuit, expansion valve & dries, thermostat etc. as required shall be provided

HIGH WALL TYPE INDOOR UNIT

The unit shall be high wall mounted type. The unit shall include pre-filters, fan section and DX coil section. The housing of the unit shall be powder coated galvanized steel. The body shall be light in weight and shall be able to suspend from four comers. The fan shall be aero dynamically designed diffuser turbo fan type.

Unit shall have an external attractive panel for supply and return air.

REFRIGERANT PIPING

All refrigerant piping for the air conditioning system shall be constructed from soft seamless upto 19.1mm and hard drawn seamless copper refrigerant pipes for above 19.1mm with copper fittings and silver soldered joints. The refrigerant piping arrangements shall be in accordance with good practice within the air conditioning industry, and are to include expansion valves, charging connections, suction line insulation and all other items normally forming part of proper refrigerant circuits.

All joints in copper piping shall be sweat joints using low temperature brazing and or silver solder. Before joining any copper pipe or fittings, its

interiors shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while constructing the joints. Subsequently, it shall be thoroughly blown out using nitrogen.

The air-conditioning system supplier shall design sizes and erect proper interconnections of the complete refrigerant circuit.

The suction line pipe size and the liquid line pipe size shall be selected according to the manufacturers specified outside diameter. All refrigerant pipes shall be properly supported and anchored to the building structure / cable tray using steel hangers, anchors, brackets and supports which shall be fixed to the building structure by means of inserts or expansion shields of adequate size and number to support the load imposed thereon.

After the refrigerant piping installation has been completed, it shall be evacuated, for carrying out the air tightness test. The refrigerant piping system shall then be pressure tested using Nitrogen, gas at a pressure of 4.0 MPaG (580 PSIG) which will be gradually increased. Pressure of 4.0 MPaG (580 PSIG) shall be maintained in the system for atleast 24 hours. If there is no pressure drop, the system will be considered as having passed the test. If a drop in pressure is detected, search for the leak site by applying soapy water to surface of the piping connections (flares, brazed joints etc.) and charge the hose connections.
A pressure between 0.2 and o.3 MPa G in the piping shall be allowed after conducting the air tightness test so as to prevent contamination in the piping.

Vacuum drying of the system has to be carried out after passing of air tightness test and will be carried out with a Vacuum Pump which can bring the pressure below – 100.7 KPaG (755 mm Hg). During Vacuum test, evacuation from both the liquid and gas piping must be carried out. The system in a vacuum state below – 100.7 KPaG (755 mm Hg) shall be left for atleast 4 hours and in case the gauge indicator does not rise the test will be considered successful. If the gauge indicator rises, there may be moisture remaining or a leak in the circuit.

After completing the vacuum drying, charge the calculated additional refrigerant from the gas cylinder via the liquid side stop valve service port using pressure difference. The refrigerant must be charged in a liquid state. Digital scale shall be used for measuring the additional refrigerant quantity.

10 SPLIT TYPE AIR CONDITIONED UNITS:

SCOPE

The scope of this section comprise the design supply, erection, testing and commissioning of air-cooled package units conforming to these specifications and in accordance with the requirements.

TYPE

The units shall consist of hermetic / semi hermetic scroll / Rotary compressor, motor, evaporator, evaporator fan, air cooled condenser, integral refrigerant piping, microprocessor control panel and wiring.

Indoor unit shall be housed in insulated cabinet consisting of motor, cooling coil, blower with motor, filter & insulated drain pan.

Outdoor unit to be installed on terrace/as directed by engineer in charge, shall consist of compressor, air cooled condenser coil with fans, all mounted on a anti corrosive treated steel frame.

The machine should be capable of operating with a total piping of 2x50 Meter (Return and supply) out of which the vertical distance can be up to 25 Meters. (Single run)

The machine shall be capable of operating at 45°C ambient.

The total derating on all accounts will not exceed more than 10%.

CAPACITY

The refrigeration capacity of air-cooled package units shall be as per requirements.

COMPRESSOR AND MOTOR

Compressor shall be hermetic / semi hermetic scroll/rotary type and shall have dual pressure stat, and fan operating oil charge. The motor shall be suction gas cooled and shall be sealed against dirt and moisture. The motor shall be suitable for 3 phase, 50 Hz ±3%, AC supply and provided with necessary safety devices to withstand voltage fluctuation from 340 V to 440 V.

REFRIGERANT PIPING AND CONTROLS:

Refrigerant piping and fitting interconnecting compressor, condenser shall be all cop per and valves shall be brass / gunmetal construction. Each refrigerant circuit shall include refrigerant filter drier, liquid line valve and thermostatic expansion valve.

CASING

The indoor & outdoor units shall be sectionalized/ cabinet construction. Indoor units shall be consisting of v, motor, fan section, coil section, filter section, and drain pan. Outdoor unit consist of compressor, condenser coil & fan. Each section shall be constructed of not less than 18 gauge thick sheet steel all welded/bolted construction, adequately reinforced with structural members and provided with sufficient access panels for proper lubrication and maintenance. Base panel shall be constructed of fabricated steel structure, provided with an under frame suitably braced. Each unit shall include one-piece drain pipe constructed of 18 gauge galvanized sheet steel plate. Drain pan shall be extending under coil and fan sections with drain connections. Removable panels in fan and coil sections shall provide access to all internal parts.

Panel shall be internally lined with 2.5 cm thick fiberglass/or equivalent as per section “Insulation” for the thermal insulation and acoustic lining.

FAN MOTOR AND DRIVE

Fan motor shall be TEFC suitable for 1/3 phase, 50 Hz ±3%, AC supply and provided with necessary safety devices to withstand voltage fluctuation from 160250 (for single phase machines) and 340 V to 440V (for 3 phase machines). Motor shall be provided with soft Starters of required capacities. Motors shall be especially designed for quiet operation and motor speed shall not exceed 1440 rpm. Drive to fan shall be provided either directly or through belt drive with an adjustable motor sheave. Belts shall be of the oil resistant type.

FAN

Fan wheels and housing shall be fabricated from minimum 18G sheet steel. Fan wheels shall be of double width, double inlet forward curve, multi speed, multi blade type enclosed in a housing with electrical heating with strip heater and mounted on a common shaft. Fan housings shall be made of deformed steel sheets with stream lined inlets to ensure smooth air flow into the fans. Fan shaft bearing shall be oil/grease lubricated. Bearing shall be mounted externally for servicing without dismantling of the unit. All rotating parts shall be dynamically balanced individually, and the complete assembly shall be statically and dynamically balanced. Fan speed shall not exceed 1000 rpm and maximum fan outlet velocity shall be 550 meters per minute.

COOLING COIL

Cooling coil shall be fin and tube type having aluminum fins firmly bonded to copper tubes assembled in zinc coated steel frame. Face and surface areas shall be such as to ensure rated capacity from each unit and air velocity across each coil shall not exceed 150 meters per minute.

The coil shall be pitched in the unit casing for proper drain age. Each coil shall be factory tested at 21 kg. Per sq.cm. air pressure under water. Tube shall be mechanically / hydraulically expanded for minimum thermal contact resistance with fins. The no. of fins per cm. shall be 4 to 5.

VIBRATION ISOLATORS

The indoor and outdoor units shall be provided with vibration isolators.

PAINTING

Package units shall be factory finished with durable alkyd spray enamel. Shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, then coated with enamel paint to match the finish over the adjoining shop painted surface.

PERFORMANCE RATING

The unit shall be selected for the lowest operating noise level. In all air conditioned spaces noise level should not exceed NC35, 2m away from face of supply air outlet. Capacity ratings and power consumption with operating points clearly indicated shall be submitted with the tenders and verified at the time of testing and commissioning of the installation.

TEMPERATURE CONTROLS

Each unit shall be provided with a temperature control assembly complete with cooling thermostat etc. All the controls except remote thermostat shall be factory wired and located in a weather proof enclosure. These shall include fuses, selector switch, safety controls, SPP, winding over heat protection and any other controls as may be necessary for safe and trouble free operation of the unit. Packaged unit shall have interlocking with the condenser fans.

MISCELLANEOUS

- Necessary charge of refrigerant gas and lubricant oil.
- Necessary concrete pedestals with vibration isolators for the unit as approved by the engineer.
- Continuous purge system with automatic purging of non-condensable gases/refrigerant
- Flexible connection at the fan outlet.
- Control wiring from unit to remote thermostat.
- Suction, discharge and oil pressure gauge in refrigerant circuit.
- Refrigerant flow control shall be provided.
- In Case of Dx type AHU, the Condensing unit shall be provided with all necessary accessories required for connections like – Expansion valve, driers, control thermostat etc.

11 STP EXHAUST AIR TREATMENT (DEODORIZATION SYSTEM)

The system shall comprise individual compartments for Ozone Generator, Fan, and Electrical/ Instrumentation Components. The equipment shall be UL listed.

Ozone Generator Compartment shall comprise set of multi plate, double sided corona discharge plates operating in unison to produce adequate quantity of ozone at medium concentration. Material of construction of all parts shall be Stainless Steel.

The system shall not require any replacement consumable except air filter, and maintenance shall be minimum or near zero subject to timely replacement of intake air filter to the unit.

The ozone generating corona and ozone wetted parts shall be confined in a fully welded stainless steel enclosure to prevent ozone leaks. It shall be provided with openable glass or plexi glass panel for inspection of corona plates while the equipment is in operation. The outer enclosure of the equipment shall be provided with lockable doors to provide easy access to the glass inspection panel.

The corona chamber shall not have any trace of exhaust air while it starts and operates. Necessary ROHS compliant and UL listed electrical relay shall be provided to ensure this safety feature. The electrical compartment shall be isolated from all other compartments, and rated to NEMA 4X (IP 66). The transformer shall be electrical induction type, UL listed. It shall not damage, burn, or elevate in temperature even if short circuit occurs. Shall revert to normal operation upon removal of short circuit. The transformer shall be fully encapsulated and housed in metallic enclosure for safety against moisture and water impregnation.

Passage of high voltage conductors across metallic enclosure shall be through UL listed liquid tight connectors.

For deodorization of exhaust air from STP, system compliance to NFPA 820 or classified area (Class 1, Div 1 II) shall be attainable by installing the equipment outside the plant room and by duct connection to exhaust air from the plant room.

High voltage cable shall be silicon insulated, ozone and corona resistant, rated for 20 KV, and UL listed with UL flame test rating.

Following accessories shall be provided in the electrical compartment;

a. UL listed Manual Regulator to modulate production of ozone.
b. UL listed Hour Meter housed in NEMA 4 enclosure for timely maintenance.
c. Air Pressure Manometer for measurement of air pressure in fan chamber.

d. UL listed switches such as DPST Main On Off Switch, Fan On Off Switch, Indicating Lamps, and Terminal Block.

Fan chamber shall comprise backward curved non overloading fan driven by thermal protected, UL listed TEFC motor to inject ozonized air into exhaust air stream. External static pressure of the fan shall be rated for injection into airstreams from 0.25" WG (60 Pa) up to 2" WG (500 Pa). Air intake shall be through grille with filter track and UL listed MERV 11 filter.

Contact Chamber of stainless steel construction of adequate volume shall be field or manufacturer provided for design contact volume.

The system shall be rated for operation on 220/240 V, 1 Ph, 50/60 Hz & supplied with Control Panel H2S Monitor, DLC Controller, and Ozone Monitor Listed to UL 867A, for automatic modulation. The system shall Delivers 0 – 10 VDC for BMS interface.

12 VENTILATION FAN

GENERAL (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.

Kitchen exhaust fan shall be of Bifurcated Axial or SISW Centrifugal direct or belt driven type. DIDW Centrifugal and Direct Drive Axial Flow Fan where belts or motor are in the air stream are not acceptable.

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 or DIDW Centrifugal Fan. Protective wire mesh with MERV-7 fresh air filter at the suction of the fan is required.

Fans for elevated temperature (Smoke Extraction Fans) with components rated for high temperature (250C, 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.

Anti-condensation heater is recommended to be installed for all Pressurization and Smoke Spill Fans, and the control circuit shall be arranged such the way that the heater is off when the starter is on and vice versa. Heaters shall be wired from the respective local motor control panel

or motor control console.

Fan should be of G-90 high grade galvanized steel or carbon steel with epoxy coat.

If fan is open to atmosphere, Fans shall be with pure polyester powder coating for minimum thickness of 60 microns.

IN-LINEFANS:

Circular/Cabinet Inline fans shall be complete with DIDW forward/backward curved centrifugal impeller fitted with external rotor motor of galvanized steel, insulated or un-insulated housing, belt/direct driven motor, vibration isolators, direction of discharge and rotation position shall be as per the job requirement and shall be marked on the fan assembly.

Housing shall be constructed of hot rolled GSS sheet metal construction. Housing metal parts shall be either spot-welded or screwed or mounted together with rivets. Indication showing rotation arrow and make, model number and duty conditions of the fan shall be available on the housing. The fan shall be of double skin construction with 20-gauge GI outer skin with 25 mm glass wool wrapped tissue paper and covered with 20 gauge perforated GI sheet from inside shall be as specified in schedule of quantities.

Fan wheel shall be DIDW forward/backward curved type, statically and dynamically balanced.

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

Motor shall be with minimum IE3 rating. Fan motor, fans shall be supplied with built-in-thermal contact (TK) at the critical high temperature point (“B” = 1300C. The thermal contact shall open and break the power supply to the fan; Fan motors have insulation class “B” and protection class IP54. Motor shall be suitable for external power supply 200~220V/50Hz/Single Phase OR 415+10% v/50Hz/Three Phase.

Fans shall be belt/direct driven type.

Fan should be provided with factory made built in hanging clits bolted firmly on fan body with the holes for installation.
Direction of rotation to be marked firmly on fan body.

All fan shall be electronic speed regulator & wiring with 3 pin plug top

between fan & speed regulator for single phase fans. In case of 3-phase fan with DOL starter panel & FRLS power cabling, earthing etc. between starter panel & fan. The incoming power supply to speed regulator/ starter panel shall be provided by electrical contractor.
Wire guard and bird-screen

Gravity louvers at fan discharge duct outlet.

Single-phase preventers for 3 phase fans.

Wiring between regulator and fan motor including termination at both ends.

PROPELLER FANS:

Propeller fans 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 venture inlet coated with baked enamel paint. Mounting plate shall be of standard size, constructed of 12 to 16 gauge steel sheet 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 aluminum or glass reinforced polypropylene. Fan hub shall be of heavy welded steel construction with blades bolted to the hub fan blades and assembly shall be statically and dynamically balanced.

Shaft shall be of steel accurately ground and shall not pass through first critical speed through entire range of specified fan speed.

Motor shall be with minimum IE3 rating. Motor shall be standard permanent split capacitor of shaded pole for small sizes, totally enclosed with pre-lubricated sleeve or ball bearings, designed for a 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 cycle 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 horizontal or vertical service as indicated in drawings and Schedule of Quantities.

Propeller fans shall be provided with following accessories: -

Wire guard and bird-screen

Gravity louvers at outlet

Regulator for controlling fan speed for single-phase fan motor.

Single-phase preventers for 3 phase fans.

Wiring between regulator and fan motor including termination at both ends.

3 pin plug top with power cable with earthling from fan motor to 3 pin socket shall be
Included in installation cost of fan.

SMOKE SPILL TUBE AXIAL FLOW FANS (DIRECT DRIVE) :

Fans shall be licensed to bear the AMCA Air and Sound Certified Ratings Seal. The test standard used shall be ANSI/AMCA 210-85, ANSI/ASHRAE Standard 51-1985 "Laboratory Method of Testing Fans for Rating" and AMCA 300 "Reverberant Room Method for Sound Testing of fans".

To achieve the minimum and equal clearance between the blade tips and casing, tube casing shall maintain its roundness by means of using one piece of sheet metal with 90 edge flanging up.

Fan motor base support shall be properly secured (locked and sealed) to the fan housing and be of adjustable type to have precise control of motor shaft central position as well as running clearance between blade tips and casing. Motor (KW/HP) shall be able to be changed or upgraded at site without changing fan housing or ducting construction.

Fans supplied shall be complete with factory fabricated mounting bracket (ceiling or foot mounted) and suction/discharge matching flanges as accessories.

All hubs shall be cast Aluminum alloy (Grade LM2) unless for Smoke Extractor Fans where high temperature (250C/2Hrs) air is expected then Aluminum alloy or steel fan impeller blades are required. Otherwise impeller blade material with Polypropylene (PP), Glass-reinforced Polypropylene (PPG) and Glass-reinforced Polyamid (PAG), to provide self-balancing, anti-static, anti-sparking characteristic is preferable.

Running clearance between blade tips and casing shall not exceed 1% of the impeller diameter, and 2% for smoke spill high temperature fan where mechanical expansion coefficient is different from normal ambient temperature. Fan manufacturer shall provide the fan assembled with the dame clearance between blade tips and casing of the tested prototype. Note that the air performance and pressure loss are greatly affected by this clearance.

Impellers shall be secured to the drive shaft by a key and keyway. Axial location shall be provided by a collar or shoulder on the drive shaft together with a retaining washer and screw fitted into a tapped hole at the end of the shaft and locked in position. Blades shall be secured in place to the

angle setting by setscrews, locking nuts or setting pins.

Fan motor shall be totally enclosed and external terminal box of at least IP56 shall be provided.

Motor shall be with minimum IE3 rating.

Fans shall not exceed 1500 RPM.

All fans after assembly shall be dynamically trim-balanced to ISO1940 and AMCA 204/3 - G2.5 quality grade. A computer printout with vibration spectrum analysis shall be attached to the fans.

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.

TUBE AXIAL FLOW FANS (DIRECT DRIVE):

Fan shall be complete with motor, motor mount, direct driven and vibration isolation type, suspension arrangement as per approved for construction shop drawings. Fresh air fans shall be equipped with filters as specified in schedule of quantity.

Casing shall be constructed of heavy gauge sheet steel. Casing shall be provided with hinged door enabling easy replacement of wheel, shaft and bearings. A small inspection door with handle and neoprene gasket shall also be provided. Casing shall have flanged connection on both ends for ducted applications. Support brackets for ceiling suspension shall be welded to the casing for connection to hanger bolts. An inspection door with handle and neoprene gasket shall be provided. Casing shall have flanged connection on both ends for ducted applications. Fan casing are with internal punched inlet and outlet flanges to prevent air leakage, for size up to 1600 mm dia. and shall be constructed of rolled steel with a continuous seam welded. Support brackets for ceiling suspension shall be welded to the casing for connection to hanger bolts. Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. Casing shall be bonderized, primed (minimum 2 coats of rust-proof primer) and finish coated with enamel paint or powder coated after phosphating process.

Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. Casing shall be de-rusted, cleaned, primed and finish coated with enamel paint.

Rotor hub and blades shall be of cast aluminum, or cast steel construction. Blades shall be die-formed aero foil shaped for maximum efficiency and shall vary in twist and width from hub to tip to effect equal air distribution

along the blade length. Fan blade mounting on the hub shall be statically and dynamically balanced. Extended grease leads for external lubrication shall be provided. The fan pitch control may be manually re-adjustable at site, upon installation, for obtaining actual airflow values, as specified.

Motor shall be with minimum IE3 rating. Motor shall be of 3 phase squirrel-cage totally enclosed, fan cooled type. Motor and starter shall be conform to IS: 1822 ―Motor starters of voltage not exceeding 1000 volts‖ and shall be air insulated and suitable for 415 volts, + 10%, 50 Hz., 3 phase AC supply. Enclosures shall have protection of IP 54.

Starter for the motor shall be direct on line (D.O.L) for motors up to and including 7.5 H.P. rating and automatic star-delta close transition type for motors of higher ratings unless otherwise specified in the tender specifications. Starters shall be rated for intermittent duty. Starting current should not exceed two times the full load current.

The starter shall be mounted on the main electrical control panel/ unit mounted/ self-mounted as specified.

Each starter shall be provided with the following protections: -
a) Thermal overload on all the three phases with adjustable settings,
b) Under voltage protection, and
c) Independent single phasing preventer. (current sensing type)

Adequate number of extra NO/ NC contacts for interlocks, indicating lamps etc. shall be provided on the starter/ contactor.

The speed of fan shall not exceed 1000 RPM for fans with impeller diameter above 450 mm, and 1450 RPM for fans with impeller diameter of 450 mm and less.

Vibration Isolation

Base shall be provided for each fan. Base for both fan and motor shall be built as an integral part and shall be mounted on a concrete foundation through cushy foot vibration isolators. The concrete foundations shall be at least 15 cm above the finished floor level and shall be further isolated from the structural floor through 5 cm. Thick layers of sand all around, topped with bitumen. In case ceiling hung fan within the ceiling shall be provided Vibration Isolation Suspension (VIS) shall be provided in each of string.

CENTRIFUGAL FANS

Centrifugal fans shall be of double-width, double-inlet construction, with bearing on both sides, complete with access door, squirrel-cage induction motor, V-belt drive, belt guard etc.

The Fan &motor assembly should be weatherproof, suitable for outdoor mounting and application. Fan to be UL 762 certified for kitchen & restaurant exhaust application all fans should be AMCA rated and UL

listed

Housing shall be of heavy gauge sheet steel in welded construction. It shall be rigidly reinforced and supported by structural angles. Split casing shall be provided on larger sizes of fans. However neoprene/ asbestos packing shall be provided throughout split joints to make it airtight. 1.2 mm galvanized wire mesh inlet guard, of 5 cms sleeves shall be provided on both inlets. Housing shall be provided with access door with quick locking tension handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.

Fan wheel shall be of GSS and backward curved non-overloading type unless otherwise specified. Fan wheel and housing shall be statically and dynamically balanced. Fan outlet velocity shall not exceed 610 meters per minute.

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. Bearing shall be self-aligned, oil grease packed, pillow block type.

Drive to fan shall be provided from 3 phase electric motor through belt with adjustable motor sheave and belt guard. Belt shall be of the oil resistant type. The number of belts shall be not less than two.

Motor shall be with minimum IE3 rating and TEFC type. Motor shall be of 3 phase squirrel-cage totally enclosed, fan cooled type. Motor and starter shall be conform to IS: 1822 ―Motor starters of voltage not exceeding 1000 volts‖ and shall be air insulated and suitable for 415 volts, + 10%, 50 Hz., 3 phase AC supply. Enclosures shall have protection of IP 54.

Starter for the motor shall be direct on line (D.O.L) for motors up to and including 7.5 H.P. rating and automatic star-delta close transition type for motors of higher ratings unless otherwise specified in the tender specifications. Starters shall be rated for intermittent duty. Starting current should not exceed two times the full load current.

The starter shall be mounted on the main electrical control panel/ unit mounted/ self-mounted as specified.

Each starter shall be provided with the following protections: -

a) Thermal overload on all the three phases with adjustable settings,
b) Under voltage protection, and
c) Independent single phasing preventer. (current sensing type)

Adequate number of extra NO/ NC contacts for interlocks, indicating lamps etc. shall be provided on the starter/ contactor.

CABINET FANS (BELT DRIVEN)

The impellers of the fan or fan shall be of GI sheets, double inlet backward curved centrifugal design, both statically and dynamically balanced. The fan housing shall be of sturdy construction made from double skinned GSS casing having 0.6mm pre-coated GI sheet outside and plain 0.6mm thick GI sheet inside with 25 mm thick puff insulation with smooth air inlets.
The fan shall be mounted on properly aligned shaft and mounted on self-aligning bearing blocks. The casing of the cab section shall be made of 16 G (1.6mm) GI sheets suitably reinforced to provide rigidity. The frame work shall either be folded G.I. sheets or of hot dipped galvanized iron.
Fresh air fans shall be equipped with filters as specified in schedule of quantity
The fan section shall be complete with V belt drive, belt guard and motor mounting base in case of Belt driven type.
Drive to fan shall be provided from 3 phase electric motor through belt with adjustable motor sheave and belt guard. Belt shall be of the oil resistant type. The number of belts shall be not less than two.

Motor shall be with minimum IE3 rating. Motor shall be of 3 phase squirrel-cage totally enclosed, fan cooled type. Motor and starter shall be conform to IS: 1822 ―Motor starters of voltage not exceeding 1000 volts‖ and shall be air insulated and suitable for 415 volts, + 10%, 50 Hz., 3 phase AC supply. Enclosures shall have protection of IP 54.

Starter for the motor shall be direct on line (D.O.L) for motors up to and including 7.5 H.P. rating and automatic star-delta close transition type for motors of higher ratings unless otherwise specified in the tender specifications. Starters shall be rated for intermittent duty. Starting current should not exceed two times the full load current.

The starter shall be mounted on the main electrical control panel/ unit mounted/ self-mounted as specified.

Each starter shall be provided with the following protections: -
a) Thermal overload on all the three phases with adjustable settings,
b) Under voltage protection, and
c) Independent single phasing preventer. (current sensing type)

Adequate number of extra NO/ NC contacts for interlocks, indicating lamps etc. shall be provided on the starter/ contactor.

CABINET FANS (DIRECT DRIVEN)

Cabinet Inline/Cabinet backward curved type direct driven fans installed in ICU/HDU and other clinical areas. The impellers of the fan or fan shall be of GI sheets. The fan housing shall be of sturdy construction made from double skinned GSS casing having 0.6mm pre-coated GI sheet outside and plain 0.6mm thick GI sheet inside with 25 mm thick puff insulation with smooth air inlets. The fan shall be mounted on properly aligned shaft and mounted on self-aligning bearing blocks. The casing of the cab section shall be made of 16 G (1.6mm) GI sheets suitably reinforced to provide rigidity. The frame work shall either be folded G.I. sheets or of hot dipped

galvanized iron.
The fan section shall be complete with brushless EC motor mounting base.

Drive to fan shall be provided from 3 phase electric motor through direct drive type complete with Brushless EC motor.

Motor shall be with minimum IE3 rating. Motor shall be of 3 phase squirrel-cage totally enclosed, fan cooled type. Motor and starter shall be conform to IS: 1822 ―Motor starters of voltage not exceeding 1000 volts‖ and shall be air insulated and suitable for 415 volts, + 10%, 50 Hz., 3 phase AC supply. Enclosures shall have protection of IP 54.

The Fan speed must be 100% adjustable with the potentiometer placed in the connection box. Fan should be send Analogue input with terminals in the terminal box to control the fan with 0-10V input signal. Models are suitable for mounting in any orientation and operation within ambient air temperatures between -20°C up to +40°C

Starter for the motor shall be direct on line (D.O.L) for motors up to and including 7.5 H.P. rating and automatic star-delta close transition type for motors of higher ratings unless otherwise specified in the tender specifications. Starters shall be rated for intermittent duty. Starting current should not exceed two times the full load current.

The starter shall be mounted on the main electrical control panel/ unit mounted/ self-mounted as specified.

Each starter shall be provided with the following protections: -
a) Thermal overload on all the three phases with adjustable settings,
b) Under voltage protection, and
c) Independent single phasing preventer. (current sensing type)

Adequate number of extra NO/ NC contacts for interlocks, indicating lamps etc. shall be provided on the starter/ contactor.

13 DRY SCRUBBER UNIT

GENERAL:

The scrubber shall be made to take care of the kitchen exhaust which shall comprise mainly of Black soot; unburnt oil and odour of roasted food from tandoor etc. Care will be taken to handle high volume of gases and P/V (Pollutants / Volumetric flow rate) ratio less than 0.001 means size of particulate matter which is reason for foul smell.

TECHNICAL PARAMETERS:

The unit shall provide efficiency of 90% or better for single pass base on ASHRAE test method at flow rates of 800 – 1300 CFM per module (supported by sample test report by a US laboratory).Multiple units can be joined together for increased volume. The system shall be suitable to connect to fan section with average velocity of 500 FPM across air cleaner. The unit shall be CE-certified.

EQUIPMENT SPECIFICATIONS:

The unit shall be designed and constructed and supplied by a specialized manufacturer capable of issuing complete data of the product.

UNIT HOUSING:

Housing shall be 16gauge zinc coated steel construction to protect against rust and corrosion. Each section shall include single door access, located one side of the unit. The access door shall be mounted on steel hinges and secured with adjustable, gasket sealed lever latches allowing for component access and removal. All doors shall be provided with gasket to prevent air leakage. Doors to charged high voltage components shall be equipped with electrical interlocks, for interconnection into the primary power supply, to prevent access when the components are energized. The housing shall be furnished completely assembled for ease of shipment and installation. Between each section, a permanent 1/8" thick gasket shall be installed to prevent leakage. The bottom drain pan under ESP section containing integral washing systems shall be pitched downward 1/4"per foot minimum towards a 3" NPT drain nipple. The casing of the Fan assembly shall be double skin, same as of fan section units.

BLOWER SECTION:

The blower section shall comprise of Centrifugal Backward Curved SISW fan wheel of totally GI Construction with Inlet Cones and shall be complete with individual motor and drive and shall be mounted on C Channel frame and Cushy Foot or Spring Mounts. The fan shall have a capacity not less than the specified in the catalogues and shall be

constructed and rated based on delivery against the rated static pressure with the media and filters in place. The fan will be of riveted construction and made with GI sheet of required thickness. The fan wheel will be of the multi blade type and mounted on two self-aligning pillow block bearings of the requisite size. The fan shall be run with the help of "V" Groove drives as per the re-commendation of the drive supplier. The blower housing will of the Pittsburg joint construction and the drive will be provided by a motor of adequate capacity. The motor plate will be constructed out of 12 G MS or heavier metal with slotted holes, which permit belt adjustment in both the directions. The outlet velocity of the blowers will be kept low.

Fan motors shall be 415 ±10% volts, 50 cycles, 3 phase, AC squirrel – cage, totally enclosed fan cooled with class F Insulation and IP – 55 protections. Motor shall be especially designed for quiet operation and motor speed shall not exceed 1450 RPM. Drive to fan shall be provided through v-belt – drive arrangement. Belts shall be of the oil resistant type. The whole fan & motor assembly shall be isolated with other air scrubber system.

BASE CONSTRUCTION:

The sections are to be mounted on a structural C-channel or floor mounting or ceiling suspension. Lifting lugs shall be incorporated in the base channel to allow for rigging, if or dared.

FINISH:

The external casing finish shall be a durable industrial grade semi-gloss bakedon epoxy ester, not less than 3 mill minimum thickness.

CELLS WASH MODULE:

The Cells Wash module shall incorporate mechanical filtration. The stationary filter from the direction of airflow will be a metal mesh filters with single, gasket access doors. Wash manifolds and headers are supplied to wash the module during the normal wash cycle.

ELECTROSTATIC PRECIPITATOR MODULE:

The electronic air cleaner shall be the two stage dual voltage plate type cells, rated at not less than 90% efficiency as per the ASHRAE test standards for dry particulate (supported by sample test report by a US laboratory). The collection cells shall be in Single Pass arrangement to provide for maximum collection efficiency.

IONIZING COLLECTION CELL:

Ionizing Collecting cell(s) shall be of one-piece construction 14.23" inches deep in direction of airflow. All support framing, end plates and

ionizer ground electrodes shall be 0.090-inch-thick aluminum. Both repelling and collector plates shall be 0.020-inch-thick aluminum, 9.125 inch deep in direction of airflow and rigidly retained in place with tubular spacers and tie rods. Spacing between plates shall be no less than 0.175 inch. Ionizing electrodes shall be 24-gauge stainless steel spiked design, ionization wires are not acceptable, rigidly supported both vertically and laterally. High voltage support insulators shall be of self-glazing Cordierite ceramic with all surfaces, including center hole, glazed to enhance dielectric strength and retard tracking. Insulators shall be mounted out of the airstream, to reduce contaminant buildup. All high voltage electrical connections within each tier of cells, shall be between cells and automatically made when cells are installed. All electrical connections between unit tiers and high voltage connections between power packs and cells shall be located on the access door end of the cabinet and manually connected for ease of service.

POWER SUPPLIES:

Power supplies shall be 100% solid state, UL Listed. operate on 200 to 240 VAC, 50 HZ, 1Phase input and provide a dual high voltage output of (+) 12 to 13 KVDC for the ionizer and (+) 6.0 to 6.5 KVDC for the collector. A regulated output of up to 5.5 MA shall be supplied to maintain the specified collection efficiency. Integrally mounted electrical interlocks shall be provided to prevent access to the high voltage components without first interrupting the primary input power. The power supply shall operate over a temperature range of 32 degrees F to 140 degrees F, be self-protecting and accommodate an LED light indicating the performance status of the ionizing/collecting cell. High voltage output leads shall be sealed and a bleed resistor incorporated to remove stored electrical charge where the power supply(s) are de energized. Module ofcapacityabove3000CFMshallbe equipped with Pulse width modulating (PWM) to maintain the specified collection efficiency by maintaining a constant charge in the event of Low/High Voltage from source thus ensuring that the unit functionality is not affected with these voltage fluctuations. Power Consumption should not be more that 50 watts per ESP cell.

All power supply components shall be designed or ease of mounting and servicing. High voltage power cables shall be of one continuous length, splicing is not acceptable.

SYSTEM CONTROLS:

Programmable Logic Controller (PLC) shall be housed in a NEMA12 type enclosure. Controller shall be shipped for remote mounting and must be installed indoors or other means of weather protection provided if installed. Terminals shall be provided to inter connect the system fan and shall sequence the detergent wash, soak, rinse fan force dry and return to operation cycle. All sequence times shall be factory set. Control initiation shall be semiautomatic, push button initiated, or fully automatic by time clock, with semi-automatic push button override.

A remote mounted Sleep Mode Reset Switch (momentary contact push button type) shall be supplied to be installed at the kitchen hood location to reenergize the air cleaning system after the wash system has completed. The switch may optionally be installed on the panel of the ATS control enclosure.

AUTOMATIC TIME CLOCK:

The control cabinet shall be furnished with a factory installed and wired 7day initiator clock with battery backup.

WATER WASH/DETERGENT SYSTEM:

Detergent wash and rinse will be accomplished with manifolds located on the air entering sides of the (pre-filter wash collar if supplied) i o n i z i n g /collecting cell tier through spray nozzles delivering a cone shaped pattern. The detergent reservoir, pump, motor and by pass valve shall be provided as a prepackaged assembly with an adjustable detergent volume setting. The detergent pump motor shall be 0.75kW TEFV motor, 220v/50hz/1ph,with pump of positive displacement self-priming and deliver not less than 6 GPM at 50PSIG minimum outlet pressure. Pump motor shall contain built in overload protection. Main water line strainer and solenoid valves are to be factory furnished with the system. Detergent system shall a 30gallon tank for remote mounting with initial supply of biode gradable detergent as per unit manufacturer's recommendations.

STATIC PRESSURE DROPS:

The pressure drop shall not exceed the following (inches H2O):

ESP Section 0.14" Metal Mesh prefilter or after filter 0.10". The ESP section must have both an internal prefilter and an after filter, select and add for each.

External losses for ductwork, exhaust hoods, manufacturing equipment with associated entry losses, kitchen hoods, etc. must be added with the above internal equipment losses to calculate total fan static pressure required.

ADSORBER MODULE:

The Absorber Module shall be designed to utilize required number of 23.38"x 23.38"x 2" deep trays that are powder painted for corrosion resistance, may be reused and are se cured in a Vbank arrangement on steel slide tracks. Trays shall be charged with 18.25 lbs. of activated carbon granules.

SAFETY FEATURES

Each unit must have safety features as under:

The fan access door shall be equipped with port hole window and micro switch inter locked with fan motor to enable switching off the fan motor automatically in the event of door opening.

The Access Door shall further have GI 8 SWG wire mesh screen as on added safety feature bolted on to the unit frame.

Fan and motor base shall be properly earthed.

PERFORMANCE DATA

The Air scrubber unit shall be selected for the lowest operating noise level of the equipment. Fan performance rating and power consumption data, with operation points clearly indicating shall be submitted and verified at the time of testing commissioning of the installation.

14 TWO-STAGE EVAPORATIVE COOLING UNIT FOR KITCHEN FRESH AIR

SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of two stage evaporative direct/indirect cooling unit for use in kitchen fresh/make-up air.

Evaporative coolers are cooling systems that use only water and a blower to circulate air. In the system, warm, dry air is pulled through a water-soaked pad. As the water evaporates, a cooling effect on the surrounding air occurs. Evaporative coolers use only a fraction of the energy of traditional air conditioning systems. Unfortunately, except for in very dry climates, they may increase humidity to a level that makes occupants uncomfortable. Two-stage evaporative coolers do not produce humidity levels as high as that produced by traditional single-stage evaporative coolers.

Features

In the first stage of a two-stage cooler, warm air is pre-cooled indirectly without adding humidity (by passing inside a heat exchanger that is cooled by evaporation on the outside).

In the direct stage, the pre-cooled air passes through a water-soaked pad and picks up humidity as it cools. Because the air supply to the second stage evaporator is pre-cooled, less humidity is added to the air (because cooler air can‘t hold as much moisture as warmer air).

This result in a cool air with a relative humidity between 50 and 70 percent, depending on the climate, compared to a traditional system that produces about 80 percent relative humidity air.

An advanced two-stage evaporative cooler uses 100 percent outdoor air and a variable speed blower to circulate cool air.

Benefits

Two-stage evaporative coolers can reduce energy consumption by 60 to 75 percent over conventional air conditioning systems.

This relative improvement depends on location and application. Evaporative coolers work best in very dry climates.

TYPE

The evaporative units shall be double skin construction, draw-thru type comprising of various sections, filter section, direct/indirect cooling section, fan and motor section as per required application as mentioned

in BOQ in suitable horizontal configuration. As shown on drawings and included in schedule of quantities.

CAPACITY

The air-moving capacity of unit shall be as shown on Drawings and in Schedule of Quantities and as per kitchen consultants.

The evaporative unit capacity of the cooling and air quantity from the blower fan and static pressure of blower fan shall be as laid down in the tender documents. Where these parameters as calculated by the tenderer exceed the specified values, the blower fan shall satisfy these calculated values.

The designed face velocity of air not exceeding 155 m/min.

The requisite static pressure demanded by the air circuit shall be developed by the fan at the selected operating speed. The static pressure value shall not in any case be less than 65 mm water gauge in evaporative case, The fan motor HP shall be suitable to satisfy these requirements and the drive losses.

CASING:

Double skinned panels shall be 40+/-2 mm thick double Skin Panels with thermal break profile, shall be made of 0.63mm Pre-coated GI on outside and 0.63mm GI inside with CFC – FREE polyurethane foam insulation of 40 (+/- 5%) kg/Cu M injected in between with an internal gasket between the skins to interrupt the thermal bridge of the panel.

The entire framework shall be mounted on an aluminum alloy/galvanized steel or heavy duty engineering composite material (depending on size) channel base as per manufacturer's recommendation. Panels shall be assembled together to form an enclosure that is capable of low air leakage potential, conforming to class A of EN 1886:2007. Handles shall be made of hard nylon and all access panels should be open-able with Allen key arrangement. Units supplied with various sections shall be suitable for on-site assembly with continuous foam gasket. All fixing and gaskets shall be concealed.

Units shall have hinged or removable type quick opening access door in the fan section and also in filter section where filters are not accessible from outside. Access doors shall be double skin type. All the section of air handling units should be accessible for easy maintenance.

Internal panels shall be fabricated so that there are no gaps between the panel and frame work. Fabrication clearances shall be closed with blank-off pieces or with sealant. Partitions shall be of sufficient thickness to prevent deflection and vibration during unit operation. Manufacturer shall provide suitable stiffening by means of box type

members across the same.

Unit shall be with clean inside surfaces with beveled corners to the best possible extent without crevices as may allow growth of algae / fungus. In case on internal fittings such as dampers, the same shall be with beveled edges and without sharp corners to prevent operator injury. There shall be no screws projecting into unit or air stream. If the same is unavoidable, the tips shall be fitted with rubber caps to prevent operator injury.

Unit panels shall be factory fitted with pressure ports for DPT installation. The number and size of these shall be confirmed in the unit technical approval stage. In case opening is to be made in unit panel, the same shall be with C-channel all around to prevent entry of PUF into air stream. The channels shall be cut at 45 degrees at the corners to avoid overlap. Material for the channel shall be same as that of internal skin of unit.

Rubber grommets shall be provided at all entry points into unit such as piping connection, cable entry etc. The same shall be double lip tight fitting to prevent air leakage.

All access doors shall be outward opening. For doors provided downstream of the fan, especially in high static units, additional clamps shall be provided along periphery of door to maintain constant pressure and ensure proper sealing.

DAMPER:

Dampers shall be opposed blade type. Blades shall be made of 16 G double skinned airfoil aluminum sections with integral gasket and assembled within a rigid extruded aluminum alloy frame. All linkages and supporting spindles shall be made of aluminum or nylon, turning in teflon bushes. Manual dampers shall be provided with a bakelite knob for locking the damper blades in position. Linkages shall be extended wherever specified for motorized operation. Damper frames shall be sectionalized to minimize blade warping. Air leakage through dampers when in the closed position shall not exceed 1.5% of the maximum design air volume flow rate at the maximum design air total pressure. Damper construction shall be such a that there is no rattling noise, when damper is partially (close to 50%) closed &unit is ON.

MOTOR & DRIVE:

Fan motors shall be energy efficient (IE-3) and shall be 415±10% volts, 50±5% cycles, three phases, totally enclosed fan-cooled class F, with IP-55 protection. Motors shall be especially designed for quiet operation. Belt driven backward cured DIDW fans shall be used for SA. Provision for cable entry to the motor shall be made at the factory itself. Drilling of holes at site shall not be acceptable. Limit switch arrangement along

with wiring shall be provided, so that when access doors opens, fan stops. Motor shall be epoxy painted.

BACKWARD CURVED DIDW FAN:

Fans shall be belt drive backward curved DIDW fan with aerofoil design blades for kitchen exhaust areas of floor mounted units. The entire fan with casing will be certified by a reputed 3rd party internationally acclaimed certifying body like Eurovent, or AHRI or AMCA, and the entire Fan + Motor assembly will be balanced at supplier's works before dispatch. Fans drive shall be suitable for variable frequency drive shall be backward inclined irrespective of static pressure value. Fans shall be selected for minimum efficiency of 70%. MS epoxy coated in case of backward curved DIDW fans. For DIDW 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 and pulleys 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. Certified Computerized selection for unit shall be with fan selection and sound level spectrum. Complete unit sound level should be given in computerized selection sheet instead of sound level of bare fan.

Motors shall be mounted inside the unit casing on rigid frame/ slide rails for alignment, and be totally enclosed, fan cooled, to be class `F' insulation.

Heavy duty anti-vibration mounts shall be provided for isolating the unit casing. Fire retardant, waterproof silicone rubber impregnated flexible connection shall be provided at the fan inlet/ discharge.

DRAIN PAN:

Condensate drain pan shall be fabricated from 1.25mm thick SS304 stainless steel sheet and a minimum of 25mm deep with all corners welded. It shall be isolated from bottom floor panel through 10 mm thick closed cell Polyethylene foam insulation or elastomeric nitrile rubber or puff with necessary dual slope to facilitate fast removal of condensate. Necessary supports will be provided to slide the coil in the drain pan.

FILTER:

The air used in a system must be filtered to maintain a clean atmosphere in the conditioned space. The concentration of contaminants in the air and the degree of cleanliness required in the conditioned space will determine the type of filter or filters that must be used.

PRE-FILTERS (MERV-8) :

Cleanable metallic viscous type filter made out of aluminium wire mesh or of dry cleanable synthetic type minimum 50mm thick, shall be provided on the suction side of AHU as standard equipment with the unit. These filters shall have the efficiency of 90% down to 10 micron particle size. When these filters become loaded or full of dirt, it is removed from service and replaced by another filter. The dirty filter can then be washed in a cleaning solution in a tank, dried and then given a bath of viscous oil. Face velocity across these filters shall not exceed 155 MPM.

COOLING PAD:

The cooling pads shall be of honey comb design to provide extended and sufficient wetted surface to give a water absorbing efficiency of at least 80% at an air velocity of 3.0 m/sec.

The cooling pads shall be made of either acetate paper or high impact PVC. The cross section and depth shall be sufficient for specified efficiency. The cooling pad section shall be of 16 G (1.6mm) G.I. sheet similar to fan section. It shall be complete with galvanized supports for mounting the pads and a water distribution through the uniform supply of water over the entire surface.

Sensible Heat Exchanger

The fresh air taken shall be cooled sensibly before mixing of water to the air stream. This is the first heat exchanger in an IDEC unit. The construction of it should be such that the air being sensibly cooled (i.e. without adding water/air to it) should not get in contact with scavenging air.

The heat exchanger shall have peak wet bulb efficiency of 80%. This heat exchanger module shall be made of engineering polymer with a cellulosic media thermally fused. The velocity within the heat exchanger should not exceed 450 FPM(2.3 m/s) at any given cross section on heat exchanger face area. These need to be stacked up modularly to required air capacity. These heat exchanger modules shall facilitate a secondary air passage without mixing with the primary air flow. The heat exchanger shall be UL type tested.

Adiabatic Heat Exchanger

This shall be of imported cellulose paper pads and of cross fluted configuration assembled in self-supporting pads in a light weight construction. The pads shall be able to redistribute the water and shall be impregnated with insoluble anti-rot salts, rigidifying saturates and wetting agents with built in eliminators. The velocity across the fill shall not exceed 450 fpm (2.3 m/s) and shall not allow carryover of water. Minimum thickness of fill shall be 200 mm and minimum efficiency of

pads 90%.

WATER SUMP:

The water sump below the pad section shall be of minimum 1mm SS 304. The tank shall be complete with makeup, overflow and drain connections. A float valve shall be provided for makeup water line.

The pump set shall be of construction, with end suction and top discharge with flanged connections, bronze impeller and casing all mounted directly on a squirrel cage, drip proof induction motor of suitable capacity. Distribution pumps (1W+1S) shall be provided for both stages. Internal distribution piping of GI IS-1239 Class-C with nozzles shall be included for efficient water distribution. Necessary valves and strainer shall be provided for pumps.

Power for pumps, scavenger fan etc. shall be obtained from starter panel along with internal power cabling.

MISCELLANEOUS:

Necessary accessories shall be provided wherever necessarily required for proper operation and shall also include:
1) Necessary GI piping for water circulation
2) Vibration isolations pads for the blowers and pumps
3) Canvass connections at the outlet of each fan
4) Nuts, bolts, shims etc. as required for the grouting of the equipment
5) Float valves in the air washer tank, along with quick fill connection

VIBRATION ISOLATORS:

Vibration isolators shall be provided with all air handling units. vibration isolators shall be cushy-foot mounting type.

NOISE LEVEL:

For Floor mounted unit: Not more than 75 dBA at 2 Mtr. Distance

ACCESSORIES:

Each air handling unit shall be complete with the following as part of Unit price.

Flexible connection between the fan outlet and duct.
Vibration isolators of 90% efficiency.
Opposed blade damper at supply air, return air & fresh air point in unit section.

PANITING:

Shop coats of low VOC 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 paint to match the finish over the adjoining shop painted surface.

INSTALLATION:

Unit installation shall be carried out as per manufacturer's recommendation and mounted on serrated rubber pads/neoprene pads/vibration isolating spring in case of floor mounted units and GI hangers of suitable sizes shall be used for hanging ceiling suspend units.

PERFORMANCE DATA:

Unit shall be selected for the lowest operating noise level of the equipment. Fan performance rating and power consumption data with operating points clearly indicated shall be submitted and verified at the time of testing, commissioning of the installation. Computerized selection for unit shall be provided through 3rd party certified software for all the FMUs.

TESTING:

Capacity of unit shall be computed from the measurements of airflow and dry and wet bulb temperatures of air entering and at outlet.

Flow measurements shall be by anemometer and temperature measurements by accurately calibrated mercury in glass thermometer. Computed result shall conform to the specified capacities and quoted ratings. Consumption shall be computed from measurements of incoming voltage and input current.

Witness test by MEP consultant and client shall be required at manufacturer place prior to dispatch of material on site.

15 PIPE WORK AND VALVE STATIONS

GENERAL

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

PIPES

All pipes up to 150 mm diameter shall be M.S. E.R.W. tube (black steel) heavy class as per I.S. 123979, part I with upto date amendments. Pipes above 150 mm dia. shall be
M.S. E.R.W. tube (black steel) heavy class as per I.S. 3589 upto date amendments.

Design Parameters

Maximum flow		Maximum friction	
FPS	**MKS**	**FPS**	**MKS**
8 FT/SEC	2.5M/S EC.	5 FT / 100ft	5M/ 100 M

FITTINGS

The dimensions of the fittings shall conform to I.S. 1239/79 partII unless otherwise indicated, in the specifications.

Fitting material shall conform to the following specifications:

- Steel Welding Fittings ASTMA106 or approved equal
- Compression & Flanged ASTMA402 or approved equal Fittings

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

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

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

The branches shall be welded straight to the main line, without making a separate fit ting.

Blank ends are to be formed with flanged joints and 6mm thick blank between flange pair for 150mm and over in case where, a future extension is to be made, otherwise blank end discs of 6mm thickness

are to be welded on, with additional cross stiffeners from 50mm x 50mm M.S. heavy angles, for sizes upto 350mm, all ends larger than 400mm dia. shall have dished ends.
For Condenser pipe 4mm FRP quoting is required.

FLANGES

All flanges shall be of mild steel as per I.S. 6392/71 and shall be steel slip on type, welded to the pipes, flanges thickness shall be to suit class II, pressures.

Flanges may be tack welded into position, but all final welding shall be done with joints dismounted, 3mm thick gaskets shall be used with all flanged joints. The gaskets shall be fiber reinforced rubber as approved by the department. Special adhesive com pound shall be used between flanges of steam, air and gas lines.

Flanges shall be used as follows:

Counter flanges for equipment having flanged connections.

Flanged pairs shall be used on all such equipment, which may require to be isolated or removed for service e.g. pumps, refrigeration machines, air handling units etc.

All threaded valves shall be provided with nipples and flanged pairs on both sides to permit flange connections, for removal of valves from main lines for re pair/replacement.

Flanges shall be of the same pressure rating as the fittings and valves in each service category. Welding neck flanges or slip on flanges shall be used with flanged valves, equipment, etc., on welded lines. All flanges shall be drilled in conformance with pressure rating requirements and shall be faced and spot faced. Welding flanges shall be of steel.

Flanged pair shall be provided at all such equipment which may require isolation or removal for services e.g.; pumps, chiller, Air Handling units, etc.

Provide flanged joints and 6 mm thick blank insertion of rubber gasket between flanged pair at blank ends for 150mm and above pipe. Provide end disc of 6 mm thickness with additional cross stiffness from 50 mm x 50 mm MS heavy angle for up to 400 mm. All ends larger than 400 mm diameter shall have dished ends.

VALVES

BUTTERFLY VALVES

The butterfly valve shall consist of Cast Steel body preferably in two-

piece construction.

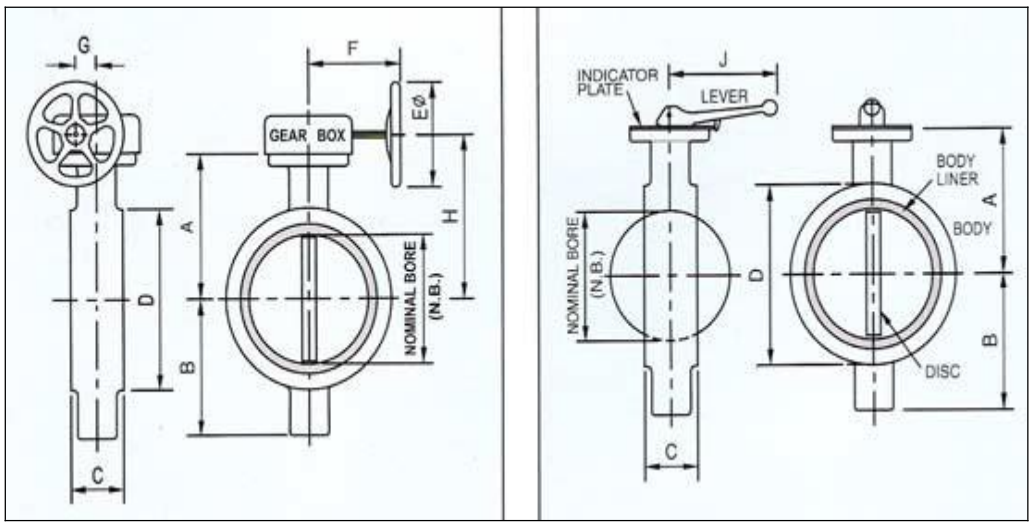
The disc shall consist of disc pivot and driving stem shall be in one piece centrally located.

The valve seat shall be of synthetic material suitable for water duty. It should be field replaceable.

The disc should move in slide bearings on both ends with `O' ring to prevent leakage.

The handle should have arrangement for locking in any set position. Valves 200 mm dia size and above shall be worm gear operated.

The valve shall be design for pressure rating of 16 bar & tested for 1.5 times higher pressure for body & 1.1 time's high for seat.



Material Specification –

Style	:Wafer Design
Body	: Cast Steel to ASTM A 216 Gr WCB
Disc	: ASTM A 351 Gr. CF8M (SS316)
Disc Coating	: No Coated
Body Liner (Seal)	: BunaN Integrally Moulded (Temp Range 57 Deg. C to 120 Deg. C)
Stem Material	: SS316
'O' Ring	: BunaN
Shaft Bushing	: Glass Field Nylon
Shaft Disc Pin	: SS316
Operator	: Hand Lever upto 150mm N.B. and Gear Operated200mm and above.
Flange Connection	: ASME B 16.5

BALANCING VALVES

These valves shall have built in pressure drop measuring facility to compute flow rate across the valve.

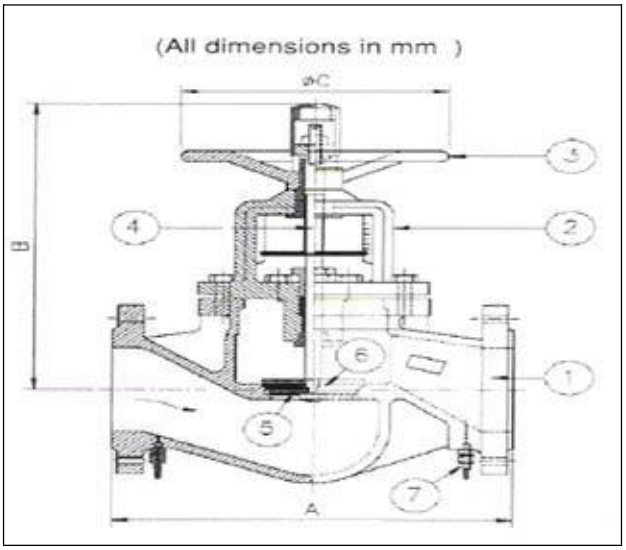
The test cocks shall be long enough to protrude out of pipe insulation.

To measure flow rate, differential pressure will be measured with calibrated instruments – Digital or Mercury Manometer. Balancing Tools shall have a programmed to provide the following functions:

- To balance the HVAC installation and calculate the necessary valve settings based on
  the systems data as observed prior to balancing exercise.
- To log measured values from a valve (differential pressure and flow rate)

To store the results of balancing
- Presetting position of Balancing Valves
- Design Flow for each Balancing Valves
- Flow at Balancing Valves
- Flow Ratio pre balancing based on actual flow / design flow
- Flow Ratio post balancing and Actual Flow

5.1.4 The valve shall be design for pressure rating of 16 bar & tested for 1.5 times higher pressure for body & 1.1 time's high for seat.



Material Specification –

Valves 25mm to 50mm (End Construction)

Style	: Globe Type BSP Threaded Screwed End Construction
Body	: IS 318 LTB 2 (Gun Metal)

Bonnet : 25mm n brass and 32 mm to 50mm in IS 318 LTB 2 (Gun Metal)Plug : IS 318 LTB 2 (Gun Metal) / Brass IS 319
Stem : IS 319 TypeI (Brass)
Temperature : 46 Degree C to 200 Degree C
Gland Nut : Brass
Hand Wheel : Nylon Gr. 66Pressure Test
Cocks : Brass

Valves 65 mm to 300mm (Cast Iron Flanged End Construction)

Style : Globe Type Flanged End Construction
Body : Ductile (SG) Iron to IS 1865 Gr. 450/10/ Cast Steel
Bonnet : Ductile (SG) Iron to IS 1865 Gr. 450/10
Hand Wheel : M S Fabricated.
Stem : SS316
Disc : SS316
Sealing Disc : BunaN
Temp Range 40 Deg. C to 120 Deg. C)
Pressure Test Cocks : Steel Chrome Plated End Connection: IS : IS 6392 Table 17

All valves shall be tested for flow vs. pressure drop within + 5% accuracy and data be furnished as part of Test Certificate.

Valves Size 350mm to 1000mm

Body : Cast Steel to ASTM A 216 Gr. WCB
Disc : ASTM A 351 Gr. CF8M (SS316)
Seal : BunaN elastomer
Stem : SS316
Trim : SS316 (CF8M)
Measuring Ring: SS316 (CF8M)
Worm : SS 410

Wafer Type Dual Plate Check Valves

Dual Plate Check Valves (Wafer Type) with spring loaded as per API 594. Inspection and testing conforms to API 598.
The detailed material of construction as given below: Style : Wafer Design
Body : Cast Steel to ASTM A 216 Gr WCB
Plates : ASTM A 351 Gr. CF8M (SS316)
Plate Coating : Integrally
Body Lining : BunaN / Nitrile (Temp. Range 57 Deg. C to 120 Deg. C)
Hinge/Stop Pin : AISI SS316
Spring(s) : SS316
Retainer : Carbon Steel

Body Bearing	: AISI SS316
Plate Bearing	: AISI SS316
Spring Bearing	: AISI SS316
End Connection	: ASTM A 16.5

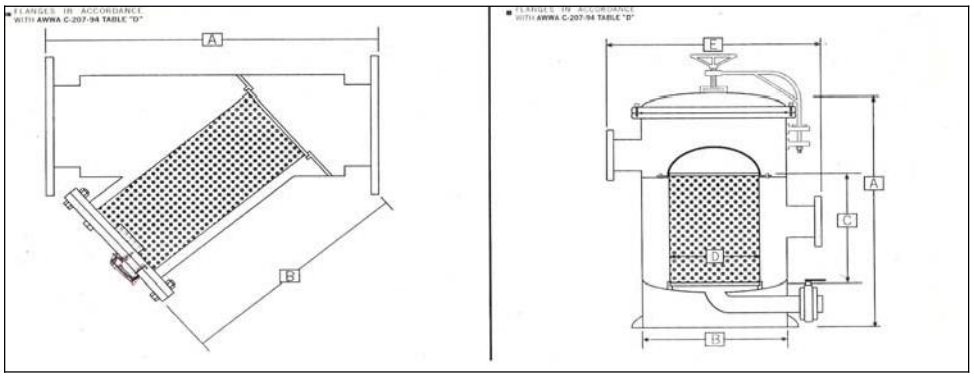
STRAINERS

The strainers shall either be pot type or Y type. Body shall be cast steel for y strainer & mild steel for Pot type strainer, tested up to pressure applicable for the butterfly valves.

The strainers shall have a perforated stainless steel sheet screen with 3 mm perforation and with a permanent magnet, to catch iron fillings. The filtration area should not be less than 75 %.

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

The strainers shall be designed to facilitate in easy removal of filter screen for cleaning, without disconnection of pipe line.



Material of Construction:

POT Strainer

Body	: Mild Steel (IS: 2062 Gr.A)
Bonnet	: Cast Steel
Basket (Filter Screen)	: SS316
Body Cover Gaskets	: Rubber Gaskets / Compressed
Asbestos Drain Plug	: Stainless Steel 410
End Connection	: Flanged

Y Strainer

Body	: Cast Steel
Bonnet	: Cast Steel
Basket (Filter Screen)	: SS316
Body Cover Gaskets	: Rubber Gaskets / Compressed
Asbestos Drain Plug	: Stainless Steel 410
End Connection	: Flanged

BALL VALVES:

All ball valves shall be forged brass body construction with chrome plated with the pressure rating PN 16 as per schedule of quantity and handle of stainless steel constructions & shall be covered with Plastic material. End connections of ball valve to be screwed type & shall be applicable for 15mm to 40mm in dia. The ball valve shall be coated with two coats of zinc chromate paint (LOW VOC) for its antirust properties and then shall be finally painted with epoxy paint of required colour including all fittings like valves, flanges & unions. The valves used for both HW and CHW application shall be covered with insulation(CFC,HCFC FREE)/lag coating/glass cloth as specified in schedule of quantity. The Adhesive used for shall be of low volatile organic compound. Pressure testing of valves shall be done at manufacturer's works. The contractor shall furnish material test certificates of various components of the valve & performance test certificates carried out by manufacturer

RUBBER EXPANSION JOINT

The rubber expansion joint should be of rubber with elastic properties textile reinforcements and integrated with alienable floating steel flanges to provide a flexible pipe joint. The flange should be powder coated.

The rubber bellow should be with following properties;

- Compensates for axial movements due to thermal changes & misalignment.
- Compensates for lateral, torsional and angular movements.
- Isolates vibrations, dampens noise and pressure surges.
- Suitable for suction and discharge.
- Higher flexibility & lower stiffness.
- 100% EPDM for longer life.

The flexible joints should be factory tested for pressure & vacuum. Before installation the proper selection of expansion joints as per the pipe dia should be done.

Full Way Type Screwed End Ball Valves

Material Specification –

Ball	Brass with Diamond Polished and Chrome Plated
Spindle	Brass
Stuffing Box	Brass
Lever	Galvanized Steel PVCGrip with"Pad Printing" asper EN13828
O Ring	2 x NBR PTFE Seal

The ball valve with strainer of nominal bores between 15mm and 40mm shall be sup plied with 316 stainless steel screen.

JOINTING

All pipe lines shall be welded type.

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

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

MISCELLANEOUS

Providing all piping, required to make the apparatus connected, complete and ready for regular and safe operation, unless otherwise noted, connect all apparatus and equipment in accordance with manufacturer's standard details, as approved by Engineer in Charge.
Consult drawings and specifications to determine number and requirements of all items of equipment, requiring piping, such as bend, drain, relief etc., wherever equipment is provided with connections for such piping.

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

All condensation drainage, including air handling unit and fan coil unit shall be pitched in the direction of flow to ensure adequate drainage, with an adequate trap seal to prevent leakage of air due to static pressure developed by air conditioning units. Pitch, 20mm per meter wherever possible, but not less than 10mm/ meter. Drains from other equipment shall be pitched similarly without trap seal.

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

During construction, temporarily close, open ends of pipes with sheet metal caps, where necessary, or required to prevent debris from entering piping system.

Support piping independently of all equipment so that the equipment is not stressed by the piping weight or expansion.

To facilitate the maintenance, repair and replacement;

Unions, if used, shall be flanged, as required, where indicated and in connections to all equipment’s, apparatus and specialties requiring disconnection for repairs or replacement. Locate unions between shutoff valves and equipment as directed by Engineer in charge.

Provide shutoff valves where indicated and for individual equipment, units at inlet and outlet, to permit unit removal for repairs, without interfering with the remainder of the system. Additional shutoff valves shall be provided as required to enable all systems to be fully sectionalized. Bypass and stop valves shall be provided for all automatic control valves as specified.

Arrange piping for maximum accessibility for maintenance and repair. Locate valves for easy access and operation. No valves shall be installed with handles pointing down, unless unavoidable.

Cut the pipes accurately according to measurements, established at building and work into place without springing or forging.

Pipe supports shall be adjustable for height and primer coated with rust preventive paint and finish coated with gray paint, both as approved by department spacing of pipe supports shall not be more than that of specified below :

Hanger Spacing (M)		
Pipe size	**Standard Steel Duty**	**Min Rod/Angle**
20	1.5	10
25	1.5	10
40	2.4	10
50	3.0	10
65	3.0	10
80	3.0	12
100	3.0	12
150	3.0	12
200	3.0	16 / Angle Iron
250	3.0	16 / Angle Iron
300	3.0	16 / Angle Iron
350	3.0	Floor Support
400	3.0	Floor Support
450	3.0	Floor Support
500	5.0	Floor Support

Extra supports shall be provided at the bends and at heavy fittings like valves to avoid undue stresses on the pipes. Pipe hangers shall be fixed on walls and ceiling by means of metallic approved dash fasteners.

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

Where pipes are to be buried under ground, they should be coated with one coat of bituminous paint without any extra charge. The top of the pipes shall not be less than 75 cms. from the ground level. Where this is not practical permission of department shall be obtained for burying the pipes at lesser depth. The pipes shall be surrounded on all sides by sand cushions of not less than 15 cms. After the pipes have been laid and top sand cushions provided, the trench shall be refilled with the excavated soil. Excess soil shall be removed from the site of work by the contractor.

HANGERS & SUPPORTS

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

All hangers and supports shall be made of steel and painted as required. Wood, wire or perforated strap iron shall not be used as permanent hangers or supports.

Hangers shall be supported from structural steel, concrete inserts and pipe racks, specifically approved.

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

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

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

SLEEVES

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

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

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

Floor sleeves shall project 50mm above finished floor level.

EXPANSION OR CONTRACTION

The contractor shall provide for expansion and contraction of all piping

installed by the use of expansion loops.

ARRANGEMENT AND ALIGNMENT OF PIPING

All piping shall be arranged and aligned in accordance with the drawings as specified. Where special conditions are encountered in the field, the arrangement and alignment of piping shall be as directed by the Engineer in Charge.

The piping shall be installed in a uniform manner, parallel to or perpendicular to walls or ceilings, and all changes in directions shall be made with fittings. The horizontal piping shall be run at right angles and shall not run diagonally across rooms or other piping. Wherever possible all piping shall be arranged to provide maximum head room.

All piping shall be installed as directly as possible between connecting points in so far as the work of other trades permits. Where interference occurs with another trade whose work is more difficult to route, this contractor shall reroute his pipes as required to avoid interference, at the discretion of the Engineer in Charge.

All piping shall be carefully installed to provide for proper alignment, slope and expansion.

The stresses in pipe lines shall be guided and pipes shall be supported in such a manner that pipe lines shall not creep, sag or buckle.

Anchors and supports shall be provided wherever necessary to prevent any misalignment of piping.

Small tubing gauges, controls or other equipment installed on any apparatus, shall not be coiled nor excessive in length, but shall be installed neatly, carefully bent at all changes in direction, secured in place and properly fastened to equipment at intervals to prevent sagging.

The piping shall be grouped wherever practical and shall be installed uniformly in straight parallel lines in either vertical or horizontal positions.

TESTING

In general, tests shall be applied to piping before connection of equipment and appliances. In no case shall piping equipment or appliances be subjected to pressures exceeding their test ratings.

The tests shall be completed and approved before any insulation is applied. Testing of segments of pipe work will be permitted, provided all open ends are first closed, by blank offs or flanges.

After tests have been completed the system shall be drained and flushed 3 to 4 times and cleaned of all dust and foreign matter. All strainers, valves and fittings shall be cleaned of all dirt, fillings and debris.

All piping shall be tested to hydraulic test pressure of at least one and half times the maximum operating pressure for a period of not less than 24 hours. All leaks and defects in the joints revealed during the testing shall be rectified to the satisfaction of the Engineer in charge without any extra cost. All the valves shall be tested to hydraulic test pressure of at least one and half times the maximum design operating pressure.

All the piping systems shall be tested in the presence of the department or his authorized representative. Advance notice of test dates shall be given and all equipment's, labour, materials required for inspection, and repairs during the test shall be provided by the contractor. A test shall be repeated till the entire systems are found satisfactory by the above authority. The tests shall be carried out for a part of work if required by department in order to avoid hindrance in the work of the insulation contractor.

The contractor shall make sure that proper noiseless circulation is achieved through all piping systems. If due to poor air bond, proper circulation is not achieved, the contractor shall bear all expenses for carrying out the rectification work including finishing of floors, walls and ceiling damaged in the process of rectifications.

The contractor shall provide all labours and materials to make provision for removing water and throwing it at the proper place during the testing or/and after the testing to avoid damages to employer or other contractor's properties. Any damages caused by the contractor to the employer or other contractors properties, shall be borne by the contractor.

COPPER PIPING (Wherever required)

Heavy gauge soft copper tubing, type M shall be used to make connections to equipment, wherever required or specified by Engineer in Charge.

Flare fittings e.g. flare nuts, tees, elbows, reducers etc. shall all be of brass.

DRAIN PIPING

The drain piping shall be medium class Hot dipped galvanized steel as per IS 1239/1979 with up to date amendments.

Rigid PVC pipes may be used for drain pipe. (Option only for single story building)

The fittings shall be of `R' brand forged with screwed connections.

The gate valves shall be of gun metal as described earlier.

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

The drain line shall be provided up to the nearest drain trap and pitched towards the trap.

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

The pipes shall be laid in proper slope for efficient drainage of condensate water. A downward gradient of atleast 1/100 will be provided for the drain piping.

For proper drainage of condensate, U Trap shall be provided in the drain piping (wherever required). All pipe supports shall be of prefabricated & pre painted slot ted angle supports, properly installed with clamps etc.

The main drain pipe should be connected to the vertical drain pipe through a Yjoint or Tjoint. A vent pipe should be installed at the top of the vertical to improve the drain water flow. Vent pipe should be provided with insect screen. Cost for these accessories is deemed to be included in the rates quoted by the tenderer.

PAINTING

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

All pipes, which are not to be insulated, shall then be given two coats of finish paint, of a type and colour, as approved by the Engineer in Charge.

CONTROLS VALVE AND ACCESSORIES

2-WAY PRESSURE INDEPENDENT BALANCING AND CONTROL VALVE (MOTORIZED) :

For AHUs:

2 way motorized shall be of MODULATING valve of PN16 rating as mentioned in schedule of quantity and complete with motor actuator of suitable torque & control power wiring from individual thermostat at Return air path of each AHU to each related actuator of 2 way valve with controller & its related wiring (including step down transformer and required accessories with internal wiring for converting 220volt AC single phase power up to 10 volt DC or as required for modulation of 2way control valve actuator- the same arrangement to be inbuilt in controller panel only which are in other scope). The valve should be IEC

534 compliant, have 20 mm stroke and insulated.
The valve shall be coated with two coats of zinc chromate paint (LOW VOC) for its anti-rust properties and then shall be finally painted with epoxy paint of required colour including all fittings like valves, flanges & unions. The valves used for both HW and CHW application shall be covered with insulation (CFC,HCFC FREE)/lag coating/glass cloth as specified in schedule of quantity. The Adhesive used for shall be of low volatile organic compound.

In case BMS is provided in the building then, only the valve with actuator shall be in the scope of HVAC vendor and rest of all control and power wiring and sensors etc. shall be excluded from HVAC vendor scope.

For FCUs:

2 way motorized shall be of on/off type valve and operated on 230 volts and of PN rating as mentioned in schedule of quantity complete with motor actuator of suitable torque & control power wiring from individual thermostat of each FCU to each related actuator of 2 way valve with controller & its related wiring. The valve should be IEC 534 compliant, have 20 mm stroke and insulated as suitable.
In case of BMS is provided in the building then only valve with actuator shall be in the scope of HVAC vendor and rest of all control and power wiring and sensors etc. shall be excluded from HVAC vendor scope.

Temperature Gauges (Dial type)

Temperature gauges of 4"dia. with stainless steel SS-304 bulb and thermowell shall be used, the length of the thermowell shall be in accordance to the condenser water pipe diameter. The temperature gauge should in range of 0-50 Deg.C & it's to be filled will red oil liquid. Gauges shall be suitable for 15mm connection and for condenser line they shall have long stem.

Water Pressure Gauges (Dial Type)

Water pressure gauges 4"dia. made out of stainless steel SS-304 all parts are made from copper alloy and stainless steel to prevent from corrosion attack. Dial shall be in white colour and number shall be in the black and red colour for the visibility, gauges shall have 'A' stainless steel 'U' tube of 6mm dia. x 400mm in length both side threaded with stainless steel nut, A pet cock along with SS syphon tubing shall be provided at one end of tube for protecting gauge during testing of system

Flow Switches

Sockets or necessary arrangements to be made by HVAC Contractor for bellow type flow switches shall be provided in condensing water outlet and chilled water outlet at the water chilling machines, and at the water

cooled condensing units for refrigeration load. The flow switch shall prevent the compressor from starting unless the water flow is established in condensing water lines, and chilled water flow is established chilled water lines.

ULTRASONIC FLOW METER:

Water flow meters shall be Ultrasonic type of PN16 rating. Ultrasonic Inline Flow Meter shall be suitable to be installed in Chilled Water Return line to each chiller with necessary fittings and isolation valves etc. The valve shall be suitable for integration with Chiller Plant Manager /Variable Primary Pump Logic Controller. The precision of flow measurement shall not be lower than +/- 2%.

The housing shall have IP 55 protection. Vendors shall have to get their design/ selection approved by the Consultant, prior to the supply.
The exact ranges to be set shall be determined by the contractor at the time of commissioning. It should be possible to 'zero' the flow meter without any external instruments.
The stem shall be coated with two coats of zinc chromate paint (LOW VOC) for its antirust properties and then shall be finally painted with epoxy paint of required colour including all fittings like valves, flanges & unions. Also the stem shall be covered with insulation (CFC & HCFC FREE)/lag coating/glass cloth as specified in schedule of quantity. The Adhesive used for shall be of low volatile organic compound.
The contractor shall furnish material test certificates of various components of the valve & performance test certificates carried out by manufacturer.

Motorized Butterfly Valves with actuator
ON/OFF Motorized butterfly valve & Actuator

Motorized valve for chillers, Chilled water piping shall be 2 position ON/OFF type Butterfly valve with standard train. The valve shall be controlled by an electric actuator mounted directly on the valve. The actuator shall have a reversible synchronous motor and generate the desired stoke by gear train. It shall be suitable for hook up to any major BMS.

The valve & Actuator shall comprise & suitable as follows:

- The valve should be able to operate at 0...95 ^{o}C working temperature.
- The design pressure of the valve shall be PN16 rating & body shall be tested at 1.5 times & seat shall be 1.1 time's higher than the design pressure.
- Leakage rate through the valve disc should be Rate A Bubble tight to EN122661.
- The valve seat should be ball profile style which eliminates elastomer movement and reduces seat ring tearing or fatiguing due to bunching.
- The valve should comprise of a double seal construction to prevent

media coming into the valve.

- The gearbox of the actuator should comprise of hardened planetary gears. The gear drive mechanism should provide efficient, smooth operation while allowing easy manual override at any time.
- There should be a provision of hand wheel or lever to operate the valve manually.
- There should be a provision of two stop screws for limiting the manual operation of actuator.
- Valves & actuator should be supplied with IP54 protection rated (for indoor application) and with IP67 protection rated actuators (for outdoor application).
- Two position or open/closed actuators shall accept 24 V AC/DC or 230V AC power supply and should be UL listed. Butterfly isolation and other valves, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop the associated pump or chiller.

- The actuators of motorized butterfly valve shall be BMS compatible.

- The disc should be nylon coated to offer a good corrosion resistance, superior resistance to a broad range of chemical environments as well as very low coefficient of friction and excellent resistance to impact and ultraviolet radiation. For higher temperatures and rust proof operations.

- The valve body should be according to ISO 5211 actuator mounting and shaft connection standards.

- The valve should have a square stem head for form fit attachment of the Rotary actuator.

- The butterfly valve shall be operated by rotary electric actuator for maintenance free application.

- The material of construction should be:

Valve Body : Cast Steel to ASTM A 216 Gr WCB

Disc : ASTM A 351 Gr. CF8M (SS316)

Seat : EPDM seat ring
Stem : Stainless steel 416

Body Liner (Seal) : BunaN Integrally Moulded (Temp Range 57 °C

to 120°C)'O' Ring : BunaN

Shaft Bushing	: Glass Field Nylon
Shaft Disc Pin	: SS316
Flange Connection	: ASME B 16.5

16 AIR DISTRIBUTION WORKS

General

The work under this part shall consist of furnishing labour materials, equipment and appliances as specified necessary and required to install all sheet metal and other allied work to make the air conditioning supply, ventilating, and exhaust system ready for operation as per drawings.

Duct Design Parameters: (Air Conditioning & Ventilation)

Maximum Velocity	Maximum Friction Rate
1350 to 1800 FPM	0.1 inch WG/100 Ft.

Duct Design Parameters: (For Fire mode application)

Maximum Velocity	
2500 FPM	

Rectangular Duct Work

The ducts shall be fabricated from galvanized steel sheets class VIII conforming to ISS: 2772003 (revised).

The steel sheets shall be hot dip galvanized with coating of minimum 220 GSM of Zinc (Total coating on both sides)

All duct work, sheet metal thickness and fabrication unless otherwise directed, shall strictly meet requirements as described SMACNA standard for factory fabricated duct. The minimum thickness of fabricated GSS duct shall be 24 G & for Al 22 G.

Raw Material

All ducting shall be fabricated of LFQ (Lock Forming Quality) grade prime G.I. raw material furnished with accompanying Mill test Certificates.

In addition, if deemed necessary, samples of raw material, selected at random by client's site representative shall be subject to approval and tested for thickness and zinc coating at con tractor's expense.

The G.I. raw material should be used in coilform (instead of sheets) so as to limit the longitudinal joints at the edges only irrespective of cross section dimensions.

Duct Connectors and Accessories

All transverse duct connectors (flanges/cleats) and accessories/related hardware are such as support system shall be zinc coated (galvanized).

Fabrication Standards

All ductwork including straight sections, tapers, elbows, branches, show pieces, collars, terminal boxes and other transformation pieces must be factory fabricated. Equivalency will require fabrication by utilizing the following machines and processes to provide the requisite equality of ducts and speed of supply.

Coil lines to ensure location of longitudinal seams at comes/folded edges only to obtain the required duct rigidity and low leakage characteristics. No longitudinal seams permitted along any face side of the duct.

All ducts, transformation pieces and fittings to be made on CNC profile cutlers for required accuracy of dimensions, location and dimensions of notches at the folding lines.

All edges to be machine treated using lock formers, flanges and roller for fuming up edges.

Sealant dispensing equipment for applying built in sealant in Pittsburgh lock where sealing of longitudinal joints are specified.

Selection of G.I. Gauge and Transverse Connectors

All transverse connectors shall be the 4bolt slipon flange system with built in sealant if any to avoid any leakage additional sealant to be used.

The specific class of transverse connector and duct gauge for a given duct dimensions will be up to 2" (500 pa) low pressure class. If required, Specific ventilation duct may as per medium pressure class.

Nontoxic, AC applications grade P.E. or PVC casketing is required between all mating flanged joints. Gasket sizes should conform to flange manufacturer's specification.

Duct Construction

The fabricated duct dimensions should be as per approved drawings and all connecting sections are dimensionally matched to avoid any gaps.

Dimensional Tolerances: All fabricated dimensions will be within ± 1.0 mm of specified dimension. To obtain required perpendicularity, permissible diagonal tolerances shall be ± 1.0 mm per meter.

Ducts shall be straight and smooth on the inside Longitudinal seams

shall be airtight and at corners only, which shall be either Pittsburgh or Snap Button Punch to ensure air tightness.

Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Turning vanes or air splitters shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.

Plenums shall be shop/factory fabricated panel type and assembled at site.

Changes in section of ductwork shall be affected by tapering the ducts with as long a taper as possible but not less than 600mm. All branches shall be taken off at not more than 45^0. Branch shoe shall be provided in each branch section. Angle from the axis of the main duct unless otherwise approved by the Engineer In Charge.

All ducts shall be supported from the ceiling/slab by means of M.S. Rods of 10 mm (3/8") DIA with M.S. Angle at the bottom up to 2200 mm size & 12 mm for above 2200 mm size. The rods shall be anchored to R.C. Slab using metallic expansion fasteners.

All nuts, bolts and washers shall be zinc plated steel. All rivets shall be galvanized or shall be made of magnesium aluminum alloy.

MISCELLANEOUS

- All ducts above 450mm are to be cross broken to provide rigidity to the ducts.
- All duct work joints are to be true right angle or approaching with all sharp edges re moved.
- Sponge rubber gaskets also to be provided behind the flange of all grilles.
- Each shoot from the duct, leading to a grille, shall be provided with an air deflector to divert the air into the grills through the shoot.
- Inspection doors measuring at least 450mm x 450mm are to be provided in each system at an appropriate location, as directed by Engineer in Charge.
- Diverting vanes must be provided at the bends exceeding 600mm and at branches connected into the main duct without a neck.
- Proper hangers and supports should be provided to hold the duct rigidly, to keep them straight and to avoid vibrations. Additional supports are to be provided where required for rigidity or as directed by

Engineer in Charge.

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

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

- All duct supports, flanges, hangers and damper boxes etc. shall be given 2 coats of red oxide paint before installation and one coat of aluminum paint after the erection, at no extra cost.

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

- All the angle iron flanges to be connected to the G.S.S. ducts by rivets at 100mm centers.

- All the flanged joints, to have a 4mm thick felt packing stack to the flanges with shellac varnish. The holes in the felt packing are to be burnt through.

- The G.S.S. ducts should be lapped 6mm across the flanges.

- Sheet metal connection pieces, partitions and plenums required, shall be constructed of
  - 1.25 (18 gauge) sheet thoroughly stiffened with 40mm x 40mm x 6mm angle iron braces and fitted with access doors.

TRANSFORMATION

Duct transformation shall be made with a side slope of 10mm to 70mm. However, if the duct Cross section area need to be reduced, a maximum reduction of 20% of the original area shall be allowable.

CIRCULAR DUCT WORK

The exposed type duct shall be double skin type spiral round metal ducts in low pressure range. The ducting shall comply with NFPA 90A1989, "Standard for the Installation of Air Conditioning and Ventilating Systems".

The contractor is required to submit all Product data including details of construction materials, dimensions of individual components, profiles, and finishes for duct, sealing materials, and fires topping materials in addition to the Shop drawings detailing Plans, elevations, sections, details of components, and attachments to duct work. Duct layout, indicating pressure classifications and sizes in plain view. Details of Fittings, Reinforcement and spacing. Seam and joint construction details. Penetrations through fire rated and other partitions.

Fabrication: "Basic Round Diameter" as used in this article is the diameter of the size of round duct that has a circumference equal to the perimeter of a given sized of flat oval duct. Except where interrupted by fittings, provide round and flat oval ducts in lengths not less than 12 feet. Ducts shall be fabricated with standard spiral lock seams (without intermediate ribs) or with butt welded longitudinal seams in gauges listed in SMACNA "HVAC Duct Construction Standards", Table 34. The flat oval ducts shall be sandwich type with 19mm thick cross linked poly ethylene insulation between 2 layers of ducts.

Fittings: Following fittings shall be used.

90Degree Tees and Laterals and Conical Tees: Fabricated to conform to SMACNA "HVAC Duct Construction Standards", 1985 Edition, Figures 34 and 35 and with metal thicknesses specified for longitudinal seam straight duct.

Diverging Flow Fittings: Fabricated with a reduced entrance to branch taps with no excess material projecting from the body onto branch tap entrance.

Elbows: Fabricated in die-formed, gored, pleated, or mitered construction. The bend radius of die-formed, gored, and pleated elbows should be 1.5 times the elbow diameter. Unless elbow construction type is indicated, provide elbows meeting the following requirements:

Mitered Elbows: Fabricated mitered elbows with welded construction in gauges specified below shall be provided. Unless otherwise indicated, the elbow shall comply with SMACNA "HVAC Duct Construction Standards", Table 31.

Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from minus 2 inches to plus 2 inches. The entire duct shall be fabricated as per SMACNA standard.

Flat Oval Mitered Elbows: The elbows shall be solid welded and with the same metal thickness as longitudinal seam flat oval duct. 90Degree, 2Piece, Mitered Elbows shall be used for supply systems, or exhaust systems only where space restrictions do not permit the use of 1.5 bend radius elbows. These will be fabricated with single thickness turning vanes.

Round Elbows for duct sizes 8 Inches and Smaller shall be Die-formed for 45 and 90degree elbows and pleated for 30, 60, and 90 degrees only. Fabricated nonstandard bend angle con figurations or 1/2" diameter (e.g. 31/2 and 41/2inch) elbows shall be with gored construction. Round Elbows for sizes 9 Through 14 Inches shall be gored or pleated elbows for 30, 45, 60, and 90 degrees, except where space restrictions require a mitered elbow.

Fabricated nonstandard bend angle configurations or 1/2" diameter (e.g. 91/2 and 101/2inch) elbows shall be with gored construction. Round Elbows larger than 14 Inches and All Flat Oval Elbows shall be Gored elbows, except where space restrictions require a mitered elbow.

Die Formed Elbows for Sizes through 8 Inches and All Pressures shall be minimum 20 gauge with 2piece welded construction. Round Gored Elbows shall be fabricated out of the gauges as specified for non-elbow fittings above. For Flat Oval Elbows the gauges shall be same of the longitudinal seam flat oval duct.

The ducts shall be Installed with the fewest possible joints. Fabricated fittings for all changes in directions, changes in size and shape, and connections shall be used. The couplings shall be secured tightly to duct wall surface with projections into duct at connections shall be kept to a minimum. Ducts shall be running, except as otherwise indicated, vertically and horizon tally, parallel and perpendicular to building lines and shall avoid diagonal runs. There shall be a clearance of 1 inch where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any.

The flat oval ducts shall be supported with support systems as indicated in SMACNA "HVAC Duct Construction Standards", tables 41 through 43 and Figures 41 through 48. The support for horizontal ducts shall be within 2' of each elbow and within 4' of each branch inter section. Support for vertical ducts shall be at a maximum interval of 16' and at each floor. All connections to and from the duct to the equipment, air terminals and branches etc. shall be as recommended by SMACNA "HVAC Duct Construction Standards", Figures 27 to 219.

TAKEOFF

All branch takeoff and collars shall be provided with turning vanes. Straightening vanes shall be provided in the collars.

DAMPERS & SPLITTERS

Butterfly Dampers shall be provided in the duct work for proper control and balancing of air distribution. Dampers shall of louver type of robust connection. Dampers shall have easily accessible operating mechanism. The operating mechanism shall consist of links, levers and quadrants as required for proper control and setting in a desired position. The position of the handle of damper operating mechanism shall be clearly visible and it shall indicate the position of the damper in the duct. Dampers, splitters and their operating mechanism shall be fabricated of GS sheets of two gauges heavier then duct piece having these fittings and shall be easily accessible through suitable access doors in the ducts.

Dampers shall be installed in duct at all required locations such as chutes, branches etc.

INSTALLATIONS

- During the construction, the contractor shall temporarily close duct openings with sheet metal covers to prevent debris entering ducts and to maintain opening straight and square, as per direction of Engineer In Charge.

- All duct work shall be of high quality approved galvanized sheet steel with at least 180 GSM coating of galvanization and guaranteed not to crack or peel on bending or fabrication of ducts. All joints shall be air tight and shall be made in the direction of air flow.

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

- All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration.

- The duct work shall be varied in shape and position to fit actual conditions at building site. All changes shall be subjected to the approval of the Engineer In Charge. The con tractor shall verify all measurements at site and shall notify the Engineer In Charge of any difficulty in carrying out his work before fabrication.

- Joints, seams, sleeves, splitters, branches, takeoffs and supports are to be as per duct details as specified, or as decided by Engineer In Charge.

- Joints requiring bolting or riveting may be fixed by Hexagon nuts and bolts, stove bolts or buck bolts, rivets or closed center top rivets or spot welding. Self-tapping screws must not be used. All jointing material must have a finish such as cadmium plating or Galvanized as appropriate.

- Fires retarding flexible joints are to be fitted to the delivery of all fans. The material is to be normally double heavy canvass.

- The flexible joints are to be not less than 75 mm and not more than 200 mm between faces.

- The duct work should be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling contractors.

- Duct passing through brick or masonry, wooden frame work shall be provided within the opening. Crossing duct shall have heavy

flanges, collars on each side of wooden frame to make the duct leak proof.

ACCESS PANEL

- A hinged and gasket access panel shall be provided on duct work before each control device that may be located inside the duct work.

MISCELLANEOUS

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

- All duct work joints are to be true right angle or approaching with all sharp edges re moved.

- Each shoot from the duct, leading to a grille, shall be provided with an air deflector to divert the air into the grills through the shoot.

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

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

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

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

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

- All duct supports, flanges, hangers and damper boxes etc. shall be given 2 coats of red oxide paint before installation and one coat of aluminum paint after the erection, at no extra cost.

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

- All the angle iron flanges to be connected to the G.S.S. ducts by rivets at 100mm centers.

- All the flanged joints, to have a 4mm thick felt packing stack to the flanges. The holes in the felt packing are to be burnt through.

- The G.S.S. ducts should be lapped 6mm across the flanges.

- The entire air distribution system shall be balance with the help of an anemometer. The measured air quantities at fan discharge and the various outlets should be within range of +5 %.

VOLUME CONTROL DAMPERS

- At the junction of each branch duct with main duct and split of main duct, volume dampers must be provided.

- Dampers shall be two gauges heavier than gauge of the large duct, and shall be rigid in construction to the passage of air.

- The volume dampers shall be of an approved type, lever operated and complete with locking devices which will permit the dampers to be adjusted and locked in any positions.

- The dampers shall be of splitter, butterfly or louver type. The damper blade shall not be less than 1.25mm (18 gauge); reinforced with 25mm angles 3mm thick along any unsupported side longer than 250mm. Angles shall not interfere with the operation of dampers, nor cause any turbulence.

- Automatic and manual volume opposed blade dampers shall be complete with frames and bronze bearings as per drawings, dampers frames shall be constructed of 1.5mm steel and blades shall not be over 225mm wide.

- The dampers for fresh air inlet shall additionally be provided with fly mesh screen, on the outside, of 0.8mm thickness with fine mesh spacing.

- Wherever required for system balancing, provide a volume balancing opposed blade damper with quadrant and thumb screw lock. Provide damper rod and damper block with upset screws.

- After completion of the duct work, dampers are to be adjusted and set to deliver the required amounts of air as specified on the drawings.

FIRE CUM SMOKE MOTORIZED DAMPER

- The fire dampers shall be made from heavy gauge galvanized steel in multi plate construction. The damper shall be provided with Jam seal (compression type) on sites to prevent spread of smoke

and fire. Dampers shall meet the requirements of the latest edition of NFPA 90A, 92A, and 92B.

- Fire dampers shall be provided in supply air ducts and return air duct (wherever provided), return air passage in the air handling unit's room and all floor crossings.

- Fire dampers shall be multi blade type. The blade remains in the air stream in open position& shall allow maximum free area to reduce pressure drop & noise in the air passage. The blade & frame shall be constructed with minimum 1.6 mm thick galvanized sheet & shall be factory fitted in a sleeve made out of 1.6 mm galvanized sheet of minimum 400 mm long. It shall be complete with locking device, motorized actuator & control panel.

- The motorized damper shall activate on a signal or either an electronic thermal sensor UL stamped mounted in the air stream or from the smoke detector system. The fire dampers and smoke detectors are to be installed in supply air duct & return air duct.

- The dampers shall be equipped with a well-designed control panel, using high components which consume less power. It shall operate at 24 volts obtained through a step down transformer or suitable for 240 V AC supply. The panel is protected against surge currents or short circuits through a Fuse connected on the PCB. The panel shall have an optional power supply of 24 V AC. The control panel shall be well protected against wrong switching.

- All fire cum smoke damper shall be CBRI tested & certified for 90-minute rating against flame penetration as per UL standard 5551995. Each damper shall be equipped with a factory installed UL approved damper actuator.

- Dampers shall have a Leakage rating of Class I and a Temperature rating of 350 F as per UL555S. Damper actuators shall be factory mounted and qualified for use with the damper in accordance with UL555S.

- Necessary wiring from fire alarm panel up to AHU electrical panel shall be provided by concerned department & from AHU panel to fire damper shall be provided by HVAC contractor.

- Each damper shall be provided with its own control panel. This control panel shall be suited for spring return actuator & shall have at least the following features:

Potential free contacts for AHU On / Off & remote alarm indication.
Accept signal from external smoke / fire detection system for tripping the actuator.
Test & reset facility.

GRILLES

The supply and return air grilles shall be fabricated from aluminum extruded sections. The supply air grilles shall have single louvers (which shall be used for air conditioning) & ventilation grille shall be of double louvers. The front horizontal louvers shall be of extruded section, fixed type. The rear vertical louvers shall of aluminum sheet and adjustable type. The return air grille shall have single horizontal extended section fixed louvers. The grilles may or may not be with an outer frame.

The aluminum grilles shall have opposed blade dampers of black anodized extruded aluminum sections, which shall be key operated from the grille face wherever required.

The adjustable grille louvers shall be fabricated from extruded aluminum sections. The damper blades shall be of black anodized extruded aluminum sections and shaped to form air tight joints. Grills longer than 450mm shall have intermediate sup ports for the horizontal louvers.

DIFFUSERS

The ceiling type round or square diffusers shall be of extruded aluminum sections with anti-smudge ring to prevent dust collection on ceiling around the diffusers.

The diffusers shall be die formed for proper air diffusion & shall have removable inner core.

All supply diffusers shall be provided with extruded aluminum dampers, with knobs for adjustment from the bottom.

VAQ Station

All the VAQ (Variable Air Quality) Station shall be Pressure Independent type with Direct Digital Controls to regulate and monitor the primary air flow rate between the scheduled minimum and maximum values to achieve the specified comfort level and ventilation rates within acceptable noise criteria.

The VAQ Station shall control air to provide desired zone temperature, and required minimum volume of outdoor air for proper ventilation. The controller shall measure the pressure, position of the damper blades, and temperature of the air flowing through the damper.

The VAQ Station shall have an air measuring station with an ultralow leak, high performance control damper similar to AMCA Class-II leakage. The complete assembly shall be factory assembled and tested to provide effective set point monitoring and adjustment. The unit shall come standard with a pressure transducer, with the output signal

proportional to CFM and factory fitted standalone DDC controller.

VAQ Station Outdoor Air (For non ducted application)

In this application, an air measuring control damper shall provide Outdoor, Return and Exhaust air control based on a demand signal. The demand signal shall be determined by a set schedule or by occupancy sensors. Examples of demand signals are carbon dioxide (CO2) concentration, a binary signal from a motion detector, or a manual switch.

Construction

The casing shall be single skin made out of galvanized sheet steel with acoustic lining from inside. Casing leakage rate shall be Similar to AMCA class II leakage. All VAQ Station shall have rectangular duct connection with 25 mm. flange connections at the outlet of the station.

The VAQ Station shall have airflow straighter of 3" deep hexagonal pattern at the inlet of the station to provide necessary laminar air flow suitable for measurement, and a multi leaf opposed blade damper with aluminum, aerofoil blade construction, width 100 mm. and exposed gear driven. The damper spindle shall be made of steel (10 mm. diameter), rotating in self-lubricating Nylon bearings.

Each VAQ Station shall be factory fitted with a multipoint, averaging air flow sensor in the inlet of the terminal. This air flow sensor shall amplify the air pressure signal linearly with an amplification factor of at least 3.0. The air flow sensor shall contain not less than 2x8 sensing points, which shall be arranged in a perpendicular axis of sensing. The points shall be arranged in such a way that they are located at the center of equal areas not more than 150 mm apart. The signal shall be averaged and measured from the center of the sensor. And the accuracy shall be within 5% even with irregular duct approach.

Controller shall be a programmable logic controller (PLC) with 100BaseT Ethernet capability each unit shall have with numerous analog and digital I/O. Multiple units shall be distributed on an Ethernet network allowing I/O expansion.

Controller shall be compatible with existing/future BMS system with Ethernet or Mod bus.

It should also have a connection facility for commissioning Diagnostic socket for operating devices.

JET NOZZLE (double skin type)

The jet nozzle assembly is designed to cater high air volumes. These are designed for the cooling application with side wall installation. Each

nozzle shall be manually adjusted to supply air to the specific zone. Each nozzle shall be manually adjusted in 30º vertically upwards and 30º vertically downwards. The set angle position shall be held by friction held fixing as standard supply. The nozzle shall be fitted with mounting plate which will allow each nozzle to rotate at 360º giving it wider air discharge pattern.

The Multiple Jet Nozzle shall comply following material and performance data

The jet nozzle shall be constructed from concentric steel tubes mounted on steel face plate with angle flanged border made from extruded aluminum sections compete with countered punched holes for screw fixing.

The jet nozzle with mounting plate and shall throw at 25m distance.

The jet nozzle should be tested in ISO 9000 certified test lab with international standards.

The acoustic data shall be as per ISO 5219 and ISO 3741.

SOUND ATTENUATORS

Attenuators may be installed in ducts in accordance with requirements.

Attenuators shall be of steel construction with casings out of minimum 22 G galvanized steel. Acoustic fill shall be inert, no hygroscopic, vermin proof, fiberglass of required density adequately protected against corrosion and covered with 26 gauge perforated aluminium sheet. Attenuators shall be supplied complete with flanges.

- Acoustic performance of the attenuators (net insertion loss) shall meet or exceed the values listed below :

OCTAVE BAND CENTRE FREQUENCY HZ

63	**125**	**250**	**500**	**1K**	**2K**	**4K**	**8K**
Insertion loss dB							
900 mm long							
atte **2**			:	1	1	:	**9**
Insertion loss dB							
1500 mm long							
atte **6**			:	4	:	:	**12**

The pressure drop values of the silencers shall be indicated for each duty.

Manufacturers shall submit a test certificate for acoustic and aerodynamic performance of the attenuators. Attenuators shall be tested in accordance with ACMA test methods/BS 4718 and insertion loss and self-generated noise for each octave band and pressure drop shall be stated in the schedule.

CO2 Sensor

Co2 sensor shall be Non dispersive infrared type shall have range of 02000 PPM with accuracy of + 30PPM. The warm up time shall be of 2 minutes and response time within 120 seconds. The sensor shall be suitable for 24Vac or 24Vdc+20 %, 50 Hz power supply & supplied with necessary step down transformer. The range of the sensor shall be approx.100 sq.m. The protection class shall be IP30 & suitable for operation at 050°C and 095 % RH range. The life of sensor should be greater than 10 years.

VENTILATION LOUVERS

Ventilation air intake louvers for interior application shall be suitable for high free area and low air flow resistance. The louvers for external wall application shall be drainable type louvers combined with back draft damper & bird mesh. The blades are inclined at 45°on a 40 mm blade pitch to minimize water ingress. The lowest blade of the assembly shall extend out slightly to facilitate disposal of rain water without falling in door/wall on which it is mounted. All the louvers shall be made of extruded aluminum construction.

DOCUMENTATION TO MEASUREMENTS

Duct measurements shall be taken before application of insulation.
Grille, diffusers shall be measured by the cross sectional area excluding the flanges.

For each drawing, all supply of ductwork must be accompanied by computer generated detailed bill of material indicating all relevant duct sizes, dimensions and quantities. In addition, summary sheets are also to be provided showing duct areas by gauge and duct size range as applicable.

Measurement sheet covering each fabricated duct piece showing dimensions and external surface area (internal skin surface area for double skin duct) along with summary of external surface area of duct gauge wise.

All duct pieces to have a part number, which should correspond to the serial number, assigned to it in the measurement sheet. The above system will ensure speedy and proper site measurement, verification and approvals.

After duct installation, a part of duct section (approximately 5% of total ductwork) may be selected at random and tested for leakage. The procedure for leak testing should be followed “HVAC Air Duct Leakage Test Manual: (First Edition).

17 INSULATION WORKS

General

The Insulation of chilled water piping, air handling unit's rooms, ducting etc., shall be carried out as per specifications given below:

Materials

The materials to be used for insulation shall be as per specification unless some other material is specifically mentioned elsewhere. The detailed specifications of the materials are listed under respective sub heads.

FOR G.I. DUCTING

SPECIFICATION FOR THERMAL & ACOUSTIC INSULATION

SCOPE

The scope of this section comprises the supply and application of insulation conforming to these Specifications.

A) DUCT THERMAL INSULATION(EPDM THERMAL INSULATION):

Insulation material for Duct insulation shall be closed cell anti-fungus, anti-microbial EPDM (CFC/HCFC FREE) on one side with factory laminated glass cloth. Thermal conductivity of the insulation material shall not exceed 0.033 W/m°K at an average temperature of 0°C. Density of the EPDM shall be 40-60 Kg/m³. The product shall have temperature range of -40 °C to 105°C. The insulation material shall be fire rated for Class O as per BS 476 Part 6: 1989 for fire propagation test and for Class 1 as per BS 476 Part 7, 1987 for surface spread of flame test. Water vapor permeability shall be not less than 0.024 per inch (1.74 x 10-14 Kg/m.s. Pa i.e. μ=10000: Water vapor diffusion resistance).

Thickness of the insulation shall be as specified for the individual application. Each lot of insulation material delivered at site shall be accompanied with manufacturer's test certificate for thermal conductivity values, density, water vapor permeability and fire properties. Samples of insulation material from each lot delivered at site may be selected by Owner's site representative and gotten tested for thermal conductivity and density at Contractor's cost. Adhesive used for sealing the insulation shall be not-flammable, vapor proof adhesive (LOW VOC) strictly as per manufacturer's recommendations.

Ducting insulation thickness shall be as follows.

- SUPPLY AIR DUCT -19/25 mm thick insulation

- RETURN AIR DUCT-13/19 mm thick insulation

Method of Application:

All Duct surfaces should be free of dust, grease, oil. To clean the duct, first wipe with a clean cloth to remove dust particles. Then remove grease and oil by applying a methylated spirit or acetone or equivalent special glue cleaner and allow evaporating. Work within reasonable clean area to avoid too much dust prior to carrying out insulation work. Measurement of surface dimensions shall be taken properly to cut closed cell nitrile rubber sheets to size with sufficient allowance in dimension. Cutting of nitrile rubber sheets shall be done with adjustable blade to make 90º cut in thickness of nitrile rubber sheet. Hacksaw or blades are not acceptable tools for cutting the insulation.

Material shall be fitted under compression and no stretching of material shall be permitted. A thin film of only OEM supplied food grade adhesive (LOW VOC) 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 by providing 6 mm thick 50 mm EPDM tape. The adhesive shall be strictly as recommended by the manufacturer.
Apply 2 coats of lag coating over insulation

B) DUCT ACOUSTIC INSULATION (WITH OPEN CELL INSULATION)

Material for Duct Lining : 15 mm thick Class O open cell structured Nitrile rubber with 150 kg/m3 density (CFC/HCFC FREE).

Material shall be engineered Nitrile Rubber open cell foam.
The Random Incidence Sound Absorption Coefficient (RISAC); tested as per ISO 354, should be minimum as per enclosed chart

Freq (Hz)	**125**	**250**	**500**	**1000**	**2000**	**4000**	**NRC**
10 mm	0.03	0.04	0.14	0.04	0.88	1.00	0.35
15 mm	0.01	0.09	0.29	0.74	1.08	0.83	0.55
20 mm	0.04	0.13	0.4	0.9	1.04	0.90	0.60
25 mm	0.02	0.25	0.86	1.14	0.88	0.99	0.80
30 mm	0.07	0.32	0.99	1.16	0.93	1.08	0.85
50 mm	0.23	0.73	1.29	0.99	1.09	1.11	1.05

The material should be fiber free
The density of the same shall be within 140-180 Kg/m3
It should have Microban®*; antimicrobial product protection, and should pass Fungi Resistance as per ASTM G 21 and Bacterial Resistance as per ASTM E 2180.
The material should have a thermal conductivity not exceeding 0.047 W/m.K @ 20 Deg. C
The material should withstand maximum surface temperature of +850C

and minimum surface temperature of -200C
The material should conform to Class 1 rating for surface spread of Flame in accordance to BS 476 Part 7 & UL 94 (HBF, HF 1 & HF 2) in accordance to UL 94, 1996.
The insulation should pass Air Erosion Resistance Test in accordance to ASTM Standard C 1071-05 (section 12.7).

Thickness of the material shall be as specified for the individual application. The insulation should be installed as per manufacturer's recommendation.

- Microban is a registered trademark of the Microban Products Company, USA.

Method of 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 closed cell Elastomeric rubber sheets to size with sufficient allowance in dimension insulating material sheet and then on to the metal surface. Apply OEM supplied food grade adhesive (LOW VOC) on duct surface and insulation sheet and 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 by providing 6 mm thick 50 mm wide Nitrile rubber tape. The adhesive shall be strictly as recommended by the manufacturer and should be of low volatile organic compound. Acoustic insulation to be applied for both supply & return air duct/PLENUM up to 3 mtr. in length from AHU.

Internal duct acoustic insulation shall not be applicable for OT & Positive isolation room of supply & return air duct.

(C) FALSE CEILING INSULATION

The false ceiling shall be insulated with 50 mm thick fiberglass slab of 16 Kg. / Cu. M. density. The fiberglass slab shall be wrapped in polyethylene bags.

(D) UNDERDECK INSULATION FOR RCC ROOF

Underdeck 25mm thick insulated with cross-linked polyolefin foam with factory applied reinforced aluminum foil and acrylic adhesive backing. Insulation shall have Density of 25 kg/m3 (foam core only), Thermal Conductivity (ASTM C518) of Maximum 0.032 W/m.°K at mean temperature 23°C, Water Vapour permeability (ASTM E96): Maximum 2.3 x 10-15 kg/Pa.s.m, (μ>80,000), Water absorption: <0.2 % v/v. Complies with Class 0 to BS476 Parts 6 and 7, Euro class B-S2,d0 classification according to EN 13501Part 1, NFPA 90A and B (ASTM E84 25/50 rating), FM 4924 fire performance criteria and "FM Approved" by FM Approvals certification body and Zero mould growth

when tested to ASTM G21. Seal all joints with 75mm reinforced aluminums foil tape.

(E) AHU ROOM ACOUSTIC INSULATION.

Material shall be engineered NITRILE RUBBER open cell foam
The Random Incidence Sound Absorption Coefficient (RISAC); tested as per ISO 354, should be minimum as per enclosed chart

Freq (Hz)	**125**	**250**	**500**	**1000**	**2000**	**4000**	**NRC**
20 mm	0.04	0.13	0.4	0.9	1.04	0.90	0.60

The material should be fiber free
The density of the same shall be within 140-180 Kg/m3
It should have antimicrobial product protection, and should pass Fungi Resistance as per ASTM G 21 and Bacterial Resistance as per ASTM E 2180.
The material should have a thermal conductivity not exceeding 0.047 W/m.K @ 20 Deg. C
The material should withstand maximum surface temperature of +850C and minimum surface temperature of -200C
The material should conform to Class 1 rating for surface spread of Flame in accordance to BS 476 Part 7 & UL 94 (HBF, HF 1 & HF 2) in accordance to UL 94, 1996.
The insulation should pass Air Erosion Resistance Test in accordance to ASTM Standard C 1071-05 (section 12.7).

Thickness of the material shall be as specified for the individual application. The insulation should be installed as per manufacturer's recommendation.

EQUIPMENT INSULATION

The complete shell of the chiller as well as its two heads shall be factory insulated.

The chilled water pumps shall be insulated with 38 mm thick closed cell Nitrile rubber (class "O") insulation having minimum 32 kg/cum density and cladded with aluminum sheets of
0.63 mm thickness and properly clamped to pump in two semicircular sections.

The Expansion tank/ air separator shall be insulated with 75mm thick T.F quality expended polystyrene of 20 kg/cum density & covered with a layer of 120 gm/sqm polythene sheet (vapor barrier) and finally finished with 26 G aluminum sheet.

PIPING INSULATION

Chilled water piping shall be insulated with closed cell EPDM insulation Class 'O' moulded pipe section having density between 40 to 60 Kg/m3. The thermal conductivity should not exceed 0.035 W/mK at mean temperature of 0°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. Moisture Diffusion Resistance Factor or 'μ' value should be greater than 7000.

Factory cut self-adhesive tube shall be used to insulate smaller pipes and factory cut sheets shall be used for large pipe diameters. All the longitudinal and butt joints should be sealed strictly by manufacturer recommended adhesive.

Thickness of the insulation material should be as follows:

Coastal Area	
CHW Pipe Size	**Thickness**
25 NB to 40 NB	32mm
50 NB to 150 NB	38mm
200 NB to 600 NB	44mm

Condensate Drain pipe	13 mm
Refrigerant Pipe	32 mm

INSTALLATION OF PIPE AND VALEVS INSULATION

Method of Application:

The surface to be insulated shall be first cleaned and a coat of zinc chromate primer (LOW VOC) shall be given. The insulation shall be fixed tightly to the surface with cold setting adhesive (LOW VOC). All joints shall be staggered and sealed. The second layer of insulation wherever required shall be similarly applied over the first layer.

Pipes shall be preferably pre insulated at factory, meeting the requirement or the insulation shall be finished at site as under:

The insulation over the pipe work shall be finished with 7 mill glass cloth. All expose pipes (terrace& in shaft) outside the building laid above ground the finishing over the pipe insulation shall be finished with 26 gauge aluminum cladding over a vapor barrier of 120 gm/sq.m polythene sheet with 50mm overlap and tied down with lacing wire and complete with type 3 grade I roofing felt strip applied by means of cold setting CPRX compound.

All valves, fittings, strainers etc. shall be insulated to the same thickness and in the same manner as for the respective piping, taking care to allow operation of valves without damaging the insulation.

MEASUREMENT OF INSULATION

Unless otherwise specified measurement for duct and pipe insulation for the project shall be as per CMMRDA specification for HVAC Work.

18 ELECTRICAL INSTALLATIONS

GENERAL

Work shall be carried out in accordance with the specifications, local rules, Indian Electricity act 1910 as amended up to date, and rules issued there under, regulations of the Fire Insurance Company and Indian Standard Code of practice No. 7321963 (revised). For items of work not covered by any of the above regulations, wiring rules in the 13th edition of the Institution of Electrical Engineers (London) shall apply. Definition of terms shall be as per the rules of the Institution of Electrical Engineers,

The following exclusion from this contract may be provided by department. Through other agencies, as per special conditions of contract:

31/2 core XLPE insulated PVC sheathed Aluminum conductor Armoured cable along with two independent earth connection up to the incoming breakers in the Air conditioning plant room main panel only.

SCOPE

The scope of work covered under this section shall be inclusive but not limited to followings, and everything necessary to complete the work shall be provided by the contractor within the rates quoted by him for the electrical package on turnkey basis.

All electrical panels including the main panel, local electrical panel boards (EPB) and distribution boards whether indicated in the drawings or not/ as required for proper functioning of the system.

All aluminum conductor armoured power distribution cables starting from main electrical panel in the plant room up to the final outlet.

All copper conductor armoured control cables from the final outlets up to the main control console.

A centralized control console to indicate the condition of various drives/equipment and also to control various feeders/drives/equipment.

WIRING SYSTEM

All power wiring shall be carried out with 650/ 1100 volts grade PVC insulated, armoured, overall, PVC sheathed aluminum conductor cables. Cables shall be sized for starting current and by applying proper derating factor. All control wiring shall be carried out by using 650/ 1100 volts FRLS insulated copper conductor wires in wire trays or in conduit. Minimum size of control wiring shall be 1.5 sq.mm. FRLS insulated copper conductor wires. Minimum size of conductor for power

wiring shall be 4 sq.mm. 650/1100 volts grade PVC insulated aluminum conductor wires in conduit.

SPECIFICATION FOR LT PANEL SWITCHBOARD

This Specification covers the requirements for the design, construction, assembly, mechanical installation and testing of a Main Low Voltage switchboard:

The Specification shall be read in conjunction with the accompanying Annexure and the Principal's drawings listed therein.

The Low Voltage Switchboard shall be with aluminium bus bars, indoor type, free standing, with Plinth, floor mounting type, extensible on either side.

SITE CONDITIONS:

Max. Peak room temperature in shade: 40degC. Altitude – Mumbai Sea Level

STANDARDS:

The design, manufacture & testing of the various items are covered by the following standards:

IEC 61943	:	For Main LT panels Low voltage switchgear And Control gear Assemblies
IS 42371967	:	General requirement for Switchgear and Control gear for Voltages not exceeding 1000V.
IS 21471962	:	Degree of protection provided by enclosure for low voltage switchgear and Control gear.
IS 36191966) IS 60051970)	:	Phosphate treatment.
IS 51978	:	Colour for ready mixed paints & enamels.
IS 50821969	:	Wrought aluminium for electrical purpose.
BS162	:	Clearance & creepage for bus systems.
IS 3751963 IS 55781970	:	Marking arrangement for busbar/cable.
IS 42371967	:	Clearances & Cree pages for Part I & II devices.
IS 6875	:	Push buttons & related control switches including control Contactors.
IS 9224 Part I & Part II – 1973	:	HRC Fuses.
IS 2516 Part I & II – 1979/ IEC609471&2	:	alternating current circuit breakers (ACB).
II Sec. I – 1977	:	Voltage not exceeding 1000V AC or 1200V DC.

IS 32311965	:	Protective relays.
IS 31561965	:	Voltage transformers.
IS 27051981	:	Current transformers.
IS 12481968	:	Elect. indicating instruments.

SPECIFICATIONS:

Rated System	:	AC nominal system voltage 240/415 with the tolerance of ± 10 percent as given in IS 12360 upto date.
Rated insulation level	:	660V rms.
HV withstand level	:	6 kV for power circuit.
(for 1 min).	:	4kVfor control circuit
Horizontal bus bar	:	As per detail design drawings rating. / Drawings.
Rated short time	:	Up to 65/50kA rms for 1 sec. 110kA Rating of H.Bus & peak (50MVA).

V. Bus. (shall be calculated at detail design stage & considered accordingly)

Degrees of Protection	:	as specified in the specs. Report& as per standards

General

- Switchboards shall in accordance with the standards (IEC 614391 & 2 (Low Voltage switchgear and control gear assemblies) for Main LT switchboards & other Front operating switchboards suitable for operation at three phase 4 wire, 415 volt, 50 Hz, neutral solidly grounded at transformer system with a short circuit level withstand as per detail design drawings. The main distribution boards shall be suitable for operating voltage up to 690 V and Insulation voltage of 1000V.

- Switchboards shall comply to Form 3B for Main compartmentalized board sand Form 1 for non compartmentalized distribution boards as per BS 5486 Part I – 1990 and IEC 4391.

- All the major components like enclosure, switchgear component and bus bar support shall be supplied by OEM manufacturer to the franchise assembler.

- The enclosures shall be designed to take care of normal stress as well as abnormal electromechanical stress due to short circuit conditions. All covers and doors provided shall offer adequate safety to operating persons and provide ingress protection of IP 54 & for external panels IP66 unless otherwise stated. Ventilating openings and vent outlets, if provided, shall be arranged such that

same ingress protection of IP specified retained. Suitable pressure relief devices shall be provided to minimize danger to operator during internal fault conditions.

- Entire switchgear used in switchboards shall be completely fuse free. No fuses shall be used anywhere in the installation.

- All accessible bares terminals shall be provided with integral shrouds and shall be finger touch proof.

- Bimetallic connectors shall be provided for termination of cable with aluminium conductors on copper bus bars.

- Main distribution boards shall be assembled only by a franchisee of the original manufacturer and approved by the consultant.

- Panel builder / assembler shall have a minimum experience of 10years in the field of switchgear assembly

- The panels shall be factory manufactured by OEM

- The Main LV (above 800A rated) & external placed panel cubicles shall have structural steel frame work. It is enclosed on all sides and top by Cold Rolled sheet steel of minimum outer thickness of 2.5 mm.

- Intrinsic load bearing member shall be used as per design verified assembly and should have min. thickness of 2 mm. Load bearing members to be supplied by OEM or by approved supplier of OEM.

- The panels shall have integral base frame.

- The LV panel shall have provision for top / bottom in coming and bottom / top out going
- respectively to suit site conditions of cable entries.

- The maximum and minimum height of the operating handles from floor level shall be as 1800/ 250 mm respectively.

- All components like, circuit breakers, switches etc. shall be compatible with the short-circuit levels.

- All internal wiring shall be with suitable stranded copper conductor FRLS insulated wire.

- The busbars shall be colour coded using identifying colour rings at regular interval. Red,
- Yellow & Blue colour shall be used for phases & Black for neutral for each shipping section of panels. The earth Busbar shall be

identified with Green color rings at regular intervals.

- The Busbar sizes shall be determined taking into consideration the continuous rat ing and fault level indicated, as applicable, without exceeding the temperature raise limits as per IEC, over ambient temperature. Feeder in adjacent vertical to be feed with common vertical busbar / dropper.

- Bus bar supporting systems shall withstand the short circuit forces circuits, without deflection or deformation.

- The busbars shall be supported of regular intervals using SMC or DMC insulators as per the tested design. It should have minimum Comparative Tracking Index (CTI) of 600 V as per IS 2824).

- Minimum clearance between phases / live parts shall be 25 mm and phases / live parts /
- neutral to ground shall be 19 mm except on the equipment terminals.

Switchboard Configuration

- The Switchboard shall be configured with Air Circuit Breakers, MCCB's, and other equipment as called for in the system requirement.

- The MCCB's shall be arranged in multitier formation whereas the Air Circuit Breakers shall be arranged in Single tier formation only to facilitate operation and maintenance.

- The Switchboards shall be of adequate size with a provision of 25% spare space to accommodate possible future additional switch gear.

i. DESIGN CONSIDERATIONS

- The main distribution boards shall be of standard, natural air cooled, well tested and proven design which ensures maximum safety to personnel, maximum service reliability and economic operations for a lifetime of at least 20years. Design and construction shall be simple, well laid out and shall provide good accessibility to components and parts.

- Unless specified otherwise, the form of construction for the main distribution board shall comply with Form3b requirements of IEC 614391.

- Unless specified otherwise, the main distribution board shall be fixed version, main incoming switching devices shall be withdraw able type and the outgoing switching devices shall be fixed type.

- Main distribution boards shall be rated on the basis of voltage, current, frequency and the symmetrical breaking capacity of incorporated switching de vices.

- The electrical system for all main distribution boards shall be 415 / 380V, 50 Hz 3phase and neutral, 4wire solidly earthed. The main distribution boards shall be suitable for operating voltage up to 690 V and Insulation voltage of 1000V.

- Unless specified otherwise, the fault level withstand capacity of the main panel board bus bar system rated up to 4000Amps shall be 65/50KA(as per detail de sign) RMS for 1second as minimum standard. The breaking capacity of the switching devices shall be 65/50KA as minimum standard. The type test certificate shall be submitted for consultant engineer verification, to prove the fault level withstand capacity of the main distribution boards. Even under extreme conditions of short circuit or mal operation there shall be no danger to persons in the vicinity of the assembly.

- All equipment and components of the main distribution boards shall be capable of continuous operation at their full current and voltage ratings and without detriment or malfunction at system continuous deviation of up to and including the following percentages of the normal values.
    - Voltages ± 10%
    - Frequency± 5%
- All components shall be capable of withstanding the dynamic, thermal and di electric stresses resulting from prospective short circuit currents without dam age or injury to personnel.

Equipment Specifications

All equipment used to configure the Switchboard shall comply to the relevant Standards and Codes of the Bureau of International / Local Standards and to the detailed technical specifications as included in this tender document.

General Arrangement & Assembly

L.V Panel shall comprise of free standing enclosure, bus bar system, switching devices such as ACB/ MCCB, metering equipment's, all necessary current transformers and the like as required. Panel shall be assembled in a systematic manner such as Transformer Incomer section, Generator Incomer section (if applicable), Bus coupler section (if applicable), Incomer Metering / Indication section and Outgoing section.

Unless otherwise specified the panels shall be designed to accept bottom/top entry of cables and shall be of rear access type. The rear access shall only be provided for access for termination of cables, all

other equipment's shall be accessible / operable from the front of panel. Where front access type is specified, the panel shall be designed completely for front access only.

Each section shall be arranged typically as described below and as per the details shown in the drawings:

Incomer section

Incomer panel shall be a 3 compartment enclosure with Top & Bottom compartment dedicated for metering / controls and the Middle compartment shall be dedicated for the circuit breaker. It shall comprise of but not limited to the following:

Bottom Compartment

- Incomer supply cables Middle Compartment
- Main Incoming circuit breakers with rating and type as per the drawing. Top Compartment

- Any control component for Incoming circuit breaker.
- Digital power meter to indicate various electrical parameters
- Phase indication lamps (R, Y, B) wired to the line side of the circuit breaker.
- Power factor meter (If required as per local authority requirement).(not in DG case)
- KWH energy meter (If location of KWh is approved by local authority).

Bus coupler / Bus Tie section – (If applicable)

The Bus Tie / Bus Coupler Panel shall be a 3 compartment enclosure to match with the incomer panels. The Top & Bottom compartment can be used for accommodating the common controls of the incoming and the bus tie circuit breakers. The Middle compartment shall be dedicated for the circuit breaker. It shall comprise of but not limited to the following:

- Where ACB's are used as incoming or bus coupler, the front face of the ACB shall be accessible for operation from the front without opening the feeder door.

- Where MCCB's are used as incoming or bus coupler circuit breakers and Direct Rotary handle shall be provided at the front face of the MCCB which is operated from front door. All such handles shall be door interlocked wherever required.

Outgoing section(s)

The outgoing section(s) enclosure shall accommodate the outgoing circuit breakers which shall be arranged in a systematic and symmetrical manner. It shall comprise of but not limited to the following:

Each panel shall have various fixed compartments with individual doors for each compartment and each compartment shall accommodate the following:

Circuit breakers with rating and type as specified in the drawings.
Any other controls, which may be part of the outgoing circuit breakers.
Notes:
All circuit breakers and other controls pertaining to a feeder shall be accommodated in its own compartment, which shall have its own feeder doors. Keys for all such External door shall be common.

Moulded case circuit breaker in each compartment shall be equipped with a Direct operating handle extended to the front face of the door for operation. All such door handles shall be door interlocked, wherever required.

Air circuit breaker front face shall be accessible without opening the door.

Circuit breakers and other control components shall be fully accessible after opening the panel door; however, no live parts shall be exposed.

All the bus bar connections / terminations to the outgoing circuit breakers shall be taken from the rear side of the circuit breaker, which shall be shrouded properly using metallic / poly carbonate sheets. All the mccb terminals shall be fully shrouded with original terminal shrouds from the mccb manufacturer, in such a way that no live parts are exposed, when the front door is opened.

Opening of the front door shall give access to the circuit breaker for rating adjustments etc.

Maximum 1 nos. air circuit breakers shall be installed in one enclosure, provided that sufficient space for cable termination is provided.

Maximum 3 nos. moulded case circuit breakers, rated at 800Amps shall be installed in one tier formation, provided that sufficient space for cable termination is provided also duration shall be considered as per manufacturer standards.

Maximum 4 nos. moulded case circuit breakers, rated below 800Amps shall be installed in one tier formation, provided that sufficient space for cable termination is provided also duration shall be considered as per manufacturer standards.

All Partitioning and shrouding shall comply the requirements of Form3b, construction as per IEC standards.

Enclosure manufacturing

Main distribution board enclosure shall be a branded catalogue product from approved manufacturer. Enclosure shall be made out of electro galvanized steel sheets conforming to international specification. AluZinc coating shall be provided on the sheets, which shall prevent rust formation during storage and handling for processing, in addition to giving corrosion protection to the finished product. The sheets have a fine surface finish, which gives good presentation to the painted components of the enclosure.

The enclosure system shall be Modular in nature with Bolt on construction.

The enclosure shall be powder coated to an approved colour. The painting process shall include removal of moisture on the sheet steel surface using and applying thermosetting polyester powder using automatic guns. Polymerization of the powder shall take place when the components are cured at about 180°C, forming a continuous integrated coating. A fairly uniform coating of atleast 7080 microns shall be provided.

The pretreated and powder coated sheet steel components shall be atleast tested randomly at regular intervals for coating thickness measurement, adhesion test, bend test, impact test, hardness test, salt spray test etc.

Enclosure construction

Main distribution board enclosure shall be a branded catalogue product from approved manufacturer. The assembler shall assemble the prefabricated elements of the enclosure system, bus bar system, switching devices and other equipment to complete the main distribution board.

Main distribution boards (above 800A rated) & external placed panel's enclosure shall be fabricated of minimum 2.5 outer body 2 mm internal (including doors), thick electro galvanized sheet steel folded construction. The enclosure shall be of simple and robust construction designed for a variety of dimensions obtainable by means of standardized basic elements. Main distribution board shall consist of several enclosures of equal height and depth mounted side by side to form a composite board of uniform assembly.

Enclosure structure composition shall be based on a supporting frame consisting of cross members, vertical members and panels fastened one another by means of bolts. The basic structure shall be completed by the addition of a compartment for the connections which may be located at rear or at side depending on the access. A single piece base shall allow anchoring of the unit to the floor. The complete assembly shall be rigid self supporting structure which is deformable and unaffected by shocks. The structure shall be completed by a metal partition made of

one or more pieces between two sections depending on the depth of the compartment. The lower part of structure shall be closed by means of bolted plates that can be removed whenever the assembly of cable glands is required. The switchgear components contained in sections shall be installed on mounting plates. Each door panel shall be equipped with integral key lock and the key shall be common for all such locks. All door hinges to be of concealed type and it shall be possible to remove the door panel whenever required. All doors, bold on cover, partitions, mounting plates and metallic shrouds shall be effectively connected to earth. Flexible earth wires shall be used for removable covers and hinged doors.

The structure and the partitions shall be protected by a durable scratch resistant textured paint finish, epoxy powder polymerized at high temperatures to an approved color.

Adequate care shall be taken while designing the main distribution board connection spaces for the external cables. Sufficient cable supports shall be provided for routing the cables inside the enclosure.

Enclosure system shall effectively dispose the heat produced by the main circuits and shall integrate a high performance natural ventilation system which shall be aimed at regulating the internal temperature based on the actual capacities of the components.

Enclosure shall be readily suitable for future extension on either side without any modifications (after installation at site).

Form 3B construction assembly shall provide protection against contact with internal live parts and components. Bus bars, functional units and cable termination shall be segregated from each other as given below:

Bus bars shall be separated from functional units;

Functional units / switching devices shall be separated from each other;
Cable termination and functional units / switching devices shall be separated from each other;

Incoming and outgoing terminals shall be separated from each other.
Busbars shall be accommodated in a separate chamber/alley with metallic shrouds and partitions to avoid accidental external contacts.
All CT's & PT's shall be resin cast unless specified otherwise or as approved
Incoming switching device shall be located in separate section and outgoing switching devices in other sections, wherever applicable. Each switching device shall be segregated from each other and located in individual compartment with hinged door.

External cable termination to the switching device terminals shall be outside the functional unit / switching device compartment. Segregation

shall be made between the switching device terminal and the switching device within its compartment by means of rigid barriers and partitions.

All segregation shall be achieved by means of rigid metallic sheet partitions. Segregation and partition shall ensure protection against contact with live parts and limitation of the faults within each of the functional unit compartment.

Constructional Features

The Switchboards shall be metal clad totally enclosed, floor mounted free standing type of modular extensible design suitable for indoor mounting. The Switchboards shall be designed for a temperature rise restricted to 40 Deg C above ambient of 45 Deg C.

Switchboards shall be either compartmentalized unless otherwise specified.

Switchboards shall be made up of requisite vertical sections, which when coupled together, shall for continuous dead front switchboards.

Switchboard shall be readily extensible on both sides by addition of vertical sections after removal of the end covers.

The switchboards shall be designed for use in high ambient temperature and high humid tropical conditions as specified. Ease of inspections, cleaning and repairs while maintaining continuity of operation shall be provided in the design.

'U' Channels forming switchboard frames shall be fabricated from 2.5 mm thick electro galvanized MS sheets. All joints shall be neatly formed and finished flush with adjacent surfaces by grinding. No joints shall be located in corners. Bare edges shall be lipped. Structural members and bracings where ever required shall be welded or bolted to the frame. The frame shall be of modular design and extensible.

All doors and covers shall also be fully gasketed with metal based neoprene gaskets to ensure proper compression of the gaskets. The hinged door shall open a maxi mum of 150^0. All hinged doors shall have earth braid connected to the cubicle. Good quality door handles fitted with toggles to operate rods to latch with suitable slots in both top and bottom of switchboards shall be provided. Latching rods and associated brackets shall be cadmium plated.

Each vertical section shall be provided with a rear/ side cable chamber housing the cable end connections and power/control cable terminations. There should be generous availability of space for ease of installation and maintenance with adequate safety for working in one vertical section without coming into contract with any liver parts.

Switchboard panels and cubicles shall be fabricated with CRCA Sheet Steel of thickness not less than 2.5(outer) ,2 mm (internal) and shall be folded and braced as necessary to provide a rigid support for all components. The doors and covers shall be fabricated from CRCA sheet steel of thickness not less than 2.5(outer) ,2 mm (inter nal). Joints of any kind in sheet metal shall be seam welded and all welding slag ground off and welding pits wiped smooth with plumber metal.

All panels and covers shall be properly fitted and square with the frame. The holes in the panel shall be correctly positioned.

Fixing screws shall enter holes tapped into an adequate thickness of metal or provided with hank nuts. Self-threading screws shall not be used in switchboards.

All electrical contacts between dissimilar metals (eg. aluminium conductor of cables connected to copper terminals of breakers etc.) shall be through bimetallic connection.

Type test certificates shall be available for the proposed type of enclosure and the bus bar system. The type test certificates shall be clearly state type, model and main characteristics of the assembly, references of the standards applied for the tests, results obtained and the observations made during & after the tests.

All Panels/ distribution board shall fully comply with requirements of TTA equipment (Type Tested Assemblies) as per IEC 61439.

Design drawings, component catalogues and type test certificates shall be submitted for consultant approval prior to placement of order for the panels/distribution boards.

Switchboard Compartmentalization

For compartmentalized switchboards, separate totally enclosed compartments shall be provided for horizontal bus bars, vertical bus bars, ACBs, MCCBs and cable alleys.

Earthed metal or insulated shutters shall be provided between draw out and fixed portion of the switchgear such that no live parts are accessible with equipment drawn out. Degree of protection within compartments shall be at least IP 4X.

Sheet steel hinged lockable doors for each separate compartment shall be provided and duly interlocked with the breaker in "ON" and "OFF" position.

For all Circuit Breakers separate and adequate compartments shall be provided for accommodating instruments, indicating lamps, control contactors and control MCB etc. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker, bus bars and connections.

Each switchgear cubicles shall be fitted with label in front and back identifying the circuit, switchgear type, rating and duty. All operating device shall be located in front of switchgear only. Minimum height from floor level for any device mounted on panel cover shall be 250 mm.

A horizontal wire way with screwed cover shall be provided at the top to take inter connecting control wiring between vertical sections.

Separate cable compartments running the height of the switchboard in the case of front access boards shall be provided for incoming and outgoing cables.

Cable compartments shall be of adequate size for easy termination of all incoming and outgoing cables entering from bottom or top.

Adequate and proper support shall be provided in cable compartments to support cables.

Spare Provision

i.2025% spare cubicles/ space shall be provided in all switchboards to cater for future use.

Switchboard Bus Bars

Bus bars shall be made of high conductivity, high strength aluminium alloy, complying with requirements of grade E 91E as per International IEC/BS and local norms. Design of bus bar system shall comply to IEC relevant standards. Bus bars shall be of rectangular cross sections suitable for full load current for phase bus bars as also neutral bus bar .The maximum current density shall be 1 amp per Sq. mm. Bus bar shall be suitable to withstand the stresses of fault level as per detail design & standards.

Bus bars shall be insulted with heat shrink PVC sleeves of 1.1 kV grade and bus bar joints provided with clip on shrouds.

The bus bars shall be extensible on either side of the switchboard.

The bus bars shall be supported on non-breakable, no hygroscopic epoxy resin or glass fiber reinforced polymer insulated supports able to withstand operating temperature of 110^{O} C at regular intervals, to withstand the forces arising from a fault level of 50/35 MVA(as per detail design) at 415 volts for 1 second or as per detail de sign.

All bus bars shall be colour coded.

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 requirement. The material for auxiliary supply bus will be electrolytic copper.

Additional cross sectional area to be added to the bus bar to compensate for the holes.

The busbar system shall be designed as per the predefined guidelines provided by the original manufacturer. The busbar system shall be type tested by the manufacturer at reputed laboratory for short circuit with stand capacity. The neutral and earth busbars shall also be type tested for the short circuit withstand capacity. The fault level rating of the busbar system shall be as per the drawings however the minimum short circuit withstand capacity shall be 65/50KA RMS for 1second. Neutral busbar shall be able to withstand a thermal stress of atleast 50%, corresponding to the main phase busbar rated short circuit withstand capacity.

The busbar system shall be supported adequately at regular intervals as per manufacturer guidelines based on the type test results on a specially designed busbar supports. The supports shall be independently fixed to structure to strengthen the busbar arrangement. Wherever required additional intermediate supports shall be provided between the busbars. All vertical droppers shall also be adequately supported as per the manufacturer guidelines and the test results. The distribution bus bars shall be connected to the main busbars by suitable sized and graded bolt & nut and contact washers. Clamp type arrangements for connections will not be permit ted. Connections to the switching devices to the main or distribution busbars shall be carried out using rigid bars of adequate and standard sizes. It shall be possible to replace the switching devices with different rating with same frame sizes without changing the interconnection busbars.

The main busbars shall be accommodated on a separate busbar chamber running horizontally at top or bottom or middle of the panel. Main busbars running behind the functional units (the switching device mounting plates) will not be permitted. Distribution busbars are permitted at the back of the switching device compartments only where with drawable versions are used

The dimensioning of the busbar system shall be as per the rated current of the main switching device, the short circuit current, the maximum rated permissible temperature at permanent operation and the ambient temperature around the busbars. The selection of busbars shall be supported by calculations and recommendations from the original manufacturer.

The neutral busbar shall run along with the phase busbars and shall outgoing switching devices neutral connection terminal shall be provided with in the switching de vice compartment.

Earth busbar shall be running throughout the panel fitted directly on to the structure for connection of the protective conductors to provide equipotential bonding of ex posed conductive parts. Earth busbar shall be located at the bottom of the panel and in the cable chamber/ alley to facilitate easy connection of protective conductor.

Switchboard Interconnection

All connection and tap offs shall be through adequately sized connectors appropriate for fault level at location. This shall include tap off to feeders and instrument/control transformers. Alternatively, current limiters of approved make and type shall be used.

For unit ratings up to 100 amps, FRLS PVC insulated copper conductor wires of adequate size to carry full load current shall be used. The terminations of such interconnections shall be crimped. Solid connections shall be used for all rating of 100 amps and above.

All connections, tapping's, clamping, shall be made in an approved manner to ensure minimum contact resistance. All connections shall be firmly bolted and clamp with even tension.

Before assembly joint surfaces shall be filed or finished to remove burrs, dents and oxides and silvered to maintain good continuity at all joints. All screws, bolts, washers shall be cadmium plated. Approved spring washers shall be used with cadmium plated high tensile steel bolts with BSF threads.

All connectivity and tap offs shall have bimetallic connectors as required, finger touch proof terminals & integral switchgear shrouds.

Draw out Features

Air Circuit Breakers shall be provided in fully draw out cubicles, unless otherwise stated. These cubicles shall be such that draw out is possible without disconnection of the wires and cables.

The power and control circuits shall have self-aligning and self-isolating contacts. The fixed and moving contacts shall be easily accessible for operation and maintenance. Mechanical interlocks shall be provided on the draw out cubicles to ensure safety and compliance to relevant Standards. The MCCB's shall be provided in fixed type cubicles.

Instrument Accommodation

Instruments and indicating lamps shall not be mounted on the Circuit Breaker Compartment door for which a separate and adequate compartment shall be provided and the instrumentation shall be accessible for testing and maintenance without danger of accidental contact with live parts of the Switchboard.

For MCCB's instruments and indicating lamps can be provided on the compartment doors.

The current transformers for metering and for protection shall be mounted on the solid copper/aluminium bus bars with proper supports.

Wiring

All wiring for relays and meters shall be with FRLS PVC insulated copper conductor wires. The wiring shall be coded and labelled with approved ferrules for identification. The minimum size of copper conductor control wires shall be 2.5 sq. mm. Wiring shall be terminated with ferrules on terminal block. CTs shall be provided with shorting facilities

Cable Terminations

Knockout holes of appropriate size and number shall be provided in the Switchboard in conformity with the location of incoming and outgoing conduits/cables.

The cable terminations of the Circuit Breakers shall be brought out to terminal cable sockets suitably located in the cable chamber

The cable terminations for the MCCB's shall be brought out to the rear in the case of rear access switchboards or in the cable compartment in the case of front access Switchboards.

The Switchboards shall be complete with tinned brass cable sockets, tinned brass compression glands, gland plates, supporting clamps and brackets etc for termination of 1100-volt grade aluminium conductor XLPE cables.

Removable gland plates shall be provided for power and control cables. The gland plates shall be 3 mm thick and for single core cables shall be of nonmagnetic material.

Space Heaters

Anti-condensation heaters shall be fitted in each cubicle together with an ON/OFF isolating switch suitable for electrical operation at 230 volts A.C 50 Hz single phase of sufficient capacity to raise the internal ambient temperature by 5ºC. The electrical apparatus so protected shall be designed so that the maximum permitted rise in temperature is not exceeded if the heaters are energized while the switchboard is in operation. As a general rule, the heaters shall be placed at the bottom of the cubicle.

Ventilation Fans

The Switchboard shall be provided with panel mounting type ventilation fans in each panel with switchgear rated for 800 amps and above. The fan shall be interlocked with switchgear operation. If ventilation fans cannot be provided for maintaining the required degree of ingress protection, the design of switch board cubical shall incorporate suitable measures like decreasing current density of conductors, increasing

cubical volume for effective heat dissipation etc. in order to restrict temperature rise to within the required limit.

Earthing

Continuous internal copper earth bus sized for prospective fault current to be provided with arrangement for connecting to station earth at two points. Hinged doors / frames to be connected to earth through adequately sized flexible braids.

Sheet Steel Treatment And Painting

Sheet steel used in the fabrication of switchboards shall undergo a rigorous cleaning and surface treatment seven tank process comprising of alkaline degreasing, descaling in dilute sulphuric acid and a recognized phosphating process after which a coat of primer paint compactively with the final paint shall be applied over the treated surface. Final paint coat of oven baked powder coating, of minimum 80-micron thickness, of sheet approved by Architect/Client shall then be provided.

Name Plates And Labels

Suitable engraved white on black name plates and identification labels of metal for all Switchboards and Circuits shall be provided. These shall indicate the feeder number and feeder designation.

Local Authorities Requirement

All other requirements by the local Authority that are imposed in course of execution of the work, particularly those listed below shall be provided.
Danger Signs
Rubber floor mats will be provided all around the panels as per IS 156522007 amended up to date.
A dry chemical type fire extinguisher of 9 kg capacity with approved label
Framed single line diagram with minimum A1 size
First Aid Demonstration sign.

CPRI TESTING
Switchboard configurations offered shall be CPRI tested. Copies of the CPRI test certificates shall be submitted with the tender.

TESTING AT WORKS
Copies of type test carried out at ACB/MCCB manufacturers works and routine tests carried out at the switchboard fabricators shop shall be furnished along with the delivery of the switchboards. Client reserves the right to get the switchboard inspected by their representative at fabricators works prior to dispatch to site to witness the routine tests

Type Test

The main distribution board and the components as applicable shall be type tested in accordance with the IEC standards to verify the specified fault level withstand capacity from a reputed and approved type testing laboratory and certified by an competent authority.

The tests as specified in IEC 614391 standards to comply with requirements of TTA equipment shall be carried out at recognized test laboratories and certificates from approved test witnessing authority shall be provided for each type test:

Type test certificates shall be submitted to the client for verification.

Routine test

The panel assembler shall perform the routine test and provide the test certificates as de fined in IEC standards. The routine test shall include but not limited to the following:
Inspection of the assembly including inspection of wiring and electrical operational test (IEC Clause 8.3.1);
Dielectric test & Insulation resistance test (IEC Clause 8.3.2 & 8.3.4);
Checking of protective measures and of the electrical continuity of the protective circuits (IEC Clause 8.3.3)
Functional test as per the approved test procedure.

Routine test certificates and test readings shall be submitted to the consultant engineer for verification.

INSTALLATION

The foundations prepared as per the manufacturers drawings shall be levelled, checked for accuracy and the Switchboard installed. All bus bar connections shall be checked with a feeler gauge after installation. The cable end boxes shall be sealed to prevent entry of moisture. The main earth bar shall be connected to the substation earths. Antistatic rubber mat ting of approved make conforming to IEC/BS relevant standards, of minimum 1000 mm width 10 mm thickness shall be provided in front of and along the full length of the Switchboard. The rubber mat shall withstand 15 KV for 1 minute and leakage current shall not exceed 160 mA/sq. meters. After installation the Switchboard shall be tested as required prior to commissioning.

TESTING AT SITE

Pre-commissioning tests as required and as per manufacturers recommendations shall be carried out on each switchboard at site before energizing the switchboards including but not restricted to the following:

Physical checking of the switchboards including checking alignment of panels, inter connection of Bus bars, tightness of bolts/connections and

evidence of dam age/cracks in any components.
Physical checking and inspections of Inter panel wiring
Checking free movement of ACBs/MCCBs/SFUs
Checking of operation of breakers
Insulation tests of bus bar supports and control wiring etc. with 1.1 kV megger.
Primary & secondary injection tests of relays and CTs.
Checking of Interlocking function.

AIR CIRCUIT BREAKER

General Points

The ACB shall conform to IS/IEC 609472. The ACBs shall be type tested & certified for compliance to standards. All ACBs shall have "CE" Marking

All ACBs shall be suitable for continuous operation at Ambient Temperature of 50°C without any deration.

All ACBs shall have Icu=Ics=Icw for 1 Second with Combined Test Sequence Certification from Independent Testing Approved Authorities CPRI/ERDA/ASTA/KEMA.

All ACBs shall have Rated Impulse withstand voltage of the main circuit of not less than 12kV (Uimp) & Rated Insulation Voltage of not less than 1000 V.

Neutral Pole shall be of 100% Current Rating as Phase pole (In case of 4 Pole ACBs). However, in case where 3 Pole ACBs with O/L, S/C, E/F (Inbuilt E/F mandatory in all ACBs) are specified, vendor to provide Neutral CT from ACB manufacturer.

The release shall be equipped with Inbuilt Thermal Memory.

All ACBs shall be provided with Door Interlock and Racking Interlock. One shall not be allowed to open the panel door without ensuring that the ACB is in "ISOLATED" position

All ACBs shall be provided with Mechanical Operation Counter.

All ACBs shall have provision of removing Arc Chutes without use of any tool thus facilitating quick inspection of electrical contacts.

All ACBs equipped with Shunt Release shall have the operating voltage range from 10% Unto 110% Un to ensure intentional tripping even at high voltage drops during short circuit.

Lockable Trip Push Button shall be provided wherever Interlock between ACBs is specified.

All ACBs shall have sealable sliding shutters to prevent unauthorized access to “TRIP” and “CLOSE” push buttons

All ACBs shall have their Electrical Life with maintenance = Mechanical Life. Minimum no. of operational life shall be as follows:

For Ratings up to 2500A: 20,000 Operations; For 3200A & 4000A: 10,000 Operations;
For 5000A & 6300A: 5,000 Operations

It shall be possible to terminate Aluminium Links directly (without any adaptors) as specified in IS139472

All ACBs shall have protection against O/L, S/C & E/F and shall provide indication of cause of tripping for individual faults.

For safety of users, interlock shall be provided between breaker operating mechanism & the arc chutes to prevent closing of ACB in case the arc chutes are not properly secured.

All Electrical Draw Out breakers shall have inbuilt electrical anti pumping

All ACBs shall provide at least last 5 trip data history & last 10 event history for analysis

All ACBs shall have 2 storable sets of LSIG protection settings to provide adequate protection against loads varying as per time (E.g. Day Time – different protection parameter set and night time – different protection parameter set) & source changeover from Transformer to DG.

All ACBs shall have Double Short Circuit Selectivity and the same shall be with Adjustable Time Delay.

All Incomer ACB releases shall have LED Display showing all Power Parameters & Harmonic Metering (I, Imax, %loading, Iavg, V, Freq, PF, W, VAr, VA, Wh, VArh, Vah, MD Active, MD Reactive, MD Apparent, Temperature in each Phase Deg C, %THD). They shall also give ad additional protection against Undercurrent, Current Unbalance, Under Voltage, Over voltage, Under frequency, Over frequency, Reverse Power, Lead/Lag PF, MD Exceed, Wrong Phase sequence, Breaker Failure.

All Outgoing ACB releases shall have LED Display for all Current Parameters

All Main Incomer ACBs shall have inbuilt Temperature rise protection for protection against abnormal temperature rise at ACB terminals.

The ACB shall confirm to the requirements of IEC 609472 & 3 (FOR

SWITCH DISCONNEC TION) / relevant local standards and shall be type tested & certified for compliance to standards from–authorized/ any accredited international lab. The circuit breaker shall be suit able for service voltage 690, 3 Phase 50 Hz supply system. Air Circuit Breakers shall be with moulded housing flush front, draw out type and shall be provided with a trip free manual operating mechanism or in accordance with requirements with mechanical "ON" "OFF" “TRIP” indications.

The ACB shall be 3/ 4 pole with modular construction, draw out, manually or electrically operated version as specified. The circuit breakers shall be for continuous rating and service short Circuit Breaking capacity (Ics) shall be as specified on the single line diagram and should be equal to the Ultimate breaking capacity(Icu) and short circuit withstand values(Icw) for 1 sec. Circuit breakers shall be designed to ‘close' and `trip' without opening the circuit breaker compartment door. The operating handle and the mechanical trip push button shall be at the front of the breakers panel. Inspection of main contacts should be possible without using any tools. The ACB shall be provided with a door interlock. i.e. door should not be open when circuit breaker is closed and breaker should not be closed when door is open.

However, door interlock should have defeat mechanism for On line testing of ACB. All current carrying parts shall be silver plated and suitable arcing contacts with proper arc chutes shall be provided with to protect the main contacts. The ACB shall have double insulation (ClassII) with moving and fixed contacts totally enclosed for enhanced safety and in accessibility to live parts. All electrical closing breaker shall be with electrical motor wound stored energy spring closing mechanism with mechanical indicator to provide ON/OFF status of the ACB.

The auxiliary contacts blocks shall be so located as to be accessible from the front. The auxiliary contacts in the trip circuits shall close before the main contacts have closed. All other contacts shall close simultaneously with the main contacts. The auxiliary contacts in the trip circuits shall open after the main contacts open . Minimum 6 NO and 6 NC auxiliary contacts shall be provided on each breaker. Rated insulation voltage shall be 1000 volts AC and impulse withstands voltage equal to 12KV. ACB shall confirm compliance to ROHS/WEEE guidelines. All ACB’s shall be compatible to IBMS having the communication port as per de tail design/requirement.

CRADLE

The cradle shall be so designed and constructed as to permit smooth withdrawal and insertion of the breaker into it. The movements shall be free from jerks, easy to operate and shall be on steel balls/rollers and not on flat surfaces.

There shall be 4 distinct and separate position with self-locking

arrangement of the circuit breaker on the cradle.

Racking Interlock in Connected/Test/Disconnected Position.

Service Position: Main Isolating contacts and control contacts of the breaker are engaged.

Test Position: Main Isolating contacts are isolated but control contacts are still engaged.

Isolated Position: Both main isolating and control contacts are isolated.

There shall be provision for locking the breaker in any or all of the first three positions. The following safety features shall be incorporated:
Withdrawal or engagement of Circuit breaker shall not be possible unless it is in open condition.

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

All modules shall be provided with safety shutters operated automatically by movement of the carriage to cover exposed live parts when the module is withdrawn.

All Switchgear module front covers shall have provision for locking.

Switchgear operating handles shall be provided with arrangement for locking in 'OFF' position.

PROTECTIONS

The breaker should be equipped with microcontroller based release to offer accurate and versatile protection with complete flexibility and shall offer complete over current protection to the electrical system in the following four zones

- Long time protection.
- Short time protection with intentional delay.
- Instantaneous protection.
- Ground fault protection.

The protection release shall have following features and settings:

True RMS Sensing

The release shall sample the current at the rate of 16 times per cycle to monitor the actual load current waveform flowing in the system and shall monitor the true RMS value of the load current. It shall take into account the effect of harmonics also.

Thermal Memory

When the breaker shall reclose after tripping on overload, then the thermal stresses caused by the overload if not dissipated completely, shall get stored in the memory of the release and this thermal memory shall ensure reduced tripping time in case of subsequent over loads. Realistic Hot/Cold curves shall take into account the integrated heating effects to offer closer protection to the system.

Defined time current characteristics:

A variety of pickup and time delay settings shall be available to define the current thresh olds and the delays to be set independently for different protection zones thereby achieving a closet ideal protection curve.

Trip Indication

Individual fault indication for each type of fault should be provided by LEDs for fault diagnosis.

Self powered

The release shall draw its power from the main breaker CTs (hog slay type) and shall require no external power supply for its operation.

Zone Selective Interlocking

The release shall be suitable for communication between breakers to enable zone selective interlocking. This feature shall be provided for both short circuit and ground fault protection zones to offer total discrimination between breakers. This feature enables the clearance of fault conditions, thereby reducing the thermal and dynamic stresses produced during fault conditions and thus minimizes the damage to the system. To implement ZSI manufacturer should supply all related equipment like power supply, wiring etc.

On Line change of settings should be possible. It should be possible to carry out testing of re lease without tripping the breaker.

The release shall meet the EMI / EMC requirements.

Derating factor In panel there shall not be any derating up to 50 degree Centigrade. Manufactures shall provide the derating table/chart and ambient temperature.

4P ACB shall have 100% Neutral as same of Phase conductor with protection setting (setting of 50%, 100%, 200% and Off)

ACB release shall have 1^{st} –ON/OFF setting to coordinate with HT

breakers.

ACB release shall have inbuilt "Auto protection" against excessive heating at terminals.

Combined accuracy (Sensor + Release) ≤ 1.5% as per international code of practice.

The setting range of release shall be as follows as per SLD :

The release should provide local indication of actual %age loading of individual phase at any instant. The release should be able to communicate on MODBUS RTU protocol using inbuilt RS485 port and shall be integral part of supply with trip unit. Parameters of the Protection Release should be changeable from Release as well as thru communication network.

ACB should have rating plug

This type of release should be equipped with data logger and information about last20 trips including cause of trip, value of interrupted current with date and real time stamping, should be stored in the memory with this type of release.

The release should also be equipped with protection against phase unbalance and over temperature.

Setting range of protection release

Overload protection shall have adjustable setting from 40% to 100% of the ACBs rated current.
Short time Short circuit protection shall have adjustable current setting from 100% to 1000% of the overload setting and adjustable time delay setting for fault discrimination from 50800 m sec.
Instant short circuit protection shall have a adjustable current setting from 150% to 1500% of the overload setting.
E/F protection if specified will have adjustable current setting from 20% to 100% of ACB rated current and adjustable time setting from 100800m sec.

Metering Function –
Phase/ Neutral/ Ground Currents Voltage and power
Power Factor
Frequency & Peak Factor
Energy (Active, Reactive, Apparent)

Signaling/ Alarm Function –
Warning Alarm Temperature
LSIG Protection
Fault release mechanical failure

Under Voltage & over Voltage (Timing & trip) Reverse Power Protection (Timing & Trip)
Under Frequency & Over Frequency (Timing & Trip)

Available Data/ Event/ Operating Mechanism
Circuit Breaker Status (Open, close)
Circuit Breaker Position (Racked In, Racked Out) Mode (Local, Remote)
Event Status – Status changes in CB and in all alarms Reset Alarms
Setting of Curves and protection thresh hold Synchronization of system time

Maintenance Data

Total no. of operations Total no. of Trips
No. of Trip test
No. of manual operation
No. of separate trip for each trip protection function

Contact Wear (%)
Record Data of last trip

SAFETY FEATURES

The safety shutter shall prevent inadvertent contact with isolating contacts when breaker is withdrawn from the Cradle.

It shall not be possible to interchange two circuit breakers of two different thermal ratings. For Draw out breakers, an arrangement shall be provided to prevent rating mismatch between breaker and cradle.

There shall be provision of positive earth connection between fixed and moving portion of the ACB either thru connector plug or sliding solid earth mechanism. Earthing bolts shall be provided on the cradle or body of fixed ACB.

The incoming panel accommodating ACB shall be provided with indicating lamps for ON OFF positions, digital voltmeter and ammeter of size not less than 96 mm x 96 mm, se lector switches, MCB for protection circuit and measuring instrument circuits.

It shall be possible to bolt the draw out frame not only in connected position but also in TEST and DISCONNECTED position to prevent dislocation due to vibration and shocks.

Draw out breakers should not close unless in distinct **Service/Test/Isolated positions.**

The insulation material used shall conform to Glow wire test as per IEC60695.

The ACB shall provide in built electrical and mechanical antidumping.

MOULDED CASE CIRCUIT BREAKER (MCCB)

The MCCB should be current limiting type with trip time of less than 10 milli sec under short circuit conditions. The MCCB should be either 3 or 4 poles as specified in report, specs. & as per detail design. MCCB shall comply with the requirements of the relevant standards IEC 609472 and should have test certificates for Breaking capacities (Ics=Icu=100%) from independent test authorities of or any accredited international lab.

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

The breaking capacity of MCCB shall be as per detail design. The rated service breaking capacity (Ics) should be equal to rated ultimate breaking capacities (Icu). MCCBs for mo tor application should be selected in line with Type2 Coordination as per IEC 609472 . The breaker as supplied with ROM should meet IP54 degree of protection.

For Motor application, motor duty type MCCBs shall be selected with reference to Type 2 coordination chart provided by the manufacturer.

a) All MCCBs shall have Phase Barriers & Extended Rotary Operating Handles with door interlocks.

All MCCBs shall have Aux Contact (For On Off Indication), Trip Alarm Contact (For Trip Indication) and Shunt / UVR Release as specified

All MCCBs shall have Icu=Ics = 25/35kA/50kA/70kA Breaking Capacity at 415V as specified & as per detail designed calculations.

- MCCB shall be suitable for positive Isolation as per IEC 609472
- MCCB shall comply with “ClassII front facia as per IEC 61140”
- MCCB shall be provided with continuously rated coils.
- All Incomer MCCB & Outgoings (where specified) shall have Earth Fault as inbuilt/extra built feature

Current Limiting & Coordination

The MCCB shall employ maintenance free minimum let through energies and capable of achieving discrimination up to the full short circuit capacity of the downstream MCCB. **The manufacturer shall provide both the discrimination tables and let through energy curves for all. It shall be responsibility of Panel builder & OEM to carry out the discrimination study at the time of drawing approval.**

Protection Functions

MCCBs with ratings up to 250 A(Wherever earth fault asked shall be inbuilt) shall be equipped with Thermal magnetic (thermal for overload and magnetic for short circuit protection) trip units Microprocessor MCCBs with ratings above 250A shall be equipped with microprocessor based trip units. (both variable setting) Microprocessor and thermal magnetic trip units shall be adjustable and it shall be possible to fit lead seals to prevent unauthorized access to the settings Microprocessor trip units shall comply IEC 609472 standard (measurement of rms current values, electromagnetic compatibility, etc. Protection settings shall apply to all poles of circuit breaker. All Microprocessor components shall withstand temperatures up to 25 to +70 °C

Testing

Original test certificate of the MCCB as per IEC 609471 &2 shall be furnished.

Pre-commissioning tests on the switch board panel incorporating the MCCB shall be done as per standard specifications.

Interlocking

Moulded, case circuit breakers shall be provided with the following interlocking devices for interlocking the door of a switch board.

Handle interlock to prevent unnecessary manipulations of the breaker.
Door interlock to prevent the door being opened when the breaker is in ON position.
Defeat interlocking device to open the door even if the breaker is in ON position.

The MCCB shall be current limiting type and comprise of quick make – Break switching mechanism. Microprocessor MCCBs shall be capable of defined variable over load adjustment.

All MCCB with microprocessor based release unit, the protection shall be adjustable Overload, Short circuit and earth fault protection with time delay.
The trip command shall override all other commands.

MOTOR PROTECTION CIRCUIT BREAKER (MPCB)

Motor circuit breakers shall conform to the general recommendations of standard IEC 60947 1,2 and 4 (VDE 660, 0113 NF EN 60 947124, BS 4752). The devices shall be in utilization category A, conforming to IEC 9472 and AC3 conforming to IEC 60947 4.MPCB shall have a rated operational and insulation voltage of 690V AC (50 Hz) and MPCB shall

be suitable for isolation conforming to standard IEC 609472 and shall have a rated impulse withstand voltage (U imp) of 6 kV. The motor circuit breakers shall be designed to be mounted vertically or horizontally without derating.

Power supply shall be from the top or from the bottom. In order to ensure maximum safety, the contacts shall be isolated from other functions such as the operating mechanism, casing, releases, auxiliaries, etc, by high performance thermoplastic chambers. The operating mechanism of the motor circuit breakers must have snap action opening and closing with free tripping of the control devices. All the poles shall close, open, and trip simultaneously. The motor circuit breakers shall accept a padlocking device in the “isolated” position.

The motor circuit breakers shall be equipped with a “PUSH TO TRIP” device on the front enabling the correct operation of the mechanism and poles opening to be checked. The auxiliary contacts shall be front or side mounting, and both arrangements shall be possible. The front mounting attachments shall not change the breaker surface area. Depending on its mounting direction the single pole contact block could be NO or NC. All the electrical auxiliaries and accessories shall be equipped with terminal blocks and shall be plug in type. The motor circuit breakers shall have a combination with the downstream contactor enabling the provision of a perfectly coordinated motor starter. The contactor should be selected as per type 2 coordination or 140% of FLC (for DOL starters) or 140% of Star and Delta Current respectively (for SD starters), whichever is higher. This combination shall enable type 1 or type 2 coordination of the protective devices conforming to IEC 6094741.Type 2 coordination shall be guaranteed by tables tested and certified by an NABL certified laboratory:

The motor circuit breakers, depending on the type, could be equipped with a door mounted operator. The motor circuit breakers shall be equipped with releases comprising a thermal element assuring overload protection and a magnetic element for short circuit protection for DOL starters. For SD starters the MPCB should be with magnetic element for short circuit protection only. Overload protection shed be provided through separate relay In order to ensure safety and avoid unwanted tripping, the magnetic trip threshold (fixed) shall be factory set to an average value of 12 Ir.

All the elements of the motor circuit breakers shall be designated to enable operation at an ambient temperature of 60°C without derating. The thermal trips shall be adjustable on the front by a rotary selector. The adjustment of the protection shall be simultaneous for all poles. Phase unbalance and phase loss detection shall be available.

CONTROL WIRING:

All control wiring shall be done as a standard, using 1.5sq.mm. Multi

stranded PVC insulated FRLS copper wires. These shall be black in color for AC and grey in color for DC. The C.T. connections shall be done using 2.5 sq.mm. Multi stranded PVC insulated copper wires of red color.

The outgoing control wires shall be terminated from the equipment terminals to control terminal block in cable chamber. Whenever required PVC channels shall be used for wire routing. On either ends of these wires self-locking yellow ferrules with black letters shall be provided. Multi stranded wire termination shall be provided with crimping type lugs.

INTERMODULE WIRING:

The control wiring between modules located in the same vertical section shall be connected at the respective terminal blocks/ terminals. These shall be routed through the cable duct in PVC wire channels. Inter connections between adjacent cubicle in the same shipping sections shall be done in a similar way.

CURRENT TRANSORMERS:

Current transformer meant for metering & protection shall be mounted on the bus links either on the incoming side or outgoing side as the case may be. They shall be wired and terminated suitably for external connection.

FUSES

All fuses shall be of the HRC cartridge type, conforming to IS: 2208 mounted on plugin type of fuse bases having a prospective current rating of not less than 50 KA. Fuses shall be provided with visible operation indicators to show that they have operated. Insulated fuse pulling handle shall be supplied with each control panel.

INDICATING INSTRUMENTS & METERS

Electrical indicating instruments shall be flush mounted digital type having min. 96 mm square dial.

CONTROL AND SELECTOR SWITCHES

Control and instrument switches shall be of the rotary type and shall be provided with properly designated plate. Control switches shall have momentary contacts spring return to centre with pistol grip handle. Instrument and selector switches shall have stay put contacts.

PUSH BUTTONS

All push buttons shall be of push to actuate type having 2 `NO' and 2

`NC' self reset contacts. They shall be provided with designation plates, engraved with their functions. Push button contacts shall be rated for 10 amps at 415V A.C. and 0.6 Amp. Inductive breaking at 220V D.C.

DRAWINGS

The contractor shall provide the following drawings for approval to the department before commencement of supply/ fabrication.

i) General layout Plan, section, elevations
ii) Foundation
iii) Wiring Power& Control

ROTARY SWITCHES

Switches upto 60amps shall be rotary type with compact and robust construction, build up from one or more stacks with contacts and a positioning mechanism with stop as required. The terminals shall be shrouded with insulation to prevent accidental contact with live parts. Rotary switches shall be backed up with moulded type HRC fuse fittings of appropriate rating.

SELECTOR SWITCH

When called for, selector switches of rated capacity shall be provided in control panel, to give the choice of operating equipment in selective mode.

STARTERS

Each motor shall be provided with a starter of suitable rating. Starters shall be in accordance with IS: 18221967.

Direct on line starters shall be provided for motors upto 7.5 HP. Star Delta type starters shall be provided for motors of 10.0 HP and above capacity.

Starters contactors shall have 3 main and 3 auxiliary contacts and shall be air break type suitable for making and breaking contact at minimum power factor of 0.38. `For design con side ration of contactors, the starting current of connected motor shall be assumed to be 6 times the full load current of the motor in case of direct online starters, and 3 times the full load current of the motor in case of star delta/Reduced Voltage Starters.

Main and auxiliary contacts shall be silver or silver alloy. The insulation for contactor coils shall be of class "B". Operating coils of contactors shall be suitable for 220/415 ± 10% volts AC, 50 cycles supply system. The contactors shall drop out when voltage drops to 80% of the rated voltage. The housing of the contactors shall be heat resistant and having

high impact strength. Each starter shall have thermal overload protection on all three phases and also single phasing preventing relay.

OVER LOAD RELAYS

Contactors shall be provided with a three element, positive acting ambient temperature compensated time lagged hand reset type thermal over load relay with adjustable setting. Handreset button shall be flush with the front door for resetting with starter compartment door closed; Relays shall be directly connected for motors upto 150 HP capacity. C.T. operated relays shall be provided for motors above 150 HP capacity. Heater circuit contactors shall also be provided with overload relays.

SINGLE PHASE PREVENTERS

Single phase preventers shall be provided on all the three phase motor starters and shall be in conformity with relevant ISI standards. Single phase preventers shall act when the supply voltage drops down to 90% of the rated voltage or on failure of one or more phases.

TIME DELAY RELAYS

Time delay relays shall be adjustable type with time delay adjustment from 0180 seconds and shall have one set of auxiliary contacts for indicating lamp connection.

TOGGLE SWITCH

Toggle switches, where called for, shall be in conformity with IS 38541969 and shall be of 5 amps rating.

PUSH BUTTON STATIONS

Push button stations shall be provided for manual starting and stopping of motors/equipment as called for, `RED' and `GREEN' colour push buttons shall be provided for `starting' and `stopping' operations. `Start' or stop indicating flaps shall be provided for push buttons. Push buttons shall be suitable for panel mounting and accessible from front without opening door, dock lever shall be provided for `Stop' push button. One set of normally open and one set of normally closed contacts shall be provided in push button stations. The push buttons contacts shall be suitable for 15 amps current capacity.

WIRES, CABLES & CONDUITS

All Cabling, Wiring & Conduits work shall be done for wiring as per Electrical Specification part of this tender. All Fire case fans & AHU's & other equipment's shall strictly be supplied with Fire survival MICC/MICA cables on GI/SS cable trays as detailed out in the electrical

part of tender specifications.

Cable Laying

Cable shall be laid generally in accordance with Indian standard code of practice. Cables shall be laid on 14 gauge perforated M.S. sheet cable trays as approved by the Supervisor. Easy access to all cables shall be provided to allow cable withdrawal/replacement in the future. Where more than one cable is running, proper spacing shall be provided to minimize the loss in current carrying capacity.

Cables shall be suitably supported with wooden cleats when run on wall/floor ducts. When buried, they shall be covered with a layer of soft sifted sand and protected with cement concrete tiles. Special care shall be taken to ensure that the cable is not damaged at bends. The radius of bend of the cables when installed shall not be less than 12 times the diameter of cable.

Cable Sizes

Power Wiring shall be of the copper/ aluminium conductor steel armored XLPE insulated PVC sheathed FRLS cables ISI marked. Sizes of the cables shall be selected considering all required parameters at detail design stage/ system requirement.

All the switches, contactors, push button stations, indicating lamps shall be distinctly marked with a small description of the service installed. Circuit wiring diagram of control panel shall be fixed to the cover of control panel for verification. The following capacity contactors and overload relays shall be provided for different capacity motors:

DRAWINGS

Shop drawings for control panel sand wiring of equipment showing the route of conduit/cable shall be submitted by the contractor for approval of purchasers before starting the fabrication of panel and starting the work. On completion, four sets of completion/"As installed" drawings incorporating all details like, conduit routes, number of wires in conduit, location of panels, switches, junction/pull and cable route etc. shall be furnished by the Con tractor.

PAINTING

All sheet steel work shall undergo a process of degressing, thorough cleaning, and painting with a high corrosion resistant primer. All panels shall then be backed in an oven. The finishing treatment shall be by application of synthetic enamel paint of approved shade.

TESTING

Before commissioning of the equipment, the entire electrical installation shall be tested in accordance with code of Practice IS:7321963 (Revised) and test report furnished by a qualified and authorized person.

All tests shall be carried out in the presence of Engineering Charge.

MISCELLANEOUS

The final connections to the equipment shall be through flexible connections in case of conduit wiring and also where the equipment is likely to be moved back and forth, such as on slide rails.

An isolator switch shall be provided at any motor which is separated from the main switch panel by a wall or partition or other barrier or is more than 15 meters away from the main panel.

Two separate and distinct earthing conductors shall be connected from the equipment upto the main switch board panel.

The branch lines from the main panel to each equipment shall be separated and should not cross other lines.

The entire installation shall be tested as per electricity rules and IS:7321963 with amendments 1,2 & 3 prior to the commissioning of the plant and a suitable test report furnished by a competent and authorized person. The test report will be obtained by contractor himself at his own expenses.

All exposed switch board panels, conduits; hangers etc. shall be given 2 coats of suitable paint of approved colour, when all work has been completed.

19 TESTS AT SITE & FACTORY

GENERAL

The contractor must perform all inspection and tests of the system as a whole and of components individually as required, under the supervision of the

Purchaser's/ Engineering charge in accordance with the provisions of the applicable ASHRAE / SMACNA / ARI standards or approved equal and as per load requirements.

EVAPORATORS/ PUMPS ETC.

- Identification of materials in accordance with test certificates.
- Inspection of various laboratory test certificates for physical properties and technical composition conducted on test samples of materials to be used for fabrication, forging etc. for all important components of various equipment.
- Hydraulic test for important components and assembled equipment's at 1.5 times de sign pressure or double the operating pressure whichever is higher.
- Pneumatic leak test after assemblies at design pressure.
- Inspection of assemblies and disassembly of various parts of equipment's and complete equipment's themselves as desired by Engineer in Charge.
- Mechanical running test on test bed at factory for various equipment's in presence of Engineer in Charge for at least 8 hours for each equipment.
- Testing of oil passages in compressor at 1.5 times pump discharge pressure.
- Vibration test for various rotating/reciprocating equipment.
- Noise level test for various rotating/reciprocating equipment.
- Pressure drop test for condenser and evaporator.

AIR HANDLING UNITS

BLOWERS

- Identification of materials in accordance with test certificates.

COILS

- Identification of materials in accordance with test certificates.
- Pneumatic test.

FILTERS

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

PIPING : Materials check for specifications and size.

VALVES

Hyd./pneumatic test certificates.

MOTORS

Manufacturer's test certificate as per motor data sheet.

INSTRUMENTS AND CONTROLS

Visual examination.

FOR ASSOCIATES WORKS AT SITE

- All electrical items will be subjected to inspection at any stage during manufacturing activity. Routine electrical test as per relevant codes. Inspection of manufacturer's test certification.
- Inspection of raw materials to be used for fabrication and assembly and inspection of manufacturer's certificates.
- Pressure testing of pipe fittings used for the refrigerant and water services.
- Pressure testing, leak testing of complete piping network for chilled water. Condenser water and refrigerant/services.
- Checking of electrical circuits (power & controls) and checking

functioning of controls of refrigerant systems and other circuits of air conditioning plant.

- Checking of assemblies for electrical control panel, instruments panels, local panels (dimensional and functional) annunciator panels etc.

- Inspection of complete electrical installation at site.

Performance testing of complete A.C. plant as per specifications.

The above inspection procedure is given for general guidance and information of vendors and inspection of purchaser is strictly not limited to these and inspection engineer of purchaser will have full right to have detailed inspection at any stage right from placement of order to completion of project as desired by inspection engineer, coordination of inspection agency of purchaser with his factory/sub contractor's factory/ erection site will be the sole responsibility of successful con tractor after placement of order for complete air conditioning plant covered under these technical specifications.

PIPING SYSTEM

- In general pressure tests shall be applied to piping only before connection of equipment and appliances. In no case shall piping, equipment or appliances be subjected to pressures exceeding their test ratings.

- Tests shall be completed and approved before any insulation is applied.

- After tests have been completed, the system shall be drained and cleaned of all dust and foreign matter. All strainers, valves and fittings shall be cleaned of all dirt, fit tings, and debris.

WATER PIPING

All water piping shall be tested and proven tight under hydrostatic pressure of 1 1/2 times the design pressure unless stated otherwise in the specifications. Prescribed pressure shall be maintained for four hours.

DUCT WORK

- All branches and outlets shall be tested for air quantity, and the total of the air quantities shall be within plus five percent (5%) of fan capacity.

- Fire dampers, volume dampers and splitter dampers shall be tested for proper operation.

BALANCING AND ADJUSTMENT

All air handling ventilation equipment, duct work and outlets shall be adjusted and balanced to deliver the specified air quantities indicated, at each inlet and outlet, on the drawings. If these air quantities cannot be delivered without exceeding the speed range available horse power, the department shall be notified before proceeding with the balancing of air distribution system.

ELECTRICAL EQUIPMENT

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

PERFORMANCE TESTS

The installation as a whole shall be balanced and tested upon completion, and all relevant information, including the following shall be submitted to the purchasers.

- Air volume passing through each unit, duct, grilles, aperures.
- Differential pressure readings across each filter, fan and coil, and through each pump.
- Electrical current readings, in amperes of full and average load running, and starting, together with name plate current of each electrical motor.
- Continuous recording over a specified period, of ambient wet and dry bulb temperatures under varying degrees of internal heat loads and use and occupation, in each zone of each part of the

building.

- Daily records for a period of seven should be maintained of hourly readings, taken under varying degrees of internal heat load and use and occupation, of wet and dry bulb temperatures, upstream "oncoil" of each cooling coil. Also suction temperatures and pressures for each refrigerating unit. The current and voltage drawn by each machine.

- Any other readings shall be taken which may subsequently be specified by the client.

MISCELLANEOUS

- The above tests are mentioned herein for general guidance and information only but not by way of limitation to the provisions of conditions of contract and specification.

- The date of commencement of all tests listed above shall be subject to the approval of the purchaser, and in accordance with the requirements of this specification.

- The contractor shall supply the skilled staff and all necessary instruments and carry out any test of any kind on a piece of equipment, apparatus, part of system or on a complete system if the purchaser requests such a test for determining specified or guaranteed data as given in the specification or on the drawings.

- Any damage resulting from the tests shall be repaired and/or damaged material re placed, to the entire satisfaction of the department.

- In the event of any repair or any adjustment having to be made, other than normal running adjustment, the tests shall be void and shall be recommended after the adjustment or repairs have been completed.

- The contractor must inform the department when such tests are to be made, giving sufficient notice, in order that the purchaser or his nominated representative maybe present.

- Complete records of all tests must be kept and 3 copies of these and location drawings must be furnished to the department.
- The contractor may be required to repeat the test as required, should the ambient conditions at the time not given, in the opinion of the purchaser, sufficient and suit able indication of the effect and performance of the installation as a whole or of any part, as required.

- In case of equipment's being supplied by the contractor from a place outside India for which department may or may not be able to send

its representative, the manufacturers test certificates (for all acceptance test) for inspection of material and witnessing the various tests at the factory as carried out by the manufacturer have to be submitted along with the supply of equipment's. This must be witnessed by a representative of the contractor.

NOTES:

A. TEST INSTRUMENTS

- All instruments for testing shall be provided by the air conditioning contractor.
- Thermometer used for measurement of temperature of water/refrigerant shall have graduations of 0.1ºC and shall be got calibrated from N.P.L. or any recognized test house before hand.
- Thermometers used in the psychrometers shall have graduations of 0.2° C and shall be calibrated as at (2) above.
- Pressure gauges shall also be got calibrated from a recognized test houses.
- Where ever the flow rate vs. pressure drop curves for the heat exchangers of the same mode, as installed, certified by department on the basis of tests conducted at manufacturer's works are produced, flow meters for measuring water flow rate through these may not be provided. Actual water flow shall in such a case, be computed with reference to these curves and the actual pressure drop measured at site.
- Integrating type flow meters may be used for measuring water flow through the individual air handling units.
- Air flow rates shall measure in the supply duct using pilot tube.

CAPACITY COMPUTATIONS

1. AIRHANDLING UNITS

The capacity shall be computed from the water temperature and water flow measurements. A tolerance of ± 5% from the A/T value shall be acceptable in the capacity to computed. Air quantity shall be measured in the supply duct and checked with the quantity specified in the A/T. A tolerance of ±10% in the air quantity shall be acceptable. The enthalpy difference of air entering and leaving the coil shall be computed from air temperature. The capacity of TFA/HR Units shall be computed 75% both sensible and latent.

20 DETAILS OF TESTS TO BE CARRIED OUT AT SITE

CONDITIONS /ITEM	UNIT	TEST
Ambient conditions		
– Date/Day/Time		
– Temp. DB/WB	°C	
– RH	%	
CHILLER		
Chiller Make/Model	N	
Water flow rate	LP	
Water temp. entering	°C	
Water temp. leaving	°C	
Water pressure entering	m	
Water pressure leaving	m	
Refrigerant Suction Temp.	°C	
Refrigerant Suction Pressure	m	
Capacity specified	K	
Capacity stipulated at 100%	K	
load on the compressor		
Capacity specified	K	
COMPRESSOR		
Compressor Make/Model	N	
Speed	R	
Refrigerant suction pressure	K	
Refrigerant discharge pressure	K	
Refrigerant discharge temp.	°C	
Oil pressure	K	
Capacity specified	T	
Capacity stipulated at various loading	T	
COMPRESSOR MOTOR		
Motor make/Model	N	
Speed	R	
Voltage	V	
Motor rating	K	
Current at 100% load	A	
Current down at various loading steps.	A	
CONDENSER		
Condenser Make/Model	N	
Refrigerant condensing pressure	K	
Refrigerant condensing temp.	°C	
Air entring temperature	°C	

	CONDITIONS /ITEM	UNIT	TEST
	No. of condenser fan	Nos	
	Motor Make/Model	Nam	
	Motor rating	KW	
	Current	Amp.	
	Capacity specified	TR.	
	Capacity stipulated at 100%	TR.	
	load on the compressor		
	PUMPS		
	(Pressure to be tested of existing pumps after installation of gauges for		
	Pumps Make/Model	Nam	
	Impeller diameter	mm	
	Speed	RPM	
	Water pressure entering	Kg/S	
	Water pressure leaving	Kg/S	
	Motor rating	KW	
	Motor current at full load	Amp	
	Motor voltage at full load	Volts	
	Water flow rate (specified)	LPM	
	Water flow rate (computed)	LPM	
	AIR HANDLING UNITS		
	(To be tested after changing of filters and capacity of AHU to evaluate whether		
	AHU Make/Model	Nam	
	Fan speed	RPM	
	Fan Motor rating (specified)	KW	
	Fan Motor current drawn	Amp	
	Line voltage	Volt	
	Fan capacity (specified Air qty.)	CFM	
	Fan capacity (computed Air qty.)	CFM	
	Coil face area	Sq.m	
	Air temp. entering		
	– Dry bulb	°C	
	– Wet bulb	°C	
	Water temp. entering	°C	
	Water temp. leaving	°C	
	Water pressure entering	Kg/S	
	Water pressure leaving	Kg/S	
	Water flow rate	LPM	
	Motor rating	KW	
	Motor current at full load	Amp	
	Total cooling capacity (specified)	TR.	
	Cooling capacity (Computed)	TR.	

CONDITIONS /ITEM	UNIT	TEST
FAN COIL UNITS		
FCU Make/Model	Na	
Fan speed	RP	
Fan Motor rating (specified)	K	
Fan Motor current drawn	A	
Line voltage	Vol	
Fan capacity (specified Air qty.)	CF	
Fan capacity (computed Air qty.)	CF	
Coil face area	Sq.	
Air temp. entering		
– Dry bulb	°C	
– Wet bulb	°C	
– Wet bulb	°C	
Water temp. entering	°C	
Water temp. leaving	°C	
Water pressure entering	Kg	
Water pressure leaving	Kg	
Water flow rate	LP	
Motor rating	K	
Motor current at full load	A	
Total cooling capacity (specified)	TR	
Total cooling capacity (Computed)	TR	
VENTILATION FANS		
FAN Make/Model/Type	Na	
Fan speed	RP	
Fan Motor rating (specified)	K	
Fan Motor current drawn	A	
Line voltage	Vol	
Fan capacity (specified Air qty.)	CF	
Fan capacity (computed Air qty.)	CF	
DRY SCRUBBER		
Make of dry scrubber & fan		
Type of fan		

CONDITIONS /ITEM	UNIT	TEST
No of fans per dry scrubber		
Capacity of each fan		
BKW of each fan		
Motor HP of fan		
Efficiency of collector plate		
Efficiency of collector plate		
Make of Ionizer		
Face velocity across filter		
ROOM CONDITIONS (For all areas)		
Date :		
Day :		
Time :		
Room Temperature	AM/PM	
– Dry Bulb	°C	
– Wet Bulb	°C	
Ambient Temperature		
– Dry Bulb	°C	
– Wet Bulb	°C	

21 MODE OF MEASUREMENTS

UNIT PRICES

The unit price shall be held to include everything necessary to complete the work covered by this item in accordance with the specifications and drawings. The sum to tal of all the individual item prices shall represent the total price of the installation ready to be handed over.

The unit price of the various items shall include the following:

- All equipment, machinery, apparatus and materials required as well as the cost of any tests which EIC may request in addition to the tests generally required to prove quality and performance of equipment.
- All the labour required to supply and install the complete installation in accordance with the specifications/drawings.
- Use of any tools, equipment, machinery, lifting tackle, scaffolding, ladders etc. required by the contractor to carry out his work.
- All the necessary measures to prevent the transmission of vibration.
- The necessary material to isolate equipment foundations from the building structure, wherever necessary.
- Storage and insurance of all equipment apparatus and materials.

The contractor's unit price shall include all equipment, apparatus, material and labour indicated in the drawings and/or specifications in conjunction with the item in question, as well as all additional equipment, apparatus, material and labour usual and necessary to make in question on its own (and within the system as a whole) complete even though not specifically shown, described or otherwise referred to.

The contractor's unit price shall also include all taxes, duties, octrois, works contract tax etc. as applicable.

MEASUREMENTS METAL DUCTS, GRILLES/ DIFFUSERS ETC.

SHEET METAL DUCTS

- All duct measurements shall be taken as per actual outer duct surface area including bends, tees, reducers, collars, vanes & other fittings. Gaskets, nuts, bolts, vibration reducing pads are included in the basic duct items of the SOQ./ or as per IS code.

- The unit of measurements shall be the finished sheet metal surfaces area in meters squares. No extra shall be allowed for laps and wastage.

- All the guide vanes, deflectors in duct elbows, branches, grille collars quadrant dampers etc. shall be measured for actual sheet metal surface and paid for at the same rate as duct of same thickness.

- The unit duct price shall include all the duct hangers and supports, exposing of concrete reinforcement for supports and making good of the same as well as any materials and labour required to complete the duct frame.

GRILLES/DIFFUSERS

All grilles/diffusers as per tender requirements shall be measured as follows.

- All measurements of grilles/diffusers shall be the actual outlet size excluding the outer flanges.

- The square or rectangular grills/diffusers shall be measured in sq.m.

- All round diffusers shall be measured by their diameters in cm.

- All linear diffusers shall be measured as per actual length in metres.

MEASUREMENTS OF PIPING, FITTINGS, VALVES, FABRICATED ITEMS

PIPE

- All pipes shall be measured in linear meter (to the nearest cm) along the axis of the pipes and rates shall be inclusive of all fittings e.g. tees, bends, reducers, elbows etc. Deduction shall be made for valves in the line.

- The rate quoted shall be inclusive of cutting holes, exposing reinforcement in wall and ceiling and floors and making good the same and inclusive of all items as specified in specification.

- Rates quoted shall be inclusive of providing and fixing vibration pads and wooden pieces, wherever specified or required by the Engineer in charge.

- Flexible connections, wherever required or specified shall be measured as part of straight length of same diameter, with no additional allowance being made for providing the same.

- The length of the pipe for the purpose of payment will be taken through the center line of the pipe and all fittings (e.g. tees, bends, reducers, elbows, etc.) as through the fittings are also resumed to be pipe lengths. Nothing extra whatsoever will be paid for over and above for the fittings. For valves and flanges, section 3.2 below app lies.

VALVES AND FLANGES

- 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 gun metal (gate & globe) 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.

STRUCTURAL SUPPORTS

Structural supports including supports fabricated from pipe lengths for pipes shall be measured as part of pipe line and hence no separate payment will be made. Rates shall be inclusive of hoisting, cutting, jointing, welding, cutting of holes and chases in walls, slabs or floors, painting supports and other items as described in specifications or as required at site by Engineer in Charge.

COPPER CONNECTIONS FOR FAN COIL UNITS (Wherever required)

Copper connection assembly for making connections to the fan coil units shall be measured, as part of the fan coil unit price and shall include brass flare nuts, brass straight connector, brass tees, brass reducing fittings, fixing of automatic 3 way valve, making connection and leak testing, complete assembly as per specifications and drawings, nothing extra shall be payable on account of any variation in the length of copper pipe.

INSULATION

The measurement for vessels, piping, and ducts shall be made over the bare un insulated surface area of the metal.

PIPES, DUCTS & VESSELS

PIPES

The measurements for insulation of piping shall be made in linear metres through all valves, flanges, and fittings. Pipes/bends shall be measured along the centerline radius between tangent points. If the outer radius is R1 and the inner radius is R2. The center line radius shall be measure as (R1+R2)/2. Measurement of all valves, flanges and fittings shall be measure with the running metre of pipe line as if they are also pipe lengths. Nothing extra over the above shall be payable for insulation over valves, flanges and fittings in pipe line/routings. Fittings that connect two or more different sizes of pipe shall be measured as part of the larger size.

DUCTS

The measurements for insulation of ducts shall be made in actual square metres of bare un insulated duct surface through all dampers, flanges and fittings. In case of bends the area shall be worked out by taking an average of inner and outer lengths of the bends. Measurements for the dampers, flanges, fittings shall be for the surface dimension for the connecting duct, nothing extra over the above shall be payable for insulation over dampers, flanges and fittings in duct routing.

VESSELS

The area of standard dished and flat ends of vessels shall be the square of the diameter of the uninsulated body of the shell. Areas for other shapes shall be the actual calculated area. There shall be no deduction or additions for nozzles, handles ribs, dampers, expansion joints etc. All projections on vessels or tanks shall be measured separately as pipe/duct.

ACCESSORIES INSULATION

- The unit of measurement for accessories such as expansion tank, pumps, chiller heads etc. shall be uninsulated area in square meters.

- In case of curved or irregular surfaces, measurements shall be taken along the curves.

- The unit insulation price shall include all necessary adhesives,

vapour proofing and finishing materials as well as additional labour and material required for fixing the insulation.

ACOUSTIC DUCT LINING

- 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 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.

NAME OF PROJECT: - PROPOSED MULTI-SPECIALITY BHANDUP HOSPITAL AT LAND BEARING C.T.S.NO681A/88,681A/3,681A/4 OF VILLAGE NAHUR IN S-WARD, BHANDUP MUMBAI

TECHNICAL SPECIFICATION FOR FIRE ALARM, PUBLIC ADDRESS, ACCESS CONTROL, CCTV, PASSIVE SECURITY & DATA VOICE NETWORKING SYSTEM

SHASHI PRABHU & ASSOCIATES

SHASHI PRABHU AND ASSOCIATES

MUNICIPAL CORPORATION OF GREATER MUMBAI

OVERVIEW & OBJECTIVES OF EXTRA LOW VOLTAGE SYSTEM

OVERVIEW:

Extra-low Voltage (ELV) is an electricity supply voltage in a range which carries a low risk of dangerous electrical shock. There are various standards that define extra-voltage. The IEC and IET go on to define actual types of extra-low voltage systems. Extra-low voltage system is consisting of all the systems which operates on low voltages like Telecommunication Systems, Enterprise Networking Systems, Audio Visual Systems, Fire Alarm & Detection Systems, Public Addressing Systems, Access Control Systems, Video Surveillance Systems.

Shop Drawings:

The contractor shall prepare and submit to the Construction Manager/Consultants for his approval six (6) sets of detailed layout drawings of all ELVequipment's and piping layouts.

He shall prepare shop drawings incorporating the details given by manufacturers for the items included in his contract and also Client supplied items and any other items which need to be coordinated with other contractors for interfacing.

Before starting the work, the contractor shall submit to the Construction Manager/Consultants for his approval in the prescribed manner, the shop/execution drawings for the entire installation.

The Construction Manager/Consultants, reserves the right to alter or modify these drawings if they are found to be insufficient or not complying with the established technical standards or if they do not offer the most satisfactory performance or accessibility for maintenance. Contractor shall supply in eight (8) sets of all approved shop drawings for execution.

Shop drawings shall be submitted under the following conditions:

Large scale drawings showing fixing detail equipment and showing coordination with other services.

Showing any change in layout in the ELVdrawings.

Equipment layout, ducting, piping and wiring/control diagram.

Manufacturer's or Contractor's fabrication drawings for any materials or equipment supplied by him.

No work will be carried out without approval of shop drawings by the Consultants.

"AS BUILT" DRAWINGS:

At the completion of work and before issuance of certificate of completion the contractor shall submit eight (8) sets to the Construction Manager/Consultants, layout drawing drawn at appropriate scale indicating the complete ELVsystem "as installed" and the same shall be approved by the Consultants before handing over to the Client

Instruction/Maintenance Manual:

The Contractor shall prepare and produce instruction, operation and maintenance manuals in English for the use, operation and the maintenance of the supplied equipment and installations, and submit to the Construction Manager/Consultants in (8) copies at the time of handing over. The manual shall generally consist of the following:

Description of the project.

Operating instructions.

Maintenance instructions including procedures for preventive maintenance.

Manufacturers catalogues

Spare parts list

Trouble shooting charts.

Drawings.

Type and routine test certificates of major items

One (1) set of reproducible `as built' drawings.

Completion Certificate:

On completion of the ELVinstallation a certificate shall be furnished by the contractor countersigned by the licensed supervisor, under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form as required by the local supply authority. The contractor shall be responsible for getting the ELVinstallation inspected and approved by the local concerned authorities and for obtaining the necessary clearance certificates from the authorities.

Guarantee:

At the close of the work and before issuance of final certificate of completion by the Construction Manager/ Consultants, the contractor shall furnish written guarantee Indemnifying the Client against defective materials and workmanship for a period of one year after completion. The contractor shall hold himself fully responsible for reinstallation or replacement, free of cost to Client, the following:

Any defective work or material supplied by the Contractor.

Any material or equipment supplied by the Client which is damaged or destroyed as a result of defective workmanship by the contractor.

Any material or equipment damaged or destroyed as a result of defective workmanship by the contractor.

Staff:

The contractor shall employ competent fully licensed qualified, full time ELVengineers to direct the work of ELVinstallation in accordance with the drawings and specifications.

The engineers shall be available at all times at site to receive instructions from the Construction Manager., in the day to day activities throughout the duration of contract. The engineer shall correlate the progress of the work in conjunction with all the relevant requirement of the supply authority.

Safety Barriers and Construction Safety:

The Contractor shall at his own cost provide for the protection and safety of the persons working in the area, safety barriers around all openings in every location and at the periphery and edges of all slabs, staircases and stairwells, lift shafts, ducts etc., all to the approval and satisfaction of the Construction Manager. However, contractor shall take appropriate safety precautions suitable for specific locations/ situations and as instructed by the Construction Managers.

The Contractor shall, in general, be fully responsible for all matters with regard to every form of safety during construction and in connection with the execution of the Works, and the Contractor shall take all necessary precautions and provide at his cost everything necessary to ensure such safety at all times. Should any accidents occur due to the Contractor's failure to comply with such safety requirements and to take all other safety measures necessary, the Contractor shall be fully responsible for all such

accidents and he shall bear and pay for all costs and damages in connection therewith and as a consequence there of.

Disposal Of Rubbish From The Works And The Site And Provision Of Safety Netting/Screens By Contractor:

The Contractor shall at all times keep the Works and the site in clean, neat and tidy condition. All rubbish from the Works and the site shall be collected and deposited in large bins provided on the site for such purpose by the Contractor at his own cost. The rubbish from such bins shall be regularly carted away by the Contractor to rubbish tips and dump yards beyond the site.

At no time or stage shall any rubbish be thrown over the edges of slabs or through any openings or shafts or ducts or stairwells.

The Contractor shall, at his own cost and to the approval and satisfaction of the Construction Manager, provide safety netting/screens at the periphery of all slabs and at all openings, shafts, ducts and stairwells and/or canopies to prevent any rubbish or material falling over or into such areas and endangering the safety of the persons working below. Should the Contractor fail to provide such safety measures and to take other necessary precautions in accidents that may occur, he shall bear all costs and damages as decided by Construction Manager in connection therewith and as a consequence there of.

The Construction Manager shall have powers to withhold amounts from payment certificates in case of Contractor's persistent noncompliance with provisions of this clause. Also the construction Manager is empowered to employ another agency at Contractor's cost after one week's notice to implement this Clause in case of Contractor's noncompliance with provisions of this Clause.

Space For Contractor's Construction Yard, Stores Etc.:

The Client shall provide adequate storage/office space to the contractor for his use. The space has to be maintained/constructed by the contractor as per his usage requirements.

All spaces allotted to the contractor, as described above shall be vacated and all structures removed from site at any time as and when required and directed by the relevant authorities or by the Client, unconditionally and without any reservation. The authorities or the Client will not be obliged to give any reason for such removal. Upon receiving instructions to vacate the space, the contractor shall immediately remove all his structures, materials,

etc., from the spaces and clear and cleanup the site to the satisfaction of the Construction Manager.

It shall be the specific responsibility of the Contractor to safeguard the site and ensure that no illegal encroachments are made by outside elements within the area allotted to the Con tractor. Upon completion of the work or earlier as required by Client/Authorities, the Con tractor shall vacate the land totally without any reservations. Necessary Bond to this effect on a stamp paper shall be signed by the contractor in a prescribed form.

The Performance Bond and/or guarantees towards retention amount furnished by the Con tractor shall not be released until the spaces allotted to the contractor are fully vacated and handed over to the Client as per the instructions of the Client.

Carrying Out Work Beyond Normal Working Hours Or In Shifts

In order to achieve the milestone and completion dates and to keep pace with the approved construction programme, the Contractor shall be permitted to carry out his work beyond the normal working hours or in shifts. The Contractor shall be responsible for obtaining any necessary permission from the relevant authorities that may be required for him to carry out the work beyond the normal working hours or in shifts. Also, the Contractor shall give prior notice to and make arrangements with the Construction Manager for the supervision of work carried out beyond the normal working hours or in shifts. The Contractor shall make his own arrangements in respect of the provision of adequate lighting and any other facilities that may be required for carrying out the work beyond the normal working hours or in shifts. No extra payments shall be made to the Contractor for or in connection with any such overtime or shift work. The Contractor will not be required to bear the overtime expenses of the Construction Manager in respect of the supervision of such overtime or shift work of the Contractor.

Period And Time Limit For Completion Of Works:

The period and time limit for Completion of the Works shall be as per client's requirement from the date of issue of Work Order to commence works or handing over of site in respect of the award of Contract. This time period shall be inclusive of the mobilization period and monsoon period.

Professional Integrity And Team Spirit:

It is the intent of the Client, Architect and Construction Manager that this project will be executed in a spirit of team and full professional integrity.

Contractor is expected to cooperate with all the agencies involved in the project to fulfill this objective.

List Of Approved Makes:

Unless otherwise specified and expressly approved in writing by the Engineer in Charge/only material of makes and specifications as mentioned in the list of approved makes attached with the specification shall be used.

The contractor shall clearly indicate the list of materials proposed to be used by him & enclose the same with the tender.

On Instruction of Engineer in Charge the Contractor shall submit samples of materials proposed to be used in the works. Approved samples shall be kept in the office of the Engineer in Charge and returned to the Contractor at the appropriate time.

Before procurement, Contractor will discuss with Client for preferred makes.

Water and electricity shall be supplied at one point.

Reference Points:

Contractor shall provide permanent bench marks, flag tops and other reference points for the proper execution of works and these shall be preserved till the end of the work.

All such reference points shall be in relation to the levels and locations, given in the architectural and ELVdrawing.

Reference Drawings:

The Contractor shall maintain one set of all drawings issued to him as reference drawings. These shall not be used on Site. All important drawings shall be mounted on boards and placed in racks indexed, no drawings shall be rolled.

All correction, deviations and changes made on the site shall be shown on these reference drawings for final incorporation in the completion drawings. All changes to be made shall be initialed by Engineer in Charge or Architect.

Vendor shall prepare Shop Drawings with all details after checking the feasibility at Site which shall be approved by the Consultants before execution. No work will be carried out without approval of Shop drawing by the Consultant.

Handing Over:

Contractor will be responsible for following:

Entire System shall be commissioned and tested as per design parameter is coordination with Client & consultant.

Complete certificate has to be obtained from the consultant to certify the quality of work and performance of the system.

Contractor has to hand over 4 sets of as Built Drawings duly approved by consultants along with 2 soft copy in CD's.

Contractor has to handover operator manual of the system with catalogue and Technical Data of equipment supplied.

OBJECTIVES:

Structure Cabling Systems:

To build an ELV System an agile, redundant and scalable structure cabling system is required.

Networking Systems:

To achieve highly available and consistence network for various equipment to communicate and seamlessly store or retrieve the data as and when required.

Telecommunication Systems:

To provide a stable and reliable Telephone / Communication network to the users of the organization or campus within or outside the campus.

Fire Alarm & Detection Systems:

To safeguard peoples and property from the risk of fire, timely detection and alarm is the essence of any campus.

Public Addressing Systems:

To help administration by providing Announcement System for General and Emergency Announcements.

Time Attendance & Access Control Systems:

To help administration by providing time Attendance systems and prevention of unauthorized access in critical areas like Operation Theatres, Intensive Care units (ICU), Auditoriums, Classrooms, Lifts and Elevators, Offices etc.

Video Surveillance Systems:

To help administration by providing real time monitoring system to maintain discipline, safeguard public and to detect any suspicious activities.

Operation Theatre Audio Visual Navigation/Teaching Solution:
To enable Operation Theatre a live Teaching / Demo Room and Enable Students to study Medical concept in visual format over the Network across Globe.

TECHNICAL SPECIFICATION FOR ELV SYSTEMS

General:

- The ELV System (Structure Cabling System, Enterprise Networking Systems, Telecommunication Systems, Audio Visual Systems, Fire Alarm & Detection Systems, Public Addressing Systems, Access Control Systems, Video Surveillance Systems) shall be seamlessly integrated.
- The rates quoted by bidder shall include such costs to ensure compatibility and seamless integration.
- The OEM should submit the authorization letter covering below mentioned points, before commencing the work by the Bidder:
    - OEM should confirm that the items quoted by the bidder are in production and would be serviceable for at least Seven Years.
    - OEM should confirm that the quoted items are not obsolete products.
    - OEM should confirm that the quoted items are produced within One Year before the date of Supply.

1. Structure Cabling System – UTP Copper (Cat6) Cables and Components, Fiber Optics Cable and Components, Network Enclosures:

- Structure Cabling shall be design, built and installed as per the best practices of Structure Cabling System, using all the components (Copper and Fiber) from a single OEM for the assurance of consistent performance. The structure cabling system shall be serve as a highway for transport of Data, Voice Telephony and Video traffic over a common network throughout the network.
- Structure Cabling System designed such as 10G backbone OFC network with ring topology for redundancy and network endpoint / host should be connected on 1G Copper network.
- Two separate network to be designed for Hospital Premises and College Premises, however it should be integrated with each other at Core Level.
- Two separate network to be designed as (i) Data (Wired & Wireless), communication System, Telepresence & Collaboration System and Audio Visual Systems, (ii) Utilities like IP Based Video Surveillance, Access Control System, Public Addressing System, Fire Alarm & Detection System and Integrated Building Management System.
- Installation, identification and termination of cables between information outlets and network rack shall be considered as a part of bidder's work.

- Cabling utilized for Voice and Data Nodes shall originate from Network Racks and terminated at Information Outlets at Wall.
- All cables and IOs shall be identified at both the ends (IO & Rackside) with appropriate ferruling.
- All balanced twisted pair cables laying and termination shall comply and be tested as per TIA/EIA 568-B series standard for Cat5, Cat5E and Cat6 installations.
- UTP Cabling system conforming to ANSI/TIA/EIA 568-B series and ISO/IEC 11801 2nd edition, EN-50173-1.
- The bidder carrying out the SITC work shall make the system entirely operational for its intended use, by addition of components specific to its make/model even if not specifically mentioned in the BOQ.
- It shall be the responsibility of the installer and OEM to ensure that the Passive Components of structured cabling system will be free from manufacturing defects in material and workmanship under normal and proper use.
- The site should be duly certified by OEM for a period of 20 years from the date of installation or issuance of the registration certificate, whichever is earlier.
- 20-year systems performance guarantee by the OEM along with actual test results conducted at site such as attenuation, return loss, NEXT & ACR. Permanent link shall be tested for minimum guaranteed performance as per standards at 500 MHZ operation as minimum.
- The final branch connections with single cables in conduit & the maximum no. of cables in each conduit shall be as per given in below table:

General Scenario Of Considering Data Points:-

- Data Point need to be consider at each and every hospital and medical college staff sitting / desk locations.
- For higher designated staff like Principal / Dean, Medical Superintendent, RMO, AHA, HODs two data points need to be place.
- For Nurse Station locations in hospital, 2 data points need to be considered. However it should be changed as per person sitting capacity.
- In Operation Theatre (i.e. Minor and Major OT), minimum two data points need to be place.
- In Laboratories, minimum of one data points need to be consider; however concern of end customer should not be compromise.

General Scenario Of Considering Voice Points:-

- Voice points need to be considering at each and every hospital and college staff sitting / desk locations.
- For higher designated staff like Principal / Dean, Medical Superintendent, RMO, AHA, HODs two voice points need to be place.

- For reception area minimum of two voice points need to be considered.
- For residential locations of Doctors, minimum of one voice point need to be consider.
- In Operation Theatre (i.e. Minor and Major OT), minimum one voice points need to be place.
- In special room, semi special room, deluxe rooms, etc V points need to be consider as per end customer requirement.
- In emergency locations and Lifts, one voice point needs to be considered.
- In pantry, kitchen, store; one voice point need to consider.

Sr. No.	Conduit Diameter		Max. Cables per Conduit
	Inch	mm	
1	1"	25	3 Nos. x Cat 6 Cables.
2	1 ½"	40	6 Nos. x Cat 6 Cables.
3	1"	25	Single Cable per Loop Public Addressing Systems.
4	1 ¼"	32	Two run of Fiber Cable.

- The SITC job includes Supply, installation, testing and commissioning of UTP Cat6 cables in existing conduit either on flooring / wall / ceiling / slab etc.
- The bidder has to furnish working drawings and commence work after approval of end user or consultant. The successful bidder has to submit as-built drawings.
- The structure cabling system should support various applications but not limited to Voice, Video and ISDN Applications, Ethernet Applications, IEEE802.3af PoE and IEEE802.3at PoE+, Fiber Channel Applications, IEEE802.11a/b/g/n/ac Wireless LAN Applications, DSL Applications, Various Audio & Video Streaming Applications.
- The structure cabling system as per the references and standards but not limited to TIA/EIA, International Electro-technical Commission (IEC), European Committee for Electro-technical Standardization (CENELEC), National Fire Protection Association (NFPA), UL Listed.
- The structure cabling system compliant channels will meet or exceed the guaranteed channel performance as per relevant standards in the structure cabling system performance specifications in effect at the time of installation.

1.1 UTP Components for Structure Cabling System:

Sr. No.	Description	Specification	Compliance
1	Common specifications shall apply to all UTP Cat6 Structure Cabling System components (i.e. Cable, Patch Cords, Information Outlets (IOs) and Patch Panels). All components of Structure Cabling System must be from same OEM		
a.	OEM Criteria	All passive material i.e. Copper and Fiber must be from the same OEM.	
b.	Standards and Compliance	Un-shielded Twisted Pair cabling systems, conforming to ANSI/TIA/EIA 568-B Series, Cat6 Cabling System, ISO/IEC 11801 2nd edition, EN-50173-1.	
c.	Warranty	System Performance Guarantee of 20 Year along with actual test results conducted at site like NEXT & ACR, Attenuation, Return-Loss etc. The cable shall be tested for minimum guaranteed performance as per standards 500MHz operation.	
2.	**Cat 6 UTP Cable**		
a.	Standard and Compliance	As per Above (1.a)	
b.	Conductors	23 or 24AWG Solid Copper Cable.	
c.	Insulation	PVC Jacket, Flame Retardant LSZH.	
3.	**Cat 6 UTP Patch Cords**		
a.	Standards and Compliance	As per Above (1.a)	
b.	Conductors	23 or 24AWG Multi-stranded Copper Cable.	
c.	Connectors	RJ-45	
d.	Length	3 Ft, 7 Ft or 10 Ft in a variety of colour as required	
e.	Insulation	PVC Jacket, Flame Retardant LSZH.	
4.	**Cat 6 Information Outlets**		
a.	Standard and Compliance	As per Above (1.a)	
b.	Colors	In a variety of color as required.	

5.	**Face Plates**		
a.	Standard and Compliance	As per Above (1.a)	
b.	No. of Ports	One, Two, Four Ports	
c.	Material	ABS / UL 94 V-0, Color: White	
6.	**Patch Panels**		
a.	Standard and Compliance	As per Above (1.a)	
b.	Height	1U – 1.75”	
c.	No. of Ports	24 Ports, Fully Loaded with Key Stone Jack.	
d.	Port Type	Individual Key Stone Type or 6 Port Modular. Blank Inserts for un-used ports.	
e.	Panel	Fully Powder Coated, Pencil Grey Color.	
f.	Termination Type	TIA/EIA 568 A & B.	
g.	Performance	NEXT, PS NEXT, FEXT, Attenuation, Return-Loss	
h.	Approval	UL Listed.	

1.2 Fiber Optic Cable Components for Structure Cabling System:

Sr. No.	Description	Specification	Compliance
1	Common specifications shall apply to all Fiber Optic Cable components of Structure Cabling System (i.e. Cable, Patch Cords, Pigtails, Adaptors, LIUs). All components of Structure Cabling System must be from same OEM.		
a.	OEM Criteria	All passive material i.e. Copper and Fiber must be from the same OEM.	
b.	Type	Single Mode OS2 Fiber Cabling System.	
c.	Network Support	Should support both 1G and 10G Bandwidth.	
d.	Performance Testing	UL Listed or ETL Certified and Fiber Channel compliance to ANSI/TIA568-B.0 for OS2.	
e.	Standards and Compliance	ITU-T G.652(A,B,C,D), IEC-60793-2-50, TIA/EIA 492-CAAB	
f.	Warranty	System Performance Warranty of 25 Year along with actual test results	

		conducted at site. Warranty to cover bandwidth of the specified and installed cabling system.	
2.	**Optical Fiber Cable:**		
a.	Cable Type	6 Core, 12 Core & 24 Core, Single Mode, Armoured (CSTA), Loose-tube, Gel filled. (Minimum 6 Tubes – Multitube Construction). Row fiber core can be Fujikura / Corning as per ISO 11801-OS2.	
b.	Cable Construction Type	BELLCORE GR20 / IEC 794-1 – Loose Tube Corrugated Steel Tape (0.155mm Min) CSTA provided with FRP Rod as strengthening members.	
c.	Outer Jacket Construction	HDPE, Anti-termite, Anti-Rodent suitable for Direct Burial Application. Jacket must be UV Stabilized.	
d.	Fiber Type	9/125, 250 Micron Primary Coated Buffers, Single Mode, UL Listed.	
e.	Fiber Core	Fiber core must be as per Telecordia GR20, ITU-T G.652D, IEC-60793-2-50, TIA/EIA 492-CAAB.	
f.	Losses @ Frequency	<= 0.35 dB/Km @ 1310nm; <=0.20 dB/Km @ 1500nm.	
g.	Max Tensile Load	>= 2670 N.	
h.	Max Crush / Impact Resistance	3000 N.	
i.	Operating Temperature	-40° C to +60° C.	
j.	Multi-Channel Requirement	Optical Fiber Cable must have been designed to provide optimum performance from 1265nm to 1625nm making it suitable for 16 – Channel Course Wavelength Division Multiplexing (CWDM) applications.	
k.	Marking	Optical Fiber Cable shall have identification mark at regular intervals of 1 Mtr, which will be of permanent nature with accuracy of the sequential marking within ± 0.5%.	
l.	Test Parameters	IEC794-1-E1, IEC794-1-E2, IEC794-1-E3, IEC794-1-E4, EIA- 455-104,	

		IEC794-1-E7, IEC794-1-E10, IEC794-1-E11, IEC794-1-F5.	
3.	**Optical Fiber Pigtails:**		
a.	Standards and Compliance	ITU-G65.B–Bend Insensitive Fiber. Fully Compliance with JIS C5973 F04 Type, Meet or exceed ITU Specifications, UL Listed.	
b.	Type, Connectors & Length	Single Mode, LC-Style, Simplex, 1 Mtrs Length.	
c.	Durability	(500 Matting's): < 0.2dB Max.	
d.	Attenuation	Not more than 0.75dB per mated pair.	
e.	Ferrules	Pre-radius Ceramic Zirconia Ferrule. Bayonet Coupling: 2.5 mm Zirconia Ferrule	
f.	Operating Temperature	-40° C to +60° C.	
4.	**Optical Fiber Patch Cords:**		
a.	Standards and Compliance	ITU-G657.B - Bend Insensitive Fiber.	
b.	Cable & Connector Type and Outside Diameter	Single Mode, LC-LC type. Available in either 1.6mm x 3mm (Simplex) or 1.6mm x 3.3mm (Duplex) Zipcord.	
c.	Fiber Type and Fiber Cores	Single mode 9/125 250 micron primary coated buffers. One Core for Simplex and Two Core for Duplex.	
d.	Length	1, 2, 3 or 5 Mtrs length.	
e.	Operating Temperature	-40° C to +60° C.	
5.	**19", Rack Mounted Fiber Shelf / LIUs.**		
a.	Fiber Optic Shelf / LIUs	19", Rack Mounted Fiber Optic Shelf, 2U Height.	
b.	No. of Fibers	6, 12, 24, 48 Cores.	
c.	No. of OSP Cables for Termination.	Minimum Two.	
d.	Cable Management Rings	Front and Rear Cable management rings, pre-loaded.	
e.	Adapter Plates	6 Port adapter plates with each plate loaded with Single Mode Couplers as required.	
f.	Grounding	2 x Earthing Lugs, Pre-loaded.	

g.	Construction	Complete Aluminum Alloy housing with Fully Powder Coated.	
h.	Splice Tray & Construction	Fully cushioned splice holder containing grooves for fixing splice protective sleeves. To be included in LIU.	
i.	CableSpool & Construction	Flame retardant plastic, high impact resistance. Two halves spool and stackable design, sufficient room provided for storage of excess cable. To be included in LIU.	

1.3 19" Wall Mount Network Enclosures:

Sr. No.	Description	Specification	Compliance
1.	Network Rack Size	Wall Mount, 19", CRCA Powder Coated Network Rack of Various size 6U, 9U, 12U, 15U. Front Glass Door, 600mmW x 600mmD.	
2.	Fan	Should have minimum 2 Nos 230V AC Fans, 90CFM	
3.	19" Cable Manager	Should have 2 Nos., 1U Metal Cable Manager.	
4.	19" Cantilever Tray	Should have 1 Nos. 1U Cantilever Tray.	
5.	AC Panel	Should have 1 Nos. 6 Socket 5/15Amp AC Panel.	
6.	Front Mount Hardware	2 Packet (10 Nos. per Packet)	

1.4 19" Floor Mount Network Enclosures:

Sr. No.	Description	Compliance
1.	Rack shall be constructed with high strength robust aluminum extruded frame structure with ventilation slots on the sides, top and bottom covers with provision to mount	

	4 nos. fans on top cover. Load carrying capacity – between 500 – 750 kg.	
2.	The other components except vertical profiles are made of CRCA Steel. CRCA steel used is as per "IS 513 Gr D" Standard. The Thickness of the CRCA sheets used for Doors is 1.2mm and foe Side Panels is 1mm.	
3.	The cabinet shall be made of high impact CRCA steel as per IS 513 Gr D standard and design confirming to DIN 41494 or EIA 310D standards.	
4.	Top Covers and Bottom Covers and Side panels shall be of sheet steel and powder coated. The top and bottom covers shall be provided with number of 50mm and 75mm round cable knockouts for cable entry and cable knockouts shall be edge protected with rubber grommets.	
5.	Fully adjustable 19" equipment mounting angles. Two pairs of 19" Equipment mounting angles with mounting holes conforming to IEC 2973.	
6.	Vertical 19" metric panel mounts and door trims shall be of sheet steel and powder coated	
7.	Perforation area should be 70% of the total door area. Perforation for full or split doors the style should be "Honeycomb" type of perforation for maximum air circulation and stiffness.	
8.	Side Panels – must contain slam latches for locking purpose and option of providing slam locks, if required.	
9.	The rack should support various Locks Options like Slam Lock - Common Key or Unique Key, Swing Handle Lock, Digital Keypad operated locks, Bio-metric locks. Lockable Industrial Grade Castors with Foot Brakes.	
10.	Cabinet can be capable of dismantling and reassemble at the site.	
11.	Front Glass door made of toughened glass, tinted with easily detachable hinges.	
12.	Two Pair of slotted vertical cable manager shall be provided at front and back for managing Cables.	
13.	Rack shall be supplied with 4 Nos. 90 CFM fans at top, or optionally 250cfm	
14.	Rack shall be supplied with equipment mounting hardware in pack of 100s such as mounting nuts and screws either 12-24 or M6 type as applicable	
15.	Minimum 2 nos. of 10 x 5/15 Amps power distribution unit, 2 nos. of vertical cable managers and 2 no. of 19" 1U size horizontal cable managers.	

16.	Finish – cabinet shall be black or grey epoxy powder-coated of durable quality. The Powder coating of the racks is as per Nano Technology process with "Zirconium Coating".	
17.	Manufacturer must be ISO Standard Plants. The product must be UL Listed and certified for use in IT/CE. Environmental Safety – the rack must be RoHS compliant.	
18.	EIA standard pattern design with 12-24 tapped holes (EIA-310-E compliant) or EIA standard pattern design with 3/8' (9.5mm) square punches for Cage Nuts for mounting.	
19.	Rack should have dimension of at least 18U, 24U, 27U, 32U, 36U, 42U usable height, 600mmWx600mmD, 600mmWx800mmD, 800mmWx800mmD, 800mmWx1000mmD or 1000mmWx1000mmD.	
20.	Powder Coating thickness should be min 80 to 100 Microns with Scratch Resistance properties. Rack to be powder coated with Nano ceramic pre-treatment process using a zirconium coat and the process should be RoHS compliant.	
21.	The Network Racks must have unit prices for its individual knocked down items such as Main Frame, Front Glass Door, Rear Perforated Steel Door, Vented Side Panels, 4x90cfm Fans & Fan Tray, 2 No.x10 Socket 5A/15A PDU with MCB, 1U Cable Manager, Sliding Shelf, Keyboard Trey, Cantilever Shelf, Heavy Duty Stationery Shelf, Castors, Vertical Cable Manager, mounting hardware etc. It must be possible to configure the enclosure as per specific needs for a customized installation for every rack.	

2. Active Components – Core Switch, Distribution Switches, Access Switches, Small-Form Factor Port Modules, Stacking Modules, Wireless LAN Controller, WiFi Access Points, Firewall / Unified Threat Management System.

Description & Design:

- It is a high performance networking design keeping in mind real time applications and reliability.
- Key considerations for network are - gigabit connectivity to each user from the server room to various users/departments/devices in a topology consisting of a central switch followed by the distribution and edge/access switches with multiple 10G ring topology. In a single 10G ring maximum Eight Locations to be consider.
- The network shall have a mix of components for supporting PoE+ as well as non-PoE devices.
- A robust fiber optics based backbone is being provided. It shall be based on ring topology using single mode fiber optics cable. The vendor shall ensure that the networking switches shall be populated with the necessary transceivers for achieving this design objective.
- Two separate network to be designed for Hospital Premises and College Premises, however it should be integrated with each other at Core Level.
- Two separate network to be designed as (i) Data (Wired & Wireless), communication System, Telepresence & Collaboration System and Audio Visual Systems, (ii) Utilities like IP Based Video Surveillance, Access Control System, Public Addressing System, Fire Alarm & Detection System and Integrated Building Management System.
- Several applications are proposed to run on this network – IP-based voice communications supporting voice-data-video, network based cameras and storage, integrated audio-video, video conferencing, interactive learning, integrated building management systems and important services integration such as fire detection.
- All Switches, SFP Modules, SFP+ Modules, Stacking Modules and Stacking Cables, Wireless Controller and Wireless Access Points be from same OEM.
- All Switches, Wireless Access Points and Existing Wireless LAN Controllers should have capability to manage, configure and troubleshoot from a single Network management system i.e. single pane of glass.
- OEM for equipment like Switches and Wireless Controller, Wireless Access Points should be listed in the leader's quadrant of the Gartner Magic Quadrant.

2.1 Core Switch – Layer 3 (Type-1):

Sr. No.	Description	Compliance
1.	Switch should support the complete STACK of IP V4 and IP V6 services	
2.	Switch with different modules should function line rate and should not have any port with oversubscription ratio applied	
3.	Switch should support non blocking, wire speed performance per access and uplink ports	
4.	The switch should be standard rack mountable	
5.	Switch should have the following interfaces: A.16 SFP+ ports B. Network Module slot for 8 SFP+ Fiber Uplink Ports	
6.	Switch should have console port	
7.	Switch should have management interface for Out of Band Management	
8.	Switch should have hardware health monitoring capabilities and should provide different parameters through SNMP	
9.	Switch should support IEEE Link Aggregation and Ethernet Bonding functionality to group multiple ports for redundancy	
10.	Switch should have the capability of holding multiple OS images to support resilience & easy rollbacks during the version upgrades etc and should support in service software upgrade including: a. Multiple System image b. Multiple system configuration c. Option of Configuration roll-back.	
11.	Switch should have all access ports support Auto MDI and MDI-X and Auto/Manual Speed negotiation	
12.	Switch should have Internal redudant power supply	
13.	Switch should have single Management Stack facility	
14.	Switch should support Spanning Tree Protocol (802.1D, 802.1W, 802.1S)	
15.	Switch should support for centralised VLAN management for the connected layer 2 domain, which propagated VLAN information	
16.	Switch should support up to 4000 number of VLAN including data for providing segregartion of different group ports for data traffic so that one group can only communicate as per allowed policy	

17.	Switch should support neighbor discovery of the network devices in both IP V4 and IP V6 environment and provide details about the platform, IP Address, Link connected through etc	
18.	Switch should support L2 switching features for carrying multiple VLAN's over a linkVLAN Trunking (802.1q)	
19.	Switch should support Multicast IGMP v1, v2, v3	
20.	Support for detecting Unidirectional links failure and disable link to avoid loop inside the network	
21.	the system should support address table lists with destination MAC address, the associated VLAN ID, and port number associated with the address and the type (static or dynamic)	
22.	To communicate with a device over Ethernet the system first must learn the 48-bit MAC address or the local data link address of that device. The Address Resolution Protocol (ARP) associates a host IP address with the corresponding media or MAC addresses and the VLAN ID.	
23.	Switch should support all physical ports to use either in Layer2 or Layer 3 mode and also should support layer 3 VLAN and Loopback ports	
24.	Switch Should support layer 3 VLAN and Loopback ports for Management	
25.	Switch should support for Layer3 Routing: a. Class-less, b. Default, c. Static, d. Policy based e. Dynamic routing and route redistibution between multiple routing protocols for IP V4 and IP V6	
26.	Switch should support Dynamic Routing: a. RIP V2, b. OSPF, c. IS-IS, d. BGP for IP V4 and IP V6. Also, it should have support for VRF as well for ip route level segmentation perspective	
27.	Switch should support for IP V4 and IP V6 Layer 3 routing simultaneously using a. Class-less, b. Default, c. Static, d. Policy based e. dynamic f. Multicast Routing.	
28.	Switch should support for Multicast routing using a. PIM, b. PIM Spare Mode, c. PIM Dense Mode, d. Source-Specific Multicast for IP V4 and IP V6	
29.	Switch should support IGMP IP V4 and MLD IP V6 Snooping for Layer 2 ports to multicast group mapping to avoid multicast boradcast inside the network	
30.	Switch should support Inter VLAN Routing for providing inter VLAN connectivity	
31.	Switch shoud support for MPLS extension routing for the connectivity to MPLS Service provider	
32.	Switch should support Address Resolution like ARP, Proxy ARP and IRDP	

33.	Switch should have line rate forwarding capacity	
34.	Switch should support Multichassis Ethercannel	
35.	Switch should support 60000 MAC addresses	
36.	Switch should support 4000 Layer 2 VLAN ID and 1000 Layer 3 VLAN	
37.	Switch should support jumbo frame of 9198 bytes	
38.	Switch should support Stateful Switchover when switching over from active to standby switch in a stack or equivalent	
39.	Switch should support IP Flow version-9 for identify users and user traffic flows in order to identify potential attackers and take corrective action at the access layer	
40.	Switch should support dual stack for Layer 2 and Layer 3 IP V4 and IP V6 at the same time	
41.	Switch should have adequate DRAM, Flash Memory, CPU and other hardware to support all the services configured	
42.	Switch should have adequate flash memory and other hardware to ensure storage of multiple operating system images, configuration file backups, event logs etc.	
43.	Furhter the switch should have adequate memory, storage, processing power, other components so that switch should be able to upgrade, patch the operating system till the end of support date without any additional hardware requirement such as flash memory, storage etc	
44.	Switch should support Uplink Redundancy & Bandwidth Aggregation for Higher bandwidth and reliability for uplinks as per 802.3ad (LACP)	
45.	Switch should support Gateway Redunancy Support using VRRP/HSRP for IP V4 and IP V6	
46.	Switch should support feature to set and verify services guanantee related to connectivity and availability of network connectivity and application usage as per business requirement using IP SLA	
47.	Switch should support to storm control Broadcast/Multicast/Unicast based storm due to network attacks and vulnerabilities	
48.	Switch system should support 802.1P classification and marking of packet using: a. CoS (Class of Service) b. DSCP (Differentiated Services Code Point) c. Source physical interfaces d. Source/destination IP subnet e. Protocol types (IP/TCP/UDP) f. Source/destination TCP/UDP ports	
49.	Switch should support methods for identifying different types of traffic for better management and resilience	
50.	Switch should support for different type of QoS features for ream time	

	traffic differential treatment using a. Weighted Random Early Detection b. Strict Priority Queuing	
51.	Switch should support to trust the QoS marking/priority settings of the end points as per the defined policy	
52.	Switch should support Flow control of Ethernet ports to control traffic rates during congestion by allowing congested nodes to pause link operation at the other end for receiving traffic as per IEEE 802.3x	
53.	Swtich should support QoS features like classification, Marking, Queueing and Scheduling, Shaping and Policing	
54.	Switch should support Egress Queues per Port for enable differentiated treatment of different traffic types	
55.	Switch should support Ingress and Egress Rate Limiting for limiting traffic on per port basis	
56.	Switch should support Identification of user based and application based multiple traffic flows for different protocols and applications for Application flow Visibility	
57.	Switch should support for Management of traffic using TCP's congestion control/ IP precedence at high utilization environment for Congestion Avoidance	
58.	Switch should support for deploying different security for each logical and physical interface using Port Based access control lists of Layer-2 to Layer-4 in IP V.4 and IP V.6 and logging for fault finding and audit trail	
59.	Switch should support control plane i.e. processor and memory Protection from unnecessary or DoS traffic by control plane protection policy	
60.	Switch should support Time based ACL	
61.	Switch should support for external database for AAA using: a. TACACS+ b. RADIUS	
62.	Switch should support MAC Address Notification on host join into the network for Audit trails and logging	
63.	Switch should support to restrict end hosts in the network. Secures the access to an access or trunk port based on MAC address. It limits the number of learned MAC addresses to deny MAC address flooding	
64.	Switch should support DHCP Snooping and rate limit DHCP packets	
65.	Switch should support Dynamic ARP Inspection to ensure host integrity by preventing malicious users from exploiting the insecure nature of the ARP protocol	
66.	Switch should support for Role Based access control (RBAC) for restricting host level network access as per policy defined	

67.	Switch should support to prevent edge devices in the network not administrator's controled from becoming Spanning Tree Protocol root nodes	
68.	Switch should support unicast and/or multicast blocking on a switch port to suppress the flooding of frames destined for an unknown unicast or multicast MAC address out of that port	
69.	Switch should support Spanning tree BPDU protection	
70.	Switch should support for MOTD banner displayed on all connected terminals at login and security discrimination messages can be flashed as per banks ISD rules	
71.	Switch should support IEEE 802.1x Based Security to support 802.1x network authentication and port security on a port basis which will help to deploy Network Admission Control (NAC)	
72.	Switch should support IEEE 802.1x With Guest VLAN to automatically assign restricted access VLAN base to guest users	
73.	Switch should support 802.1x network authentication and port security for specific devices using MAC Address like network printer, scanner etc for MAC Auth Bypass	
74.	Switch should support to support authentication and allow IP Phone and System on the same port of the switch for Multi Domain Authentication	
75.	Switch should support RADIUS Change of Authorization (CoA) for Network Admission Control for Network admission Control deployments to provide network access rights based on the user credentials	
76.	Switch should support to RADIUS CoA and URL Redirection for posture, VLAN and ACL assignment for integrating 802.1x NAC solution	
77.	Switch should support Support for multilevel security to access the switch with different administrative privilege	
78.	Switch should support Prevents a malicious user from spoofing or taking over another user's IP address by creating a binding table between the client's IP and MAC address, port, and VLAN	
79.	Switch should support and Prevent to limit the appearance of spoofed addresses on a network, which verify the reachability of the source address in packets being forwarded in IP V4 and IP V6	
80.	Switch should support to protect the switch from unauthorised users and system attackers to the Control Plane of the switch and Protect	
81.	Switch should support to prevent edge devices not in the network administrator's control from becoming Spanning Tree Protocol root nodes	

82.	Switch should support to restricting Edge of switching Network and prevent to connect to the network	
83.	Switch should be able to generate Flows that give visibility of the network activities for Detecting network reconnaissance and attacks initiated for TCP and UDP port scanning across multiple hosts	
84.	Switch should have capability to control network basline and the policy enforcer, for which it should support to get integrated with central security policy managers	
85.	Switch should be embedded with classification and policy enforcement functions. Capability to segment the network and enforce role-based, topology-independent, and access-independent access control.	
86.	Switch should support for automatic policy enfored by central security enforcer for granting right access and limits the impact f data breanch thorugh software-defined segmentation and real-time threat response	
87.	Switch ports should support macsec as per IEEE standards	
88.	Switch should support Embedded RMON Software Agent Support to collect of performance statistics	
89.	Switch should support to capture traffic flow using netflow version 9 up to 24000 flows, on all ports of the switch for ingress and Egress traffic	
90.	Switch should support DNS protocol the Domain Name System (DNS), a distributed database with which you can map hostnames to IP addresses of network devices	
91.	Switch should support Secure and remote administration of switches using SSH2 & TELNET	
92.	Switch should have ability to capture packets Local and remote port mirroring for troubleshooting to identify network based attacks, application performance and traubleshooting	
93.	Switch should support SNMP v. 2 & SNMPV3 Based Administration & Monitoring	
94.	Switch should support Link layer media protocol to identify endpoints in the network. For example IP Phones and other devices (LLDP & LLDP-MED)	
95.	Switch should support Layer 2 and Layer 3 traceroute to aid troubleshooting	
96.	Switch should support to sync time on all network devices to synchronize the log collection and events using NTP V.4	
97.	Switch should support Auto configuration to aid error free configuration and upgradation	
98.	Switch should support to function as a DHCP server and relay for IP V4 and IP V6	

99.	Switch should support to capture packets using Wireshark in real time for traffic analysis and fault finding	
100	Switch should support to configure switch port based on detection of end points in the network. For example IP Phone requires separate QoS policies than PC workstations etc.	
101	Switch should support to check cabling faults, crimping faults, length of cables etc. (TDR or Time domain Reflectometer for layer 1 or cabling layer troubleshooting)	
102	Switch should support programmability with netconf-yang data models to have automated way of configuration and operations	
103	Switch should be certified ready logo of IPv6 of Phase II	
104	Switch sould support Network management based on IPv6 access using SNMP over IPv6	
105	Switch sould support SYSLOG over IPv6 for Network management based on IPv6 access	
106	Switch should support IPv6 Stateless Auto Config to provide auto configured IPv6 address	
107	Switch should support NTPv4 over IPv6 Network time sync capability of IPv6	
108	Switch should support IPv6 QoS trust to trust IPv6 QoS markings	
109	Switch should support RFC4292/RFC4293 MIBs for IPv6 traffic for IPv6 management	
110	Switch should support IPv6: HPPT, HTTPS, ICMPv6, TCP/UDP over IPv6, DNS Lookup for IPv6 access	
111	Switch should support IPv6 Applications: Ping/Traceroute/VTY/SSH/TFTP for IPv6 troubleshooting	
112	Switch should support IPv6: Option processing and fragmentation	
113	Switch should support Support for IPv6 RA guard, DHCPv6 guard, IPv6 Snooping to prevent any man-in-middle attack	

2.2 24 SFP+ Ports Distribution Switch – Layer 3 (Type - 2):

Sr. No.	Specification	Compliance Yes / No
	Hardware Architecture:	
1.	Switch should have Stackable Architecture to provide Scalable network.	
2.	Switch should be stackable switch at least eight switch should be stack with a minimum stacking bandwidth of 80 Gbps.	
3.	Switch should have Resilient Stacking Architecture.	

4.	Manageable 24 Port Giga Switch. Number of Ports: 24 x 10/100/1000 Mbps and additional 4 x 10G SFP+.	
5.	Switch should have switching capacity of 128 Gbps and 208 Gbps with stacking or more.	
6.	Switch should have Redundant Power Supply Slot.	
7.	Switch should have non-blocking wire-speed architecture.	
8.	Switch port should support IEEE 802.3 10Base-T, IEEE 802.3u 100Base-Tx Fast Ethernet, IEEE 802.3ab 1000Base-T Gigabit Ethernet, 802.3ae 10 GbE, IEEE 802.3x Flow Control for Full Duplex Mode, Auto negotiation, IEEE802.1X Authentication.	
9.	Switch should be architected to support real time applications like voice, video, data by having distributed architecture.	
	Requirement per Switch:	
10.	Minimum 24 interfaces of 10/100/1000 base-TX and 04 interfaces of 10 Gigabit SFP+.	
11.	Switch should support IEEE 802.3az Energy Efficient Ethernet.	
12.	Switch should have at least 2GB DRAM and 4GB Flash or higher.	
13.	Switch should support LED indication for System Status, per port integrity, Activity, Disabled, Link Speed, etc.	
	Performance:	
14.	Switch should have non-blocking switching backplane of 80 Gbps.	
15.	Switch should have forwarding rate of minimum 95 Mpps on 64 Byte Packet.	
16.	Switch should support 16K or more MAC Addresses.	
17.	Switch should support up to 512 static MAC entries and should support auto-learning MAC addresses with enable / disable function.	
18.	Switch should support Hibernation Mode.	
19.	Switch should support EtherChannel Technology across different members of stack.	
20.	Switch should support Power Redundancy and Fan Redundancy.	
21.	Switch should support Switched Port Analyzer (SPAN) & Enhanced SPAN.	
22.	Switch should have SYSLOG capabilities to enable system logging.	
23.	Switch should support to NTP Client.	
24.	Switch should support logging banner for console.	
25.	Switch should support Spanning Tree Protocol per VLAN.	
26.	Switch should have functionality to add new features like IOS / Firmware upgrades.	
27.	MTBF should be 525000 hours or more.	
	L2 Features:	
28.	Switch should support 9K Jumbo frames.	
29.	Switch should support Loop Back detection.	
30.	Switch should support Dynamic VLAN.	
31.	Switch should support HW based Source Learning, should support voice VLAN.	
32.	Switch should support IEEE 802.1Q Tagged VLAN – Port based VLANs and VLAN Stacking.	

33.	Switch should support for at least 1K Active VLAN's.	
34.	Switch should support 1500 ACLs or Higher.	
35.	Switch should support Spanning Tree Protocol per VLAN.	
36.	Switch should support 802.1d STP, 802.1s MSTP and 802.1w RSTP Protocols.	
37.	Switch should support IPv4: IGMP V1, V2 Snooping and V3 awareness.	
38.	Switch should support IPV4 and IPv6: MLD V1/V2 awareness.	
39.	Switch should support Link Aggregation based on 802.3ad across the switches	
40.	Switch should support latency < 4µ seconds.	
41.	Switch should support IPv4 and IPv6 Features.	
	Quality of Service:	
42.	Switch should support QoS based on 802.1p Priority - 8 hardware queues per port.	
43.	Switch should support Ingress Policing and Egress Shaping.	
44.	Switch should support 802.1p / ToS / DiffServ marking and mapping.	
45.	Switch should support CoS based on 802.1p priority, VLAN, MAC Address, Ether type, IP address, DSCP, Protocol type, TCP/UDP Port Number, DSCP of IPv6 Traffic Class and IPv6 flow label.	
46.	Switch should support WRR and SP.	
	Security:	
47.	Switch should support Broadcast / Multicast / Unicast Storm Control.	
48.	Switch should support DHCP Snooping	
49.	Switch should support Dynamic ARP Inspection.	
50.	Switch should support IP Source Guard.	
51.	Switch should support SSH for IPv4 and IPv6.	
52.	Switch should support SSL for IPv4 and IPv6.	
53.	Switch should support IP-MAC port binding.	
54.	Switch should support 802.1x Authentication on all ports.	
55.	Switch should support 802.1x with Guest VLAN allows guests without 802.1x client to have limited network access on the guest VLAN.	
56.	Switch should support RADIUS and TACACS + authentication for switch access.	
57.	Switch should support scanning of network attacks based on behavioral analysis.	
58.	Switch should support Port Mirroring, Remote Port Mirroring and Policy-based Mirroring.	
59.	Switch should support Standard and extended ACLs on all ports.	
60.	Switch should support system event logging.	
61.	Switch should support real time multi-port statistics.	
62.	Switch should support MAC / IP Address Finder.	
63.	Device and Port Grouping for Navigation and Policy Management.	
64.	The Switch should be able to discover the neighbouring device of the same vendor giving the details about the platform, IP Address, Link	

	connected through etc, thus helping in troubleshooting connectivity problems.	
	Physical/Environmental:	
65.	AC Input: 100 to 240 VAC, 50/60 Hz internal	
66.	Operating Temperature: 0 to 45 °C	
67.	Certifications: CE, FCC, VCCI, UL, EN, IEC, RoHS.	
	Management:	
68.	Switch should support management using CLI, Telnet and GUI using Web interface.	
69.	Switch should support IPv6 Neighbor Discovery.	
70.	Switch should support SNMP V1, V2, V3, SNMP Traps and RMON.	
71.	Switch should support ICMPv6 and IPv4/v6 Dual Stack.	
72.	Switch should support LLDP and LLDP-MED.	
73.	Switch should support FTP / TFTP for upgrading the Operating System.	
	Licensing:	
74.	Switch should support a licensing mechanism which will enable the client to port the license to the new switch when client want to replace the existing switch.	
75.	Switch should support new updates and upgrades along with new features with that licensing mechanism.	
76.	Switch should support L3 Features like advanced IP unicast routing, OSPFv3, EIGRPv6, IS-ISv4 with backward compatibility.	
77.	Offered Product must have OEM Support Contract for 1 Years with 8x5xNBD.	
78.	OEM Service Contract paper to be submitted after Installation.	
79.	Switch should support Software Defined Network (SDN) from Day One, If any license required should be included.	
	OEM Criteria:	
80.	OEM should be Leaders in Gartner Magic Quadrant for Wired and Wireless, atleast for Last 3 Years.	
81.	Offered Product Should not be End of Sale for atleast 5 Years.	

2.3 24 Port Access PoE+ Switch with 4 10G Uplink – Layer 2 (Type - 3):

Sr. No.	Specification	Compliance Yes / No
	Hardware Architecture:	
1.	Switch should have Stackable Architecture to provide Scalable network.	
2.	Switch should be stackable switch at least eight switch should be stack with a minimum stacking bandwidth of 160 Gbps.	
3.	Switch should have Resilient Stacking Architecture.	
4.	Manageable 24 Port PoE+ Giga Switch. Number of Ports: 24 x 10/100/1000 Mbps PoE+ and additional 4 x 10G SFP+ Ports.	
5.	Switch should have 802.3at PoE+ Ports, 30W per port or higher.	

6.	Switch should have 370W PoE budget from day one and should support 740W PoE budget, if required.	
7.	Switch should have switching capacity of 128 Gbps and 288 Gbps with stacking or more.	
8.	Switch should have Redundant Power Supply Slot.	
9.	Switch should have non-blocking wire-speed architecture.	
10.	Switch port should support IEEE 802.3 10Base-T, IEEE 802.3u 100Base-Tx Fast Ethernet, IEEE 802.3ab 1000Base-T Gigabit Ethernet, 802.3ae 10 GbE, IEEE 802.3x Flow Control for Full Duplex Mode, Auto negotiation, IEEE802.1X Authentication.	
11.	Switch should be architected to support real time applications like voice, video, data by having distributed architecture.	
	Requirement per Switch:	
12.	Minimum 24 interfaces of 10/100/1000 base-TX PoE+ and 04 interfaces of 10G SFP+.	
13.	Switch should support IEEE 802.3az Energy Efficient Ethernet.	
14.	Switch should have at least 4GB DRAM and 4GB Flash or higher.	
15.	Switch should support LED indication for System Status, per port integrity, Activity, Disabled, Link Speed, etc.	
	Performance:	
16.	Switch should have non-blocking switching backplane of 128 Gbps.	
17.	Switch should have forwarding rate of minimum 95 Mpps on 64 Byte Packet.	
18.	Switch should support 32K or more MAC Addresses.	
19.	Switch should support up to 512 static MAC entries and should support auto-learning MAC addresses with enable / disable function.	
20.	Switch should support Hibernation Mode.	
21.	Switch should support EtherChannel Technology across different members of stack.	
22.	Switch should support Power Redundancy and Fan Redundancy.	
23.	Switch should support Switched Port Analyzer (SPAN) & Enhanced SPAN.	
24.	Switch should have SYSLOG capabilities to enable system logging.	
25.	Switch should support to NTP Client.	
26.	Switch should support logging banner for console.	
27.	Switch should support Spanning Tree Protocol per VLAN.	
28.	Switch should have functionality to add new features like IOS / Firmware upgrades.	
29.	MTBF should be 420000 hours or more.	
	L2 Features:	
30.	Switch should support 9K Jumbo frames.	
31.	Switch should support Loop Back detection.	
32.	Switch should support Dynamic VLAN.	
33.	Switch should support HW based Source Learning, should support voice VLAN.	
34.	Switch should support IEEE 802.1Q Tagged VLAN – Port based VLANs and VLAN Stacking.	
35.	Switch should support for at least 1K Active VLAN's.	

36.	Switch should support 1600 ACLs or Higher.	
37.	Switch should support Spanning Tree Protocol per VLAN.	
38.	Switch should support 802.1d STP, 802.1s MSTP and 802.1w RSTP Protocols.	
39.	Switch should support IPv4: IGMP V1, V2 Snooping and V3 awareness.	
40.	Switch should support IPV4 and IPv6: MLD V1/V2 awareness.	
41.	Switch should support Link Aggregation based on 802.3ad across the switches	
42.	Switch should support latency < 4µ seconds.	
43.	Switch should support IPv4 and IPv6 Features.	
	Quality of Service:	
44.	Switch should support QoS based on 802.1p Priority - 8 hardware queues per port.	
45.	Switch should support Ingress Policing and Egress Shaping.	
46.	Switch should support 802.1p / ToS / DiffServ marking and mapping.	
47.	Switch should support CoS based on 802.1p priority, VLAN, MAC Address, Ether type, IP address, DSCP, Protocol type, TCP/UDP Port Number, DSCP of IPv6 Traffic Class and IPv6 flow label.	
48.	Switch should support SRR / WRR / CIR and SP.	
	Security:	
49.	Switch should support Broadcast / Multicast / Unicast Storm Control.	
50.	Switch should support DHCP Snooping	
51.	Switch should support Dynamic ARP Inspection.	
52.	Switch should support IP Source Guard.	
53.	Switch should support SSH for IPv4 and IPv6.	
54.	Switch should support SSL for IPv4 and IPv6.	
55.	Switch should support IP-MAC port binding.	
56.	Switch should support 802.1x Authentication on all ports.	
57.	Switch should support 802.1x with Guest VLAN allows guests without 802.1x client to have limited network access on the guest VLAN.	
58.	Switch should support RADIUS and TACACS + authentication for switch access.	
59.	Switch should support scanning of network attacks based on behavioral analysis.	
60.	Switch should support Port Mirroring, Remote Port Mirroring and Policy-based Mirroring.	
61.	Switch should support Standard and extended ACLs on all ports.	
62.	Switch should support system event logging.	
63.	Switch should support real time multi-port statistics.	
64.	Switch should support MAC / IP Address Finder.	
65.	Device and Port Grouping for Navigation and Policy Management.	
66.	The Switch should be able to discover the neighbouring device of the same vendor giving the details about the platform, IP Address, Link connected through etc, thus helping in troubleshooting connectivity problems.	
	Physical/Environmental:	
67.	AC Input: 100 to 240 VAC, 50/60 Hz internal	

68.	Operating Temperature: 0 to 45 °C	
69.	Certifications: CE, FCC, VCCI, UL, EN, IEC, RoHS.	
	Management:	
70.	Switch should support management using CLI, Telnet and GUI using Web interface.	
71.	Switch should support IPv6 Neighbor Discovery.	
72.	Switch should support SNMP V1, V2, V3, SNMP Traps and RMON.	
73.	Switch should support ICMPv6 and IPv4/v6 Dual Stack.	
74.	Switch should support LLDP and LLDP-MED.	
75.	Switch should support FTP / TFTP for upgrading the Operating System.	
	Licensing:	
76.	Switch should support a licensing mechanism which will enable the client to port the license to the new switch when client want to replace the existing switch.	
77.	Switch should support new updates and upgrades along with new features with that licensing mechanism.	
78.	Switch should support L3 Features like advanced IP unicast routing, OSPFv3, EIGRPv6, IS-ISv4 with backward compatibility.	
79.	Switch should support Software Defined Network (SDN) from Day One, If any license required should be included.	
80.	Offered Product must have OEM Support Contract for 1 Years with 8x5xNBD.	
81.	OEM Service Contract paper to be submitted after Installation.	
	OEM Criteria:	
82.	OEM should be Leaders in Gartner Magic Quadrant for Wired and Wireless, atleast for Last 3 Years.	
83.	Offered Product Should not be End of Sale for atleast 5 Years.	

2.4 24 Port Access Switch with 4 10G Uplink – Layer 2 (Type - 4):

Sr. No.	Specification	Compliance Yes / No
	Hardware Architecture:	
1.	Switch should have Stackable Architecture to provide Scalable network.	
2.	Switch should be stackable switch at least eight switch should be stack with a minimum stacking bandwidth of 160 Gbps.	
3.	Switch should have Resilient Stacking Architecture.	
4.	Manageable 24 Port Giga Switch. Number of Ports: 24 x 10/100/1000 Mbps and additional 4 x 10G SFP+ Ports.	
5.	Switch should have switching capacity of 128 Gbps and 288 Gbps with stacking or more.	
6.	Switch should have Redundant Power Supply Slot.	
7.	Switch should have non-blocking wire-speed architecture.	

8.	Switch port should support IEEE 802.3 10Base-T, IEEE 802.3u 100Base-Tx Fast Ethernet, IEEE 802.3ab 1000Base-T Gigabit Ethernet, 802.3ae 10 GbE, IEEE 802.3x Flow Control for Full Duplex Mode, Auto negotiation, IEEE802.1X Authentication.	
9.	Switch should be architected to support real time applications like voice, video, data by having distributed architecture.	
	Requirement per Switch:	
10.	Minimum 24 interfaces of 10/100/1000 base-TX and 04 interfaces of 10 Gigabit SFP+.	
11.	Switch should support IEEE 802.3az Energy Efficient Ethernet.	
12.	Switch should have at least 4GB DRAM and 4GB Flash or higher.	
13.	Switch should support LED indication for System Status, per port integrity, Activity, Disabled, Link Speed, etc.	
	Performance:	
14.	Switch should have non-blocking switching backplane of 128 Gbps.	
15.	Switch should have forwarding rate of minimum 95 Mpps on 64 Byte Packet.	
16.	Switch should support 32K or more MAC Addresses.	
17.	Switch should support up to 512 static MAC entries and should support auto-learning MAC addresses with enable / disable function.	
18.	Switch should support Hibernation Mode.	
19.	Switch should support EtherChannel Technology across different members of stack.	
20.	Switch should support Power Redundancy and Fan Redundancy.	
21.	Switch should support Switched Port Analyzer (SPAN) & Enhanced SPAN.	
22.	Switch should have SYSLOG capabilities to enable system logging.	
23.	Switch should support to NTP Client.	
24.	Switch should support logging banner for console.	
25.	Switch should support Spanning Tree Protocol per VLAN.	
26.	Switch should have functionality to add new features like IOS / Firmware upgrades.	
27.	MTBF should be 580000 hours or more.	
	L2 Features:	
28.	Switch should support 9K Jumbo frames.	
29.	Switch should support Loop Back detection.	
30.	Switch should support Dynamic VLAN.	
31.	Switch should support HW based Source Learning, should support voice VLAN.	
32.	Switch should support IEEE 802.1Q Tagged VLAN – Port based VLANs and VLAN Stacking.	
33.	Switch should support for at least 1K Active VLAN's.	
34.	Switch should support 1600 ACLs or Higher.	
35.	Switch should support Spanning Tree Protocol per VLAN.	
36.	Switch should support 802.1d STP, 802.1s MSTP and 802.1w RSTP Protocols.	
37.	Switch should support IPv4: IGMP V1, V2 Snooping and V3 awareness.	

38.	Switch should support IPV4 and IPv6: MLD V1/V2 awareness.	
39.	Switch should support Link Aggregation based on 802.3ad across the switches	
40.	Switch should support latency < 4µ seconds.	
41.	Switch should support IPv4 and IPv6 Features.	
	Quality of Service:	
42.	Switch should support QoS based on 802.1p Priority - 8 hardware queues per port.	
43.	Switch should support Ingress Policing and Egress Shaping.	
44.	Switch should support 802.1p / ToS / DiffServ marking and mapping.	
45.	Switch should support CoS based on 802.1p priority, VLAN, MAC Address, Ether type, IP address, DSCP, Protocol type, TCP/UDP Port Number, DSCP of IPv6 Traffic Class and IPv6 flow label.	
46.	Switch should support SRR / WRR / CIR and SP.	
	Security:	
47.	Switch should support Broadcast / Multicast / Unicast Storm Control.	
48.	Switch should support DHCP Snooping	
49.	Switch should support Dynamic ARP Inspection.	
50.	Switch should support IP Source Guard.	
51.	Switch should support SSH for IPv4 and IPv6.	
52.	Switch should support SSL for IPv4 and IPv6.	
53.	Switch should support IP-MAC port binding.	
54.	Switch should support 802.1x Authentication on all ports.	
55.	Switch should support 802.1x with Guest VLAN allows guests without 802.1x client to have limited network access on the guest VLAN.	
56.	Switch should support RADIUS and TACACS + authentication for switch access.	
57.	Switch should support scanning of network attacks based on behavioral analysis.	
58.	Switch should support Port Mirroring, Remote Port Mirroring and Policy-based Mirroring.	
59.	Switch should support Standard and extended ACLs on all ports.	
60.	Switch should support system event logging.	
61.	Switch should support real time multi-port statistics.	
62.	Switch should support MAC / IP Address Finder.	
63.	Device and Port Grouping for Navigation and Policy Management.	
64.	The Switch should be able to discover the neighbouring device of the same vendor giving the details about the platform, IP Address, Link connected through etc, thus helping in troubleshooting connectivity problems.	
	Physical/Environmental:	
65.	AC Input: 100 to 240 VAC, 50/60 Hz internal	
66.	Operating Temperature: 0 to 45 °C	
67.	Certifications: CE, FCC, VCCI, UL, EN, IEC, RoHS.	
	Management:	
68.	Switch should support management using CLI, Telnet and GUI using Web interface.	
69.	Switch should support IPv6 Neighbor Discovery.	

70.	Switch should support SNMP V1, V2, V3, SNMP Traps and RMON.	
71.	Switch should support ICMPv6 and IPv4/v6 Dual Stack.	
72.	Switch should support LLDP and LLDP-MED.	
73.	Switch should support FTP / TFTP for upgrading the Operating System.	
	Licensing:	
74.	Switch should support a licensing mechanism which will enable the client to port the license to the new switch when client want to replace the existing switch.	
75.	Switch should support new updates and upgrades along with new features with that licensing mechanism.	
76.	Switch should support L3 Features like advanced IP unicast routing, OSPFv3, EIGRPv6, IS-ISv4 with backward compatibility.	
77.	Switch should support Software Defined Network (SDN) from Day One, If any license required should be included.	
78.	Offered Product must have OEM Support Contract for 1 Years with 8x5xNBD.	
79.	OEM Service Contract paper to be submitted after Installation.	
	OEM Criteria:	
80.	OEM should be Leaders in Gartner Magic Quadrant for Wired and Wireless, atleast for Last 3 Years.	
81.	Offered Product Should not be End of Sale for atleast 5 Years.	

2.5 10 Gigabit SFP Modules:

Sr. No.	Description	Compliance
1.	Connector Type – LC.	
2.	10G Base-LR.	
3.	Should support 10 Gbps up to 10 Km on Single Mode Fiber.	
4.	Should be from same OEM of Switches.	

2.6 Wireless Controller:

Sr. No.	Description	Compliance
1.	Wireless deployment shall be on Centralized Controller-based architecture with High Availability Mode providing seamless scalability up to at least 1500 Access Points and 20000 Clients.	
2.	Must be compliant with IEEE CAPWAP or equivalent for controller-based WLANs.	

3.	2 x 10 Gigabit Ethernet interfaces or 2 x 1 Gigabit Ethernet interfaces	
4.	Should support both centralized as well as distributed traffic forwarding architecture with L3 roaming support from day 1. Should have IPv6 ready from day one.	
5.	Controller should have hot-swappable redundant power supplies.	
6.	Controller should be capable of supporting both 1G and 10 G SPFs on same Network I/O ports	
7.	Controller should have Redundant power supply from day one.	
8.	WLC should support Trustsec SXP	
9.	WLAN Controller should support minimum of 1500 Access points in a single chassis.	
10.	Shall support WIPS, and spectral analysis from day one.	
11.	Should be rack-mountable. Required accessories for rack mounting to be provided.	
12.	WLC should support AVC functionality on local switching architecture	
13.	WLC should support AC and DC powering options	
14.	WLC should support AP License Migration from one WLC to another	
15.	Should support minimum 4000 VLANs	
16.	Must support stateful switchover between active and standby controller in a sub second time frame.	
17.	WLC should support L2 and L3 roaming for IPv4 and IPv6 clients	
18.	WLC should support guest-access functionality for IPv6 clients.	
19.	Should support IEEE 802.1p priority tag.	
20.	Should ensure WLAN reliability by proactively determining and adjusting to changing RF conditions.	
21.	Should provide real-time radio power adjustments based on changing environmental conditions and signal coverage adjustments.	
22.	Should support automatic radio channel adjustments for intelligent channel switching and real-time interference detection.	
23.	Should support client load balancing to balance the number of clients across multiple APs to optimize AP and client throughput.	
24.	Should support policy based forwarding to classify data traffic based on ACLs	

25.	WLC should support PMIPv6 and EoGRE tunnels on northboud interface	
26.	Should support flexible DFS to prevent additional 20/40 Mhz channels from going unused	
27.	Should support minimum 100 WLANs	
28.	Should support dynamic VLAN assignment	
29.	Should support Hot Spot 2.0	
30.	To deliver optimal bandwidth usage, reliable multicast must use single session between AP and Wireless Controller.	
31.	Should able to do dynamic channel bonding based on interference detected on particular channel.	
32.	Must support coverage hole detection and correction that can be adjusted on a per WLAN basis.	
33.	Must support RF Management with 40 MHz and 80 Mhz channels with 802.11n & 802.11ac	
34.	Should provide visibility to Network airtime in order to set the airtime policy enforcement	
35.	Must support dynamic Airtime allocation on per WLAN, per AP, Per AP group basis.	
36.	Must be able to restrict the number of logins per user.	
37.	Must support RF Management with 40 MHz and 80 Mhz channels with 802.11n & 802.11ac	
38.	Should support web-based authentication to provide a browser-based environment to authenticate clients that do not support the IEEE 802.1X supplicant.	
39.	Should support port-based and SSID-based IEEE 802.1X authentication.	
40.	Should support MAC authentication to provide simple authentication based on a user's MAC address.	
41.	WLC Should support Rogue AP detection, clasification and standard WIPS signatures.	
42.	WLC should be able to exclude clients based on excessive/multiple authentication failure.	
43.	Shall support AES or TKIP encryption to secure the data integrity of wireless traffic	
44.	Shall able to provide an air quality index for ensuring the better performance	
45.	Shall able to provide real time chart showing interference per access point on per radio and per-channel basis.	
46.	Should support AP location-based user access to control the locations where a wireless user can access the network	

47.	Should support Public Key Infrastructure (PKI) to control access	
48.	Must be able to set a maximum per-user bandwidth limit on a per-SSID basis.	
49.	Should support SNMPv3, SSHv2 and SSL for secure management.	
50.	Should support encrypted mechanisum to securely upload/download software image to and from Wireless controller.	
51.	Should provide visibility between a wired and wireless network using IEEE 802.1AB Link Layer Discovery Protocol (LLDP) and sFlow/equivalent.	
52.	Should support AP Plug and Play (PnP) deployment with zero-configuration capability	
53.	Should support AP grouping to enable administrator to easily apply AP-based or radio-based configurations to all the APs in the same group	
54.	Should support selective firmware upgrade APs, typically to a group of APs minimize the impact of up-gradation	
55.	Should have a suitable serial console port.	
56.	Should have Voice and Video Call Admission and Stream prioritization for preferential QOS	
57.	Controller should have Deep Packet Inspection for Layer 4-7 traffic for user for all traffic across the network to analyses information about applications usage and prioritization	
58.	Controller should have profiling of devices based on protocols like HTTP, DHCP and more to identify the end devices on the network.	
59.	Should support visibly and control based on the type of applications	

2.7 Wireless Access Points Medium Density (Type – 1):

Sr. No.	Description	Compliance
1.	Access Points proposed must include radios for 2.4 GHz and 5 GHz with 802.11ac Wave 2 with Connection rate of upto 1 Gbps with Dual Radio.	
2.	Must have a robust design for durability, without visible vents	
3.	Mounting kit should be standard from OEM directly.	

4.	High-speed spectrum intelligence across 20-, 40-, and 80-MHz-wide channels to combat performance problems due to wireless interference	
5.	Must have 1x10/100/1000BASE-T autosensing (RJ-45) ports & management Console port RJ-45	
6.	Must have atleast 3 dBi Antenna gain on 2.4Ghz and 4 dbi on 5Ghz	
7.	Must support 3x3 multiple-input multiple-output (MIMO) with two spatial streams or higher	
8.	Must support simultaneous 802.11n on both the 2.4 GHz and 5 GHz radios.	
9.	Must support 802.11ac Wave 1 on the integrated 5-GHz radio	
10.	Access Point shall be 802.11ac/Wave-2, supporting up to 40, 80 & if possible 160MHz 11ac channel bandwidth. 40 & 80 is must.	
11.	Access Point shall be able to support .3ad LCAP(LAG), MACsec	
12.	Access Point shall be able to support Hardware-Accelerated Deep Packet Inspection (Application Visibility) and Control to increase overall access point performance	
13.	Access point should support USB port	
14.	The Wireless AP should have the technology to improve downlink performance to all mobile devices including one-, two-, and three spatial stream devices on 802.11n and 802.11ac. The technology should work without requiring feedback from clients and should work with all existing 802.11 clients.	
15.	Should support detecting and classifying non-Wi-Fi wireless transmissions while simultaneously serving network traffic	
16.	Should support configuring the access point as network connected sensor to access any network location covered by the access point to get real-time Spectrum analysis data.	
17.	Must support AP enforced load-balance between 2.4Ghz and 5Ghz band.	
18.	Must incorporate radio resource management for power, channel, coverage hole detection and performance optimization	
19.	Should be able to detect atleast 20 sources of non 802.11 interference within 30 seconds	
20.	Must support Proactive Key Caching and/or other methods for Fast Secure Roaming.	
21.	Must support Management Frame Protection.	

22.	Should support locally-significant certificates on the APs using a Public Key Infrastructure (PKI).	
23.	Must operate as a sensor for wireless IPS	
24.	Should support non-Wi-Fi detection for off-channel rogues and Containment for both radio	
25.	Access Points must support a distributed encryption/decryption model.	
26.	Access Points must support Hardware-based DTLS encryption on CAPWAP Standard or equivalent	
27.	Must support the ability to serve clients and monitor the RF environment concurrently.	
28.	Same model AP that serves clients must be able to be dedicated to monitoring the RF environment.	
29.	Must support telnet and/or SSH login to APs directly for troubleshooting flexibility.	
30.	Must Support 802.3at /PoE+ as the source of power for POE through Switch or POE Injector	
31.	802.11e and WMM	
32.	Must support QoS and Video Call Admission Control capabilities.	
33.	Access Point should 802.11 DFS certified	

2.8 Firewall / Unified Threat Management System:

Sr. No.	Description	Compliance
1.	The Firewall solution offered must be rated as in the latest Magic Quadrant for Firewall published by Gartner.	
2.	The appliance based security platform should be capable of providing firewall, application visibility, IPS, Anti-APT and URL filtering functionality in a single appliance from day one.	
3.	The appliance should support atleast 8 * 1G ports and 2 * 1G Fiber ports from Day one	
4.	The appliance hardware should be a multicore CPU architecture with a hardened 64 bit operating system to support higher memory (minimum 16GB from day one).	
5.	Proposed Firewall should not be proprietary ASIC based in nature & should be open architecture based on multi-core cpu's to protect & scale against dynamic latest security threats.	
6.	Should support atleast 2 Gbps of production performance / multiprotocol combined firewall & ips throughput	

7.	Firewall should support atleast 10M concurrent connections	
8.	Firewall should support atleast 12,000 new connections per second	
9.	Firewall should support atleast 1024 VLANs	
10.	Firewall should provide application detection for DNS, FTP, HTTP, SMTP,ESMTP, LDAP, MGCP, RTSP, SIP, SCCP, SQLNET, TFTP, H.323, SNMP	
11.	Firewall should support creating access-rules with IPv4 & IPv6 objects simultaneously	
12.	Firewall should support operating in routed & transparent mode	
13.	Should support Static, RIP, OSPF, OSPFv3 and BGP	
14.	Firewall should support manual NAT and Auto-NAT, static nat, dynamic nat, dynamic pat	
15.	Firewall should support Nat66 (IPv6-to-IPv6), Nat 64 (IPv6-to-IPv4) & Nat46 (IPv4-to-IPv6) functionality	
16.	Firewall should support Multicast protocols like IGMP, PIM, etc	
17.	Should support security policies based on security group names in source or destination fields or both	
18.	Should support capability to limit bandwidth on basis of apps / groups, Networks / Geo, Ports, etc	
19.	Firewall should support Active/Standby failover	
20.	Firewall should support ether channel functionality for the failover control & date interfaces for provide additional level of redundancy	
21.	Firewall should support redundant interfaces to provide interface level redundancy before device failover	
22.	Firewall should support 802.3ad Ether channel functionality to increase the bandwidth for a segment.	
23.	Should support Reputation- and category-based URL filtering offering comprehensive alerting and control over suspect web traffic and enforces policies on more than 280 million of URLs in more than 80 categories.	
24.	Should have identification support for atleast 3000 applications and the identification should be regardless of ports. The application needs to be predefined on the box.	
25.	Solution should provide granual control of applications.	
26.	The solution should be able to mitigate sophisticated client-side attacks by providing controlled access to URLs.	
27.	Firewall should support integrated Reputation & dynamic category based web filtering.	

28.	Support manual URL filtering that specify individual URLs, groups of URLs, and URL lists and feeds to achieve granular, custom control over web traffic.	
29.	The solution must support creation of user-defined application protocol detectors.	
30.	Should have the capability of passively gathering information about virtual machine traffic, network hosts and their activities, such as operating system, services, open ports, client applications, and vulnerabilities, to assist with multiple activities, such as intrusion event data correlation, elimination of false positives, and policy compliance.	
31.	The device shall allow administrators to create Custom IPS signatures	
32.	Should be capable of dynamically tuning IDS/IPS sensors (e.g., selecting rules, configuring policies, updating policies, etc.) with minimal human intervention.	
33.	Should be capable of automatically providing the appropriate inspections and protections for traffic sent over non-standard communications ports.	
34.	Should be able to link Active Directory and/or LDAP usernames to IP addresses related to suspected security events.	
35.	Should be capable of detecting and blocking IPv6 attacks.	
36.	Should support the capability to quarantine end point	
37.	Solution should support full-featured NBA capability to detect threats emerging from inside the network. This includes the ability to establish “normal” traffic baselines through flow analysis techniques (e.g., NetFlow) and the ability to detect deviations from normal baselines.	
38.	The solution must provide IP reputation feed that comprised of several regularly updated collections of poor repuration of IP addresses determined by the proposed security vendor	
39.	Solution must support IP reputation intelligence feeds from third party and custom lists of IP addresses including a global blacklist.	
40.	Should must support URL and DNS threat intelligence feeds to protect against threats	
41.	Should support safe search for YouTube EDU enforcement	
42.	Solution must be capable of passively gathering details unique to mobile devices traffic to identify a wide variety of mobile operating systems, mobile applications and associated mobile device hardware.	

43.	Should support more than 3000 application layer and risk-based controls that can invoke tailored intrusion prevention system (IPS) threat detection policies to optimize security effectiveness.	
44.	The appliance OEM must have its own threat intelligence analysis center and should use the global footprint of security deployments for more comprehensive network protection.	
45.	The detection engine should support capability of detecting and preventing a wide variety of threats (e.g., malware, network probes/reconnaissance, VoIP attacks, buffer overflows, P2P attacks, etc.).	
46.	Should be able to identify attacks based on Geo-location and define policy to block on the basis of Geo-location.	
47.	The detection engine should support the capability of detecting variants of known threats, as well as new threats	
48.	The detection engine must incorporate multiple approaches for detecting threats, including at a minimum exploit-based signatures, vulnerability-based rules, protocol anomaly detection, and behavioral anomaly detection techniques. Identify and explain each type of detection mechanism supported.	
49.	Should support Open based Application ID for access to community resources and ability to easily customize security to address new and specific threats and applications quickly	
50.	Must be capable of providing network-based detection of malware by checking the disposition of known files in the cloud using the SHA-256 file-hash as they transit the network and capability to do dynamic analysis on premise (if required in future) on purpose built-appliance	
51.	Should support the capability of providing network-based detection of malware by checking the disposition of unknown files using SHA-256 file-hash or signature (update to be provided in 300 seconds) as they transit the network and capability to do dynamic analysis on premise on purpose built-appliance	
52.	Solution shall have capability to analyze and block TCP/UDP protocol to identify attacks and malware communications. At minimum, the following protocols are supported for real-time inspection, blocking and control of download files: HTTP, SMTP, POP3, IMAP, NetBIOS-SSN and FTP	

53.	Proposed solution shall have required subscription like Threat Intelligence for proper functioning	
54.	Centralized management should be separate appliance. It should be VM appliance or Hardware appliance	
55.	The management platform must be accessible via a web-based interface and ideally with no need for additional client software.	
56.	The management platform must be capable of role-based administration, enabling different sets of views and configuration capabilities for different administrators subsequent to their authentication.	
57.	The management platform must include a scheduling subsystem to facilitate automation of routine tasks, such as backups, upgrades, report creation, and policy application.	
58.	Centralised management can do contextual threat intelligence service accelerates analysis, correlation of events. This can be on apliance or can be cloud services	
59.	The management platform must be capable of automatically receiving rule updates published by the vendor and automatically distributing and applying those rule updates to sensors.	
60.	The Centralised management platform must provide robust reporting capabilities, including a selection of pre-defined reports and the ability for complete customization and generation of new reports. Report can be consolidated or can be generate individual NGFW	
61.	Logging of Administrative Changes that provides an audit trail for administrative activities.	
62.	The management platform must provide a highly customizable dashboard.	
63.	The management platform must be capable of integrating third party vulnerability information into threat policy adjustment routines and automated tuning workflows	
64.	The management platform must be capable of role-based administration, enabling different sets of views and configuration capabilities for different administrators subsequent to their authentication.	
65.	Should support REST API for monitoring and config programmability .	
66.	The management platform must provide multiple report output types or formats, such as PDF, HTML, and CSV.	
67.	The management platform must support multiple mechanisms for issuing alerts (e.g., SNMP, e-mail, SYSLOG).	

68.	The management platform must risk reports like advanced malware, attacks and network	
69.	The management platform must include an integration mechanism, preferably in the form of open APIs and/or standard interfaces, to enable events and log data to be shared with external network and security management applications, such as Security Information and Event Managers (SIEMs), and log management tools.	

3. Telecommunication System:-

3.1 EPABX System

Sr. No.	Description	Specification	Compliance
1.	System Features	The telephony system should be a converged communication System with ability to run TDM and IP on the same platform using same software load based on server and Gateway architecture. The system should be capable of support Analog and IP SIP based phones. The communication server should be appliance based; no card based processor should be quoted.	
2.		The Telephony system shall have all the hotel / hospitality features including integration with PMS system.	
3.		The system should support duplicated databases such that it is possible to make administrative changes to the system even during outage of primary server/database.	
4.		EPBX system shall have valid TEC compliance	
5.		The system should have support for 1800 users from day 1 and should be scalable upto 10,000 users on the single server.	
6.		The system should support complete UC functionality including soft phone, IM, presence and collaboration for 500 users from day 1.	
7.		The system should be based on server gateway architecture with external appliance server. No card based processor systems should be quoted.	
8.		The system should be modular, scalable and distributable in nature.	
9.		The system to have distributed architecture and the centralized control for all the IP PBX entities in the network. It should be possible to have centralized applications like voice mail, UC for the network users	
10.		The system shall be configured for SIP and IP trunk interfaces without any external interfaces or adapters.	
11.		The Call Server should able to handle traffic minimum 300K BHCC	

12.		It should be possible for the IP phone to be connected on the same line which is connected to the computer i.e. single wire to desk.	
13.		System should support commercial grade encryption security with minimum 250 bit key security for both signaling and voice with in a node for all IP subscribers	
14.		The VOIP should be implemented through Plug and Play interface boards in any of the Universal slots of the system. The replacement of cards in both Call Control and Media gateways should be online (i.e. hot pluggable) without the need to power off the system.	
15.		System should be able to operate with any SIP compliant devices and should be able to support internal Gatekeeper for the same. If required it should be able to operate with SIP Standard based external gatekeepers.	
16.		System should have from day one Multi Media Conferencing solutions including audio, Video and Data Collaboration applications.	
17.		System should have inbuilt presence server supporting both SIMPLE and XMPP protocols from day 1.	
18.		The PBX system should have full virtualization support from day 1 and should provide option for both customer supplied servers or provisioned by the OEM.	
19.		The system software version offered should be the latest release as on the date of supply of EPABX as available globally.	
20.	System features	The system should support at least 10 digit numbering scheme.	
21.		The proposed system should support automatic route selection (ARS) and least Cost routing (LCR) features to route the calls based on priorities related to user profile, tariff, and network availability, along the most cost-effective path. This service will be transparent for users and irrespective of the physical carrier connection.	
22.		Auto-attendant facility on all trunks simultaneously with flexibility of having different sets of announcements to separate incoming trunk groups.	

23.		The system must be equipped with a server based voice mail of the same OEM, offering the best interactivity with user. Mailboxes for all the users should be provisioned	
24.		ISDN – PRI with QSIG. The EPABX should provide ISDN-PRI trunk with open-ended QSIG (ETSI) to support private networking. It is required to have 2 port E1/ PRI cards, the ports should be provided across 2 cards for redundancy.	
25.		All future upgrades of system software as and when released shall be provided by vendor subsequently without any additional cost to the user. The user will however, procure essential hardware required.	
26.		The system should be able to synchronize with external LDAP or Microsoft AD director service. It should be possible to provide bi-directional synchronization i.e. a user created in the directory should be auto-provisioned for telephony basis rules and subsequently the number assigned by the system should be reflected in the directory service	
27.		Class of Service (COS). Should be able to define whether or not voice terminal users may access the following features and functions: Automatic Callback, Call Forwarding All Calls, Call Forward Busy / Don't Answer, Data Privacy, Extended Forwarding All, Extended Call Forward Busy / Don't Answer, Priority Calling, Restrict Call Forwarding Off-Net, Personal Station Access, Trunk – to Trunk Transfer Restriction Override, Off-Hook Alert, Console Permission and Client Room.	
28.		The following basic telephony features to be provided by the offered system:- a. Abbreviated Dialing b. Automatic Callback on Busy c. Automatic callback on No answer d. Direct Inward Station Access e. Call forwarding Unconditional f. Call forwarding on No answer g. Call forwarding on Busy h. Malicious call trace i. Group Call Pick up j. Extended Group Call Pickup k. Call Park	

		l. Call retrieve m. Calling line identification restriction n. Call waiting o. class of service p. Hot Line q. Do not Disturb r. Do Not Disturb override s. Call Hold t. Call Transfer u. Internal Music On Hold v. External Music on Hold Support w. Last Number Redial x. Save Number Redial y. Instrument locking for preventing outgoing calls z. One Number service.-Through this feature it should be possible to have the same number for internal extension and Mobile Number. Through this feature both internal extension and Mobile number will ring simultaneously and once the call is picked up from either of the devices the ringing on the other device stops. This requires integration of PRI Lines with DOT/MTNL. This feature may also be termed as parallel ringing.	
29.	IM and Presence	The solution must be able to support point-to-point and multi-party messaging	
30.		It must support ability to send Multimedia (Text, voice, video and photo) messages between users	
31.		It must have ability to store messages centrally and be able to deliver them when users connect. Senders should be able to send to offline receivers and messages should be able to be delivered on demand. The centrally stored messages should provide secure access through encryption between servers and endpoints. Also data should be available only through secured logins	
32.		Conversation persistency should be maintained so that users can view and participate in active conversations from multiple messaging applications, until they leave the conversation	
33.		It must support notification events for all new messages	

34.		It must support user search for current and active conversations	
35.		It should provide administrators to retrieve archived messages in future	
36.		It should support synchronization with Microsoft Active Directory 2012	
37.		It should be possible to provide storage management through automatic closure of old conversations and controlling of over-size media files that can be sent by users	
38.		The solution should be deployed on the virtualized server on the same hardware for simplicity	
39.		It should support multiple devices like Windows, Android and IOS on iPhones and iPads	
40.		The advanced soft phone users must have access to Rich telephony services as any other user of the IP PBX. The soft client should provide Web RTC based option along with mobile on IOS and Android. The IP softphone users should be able to view the IM and telephony presence of other softphone users and do instant messaging with each other. The system must allow the association of a user's extension with up to 10 devices.	
41.	Voice, Video and Web Conferencing	Within its proposal, the vendor must include the provision of a solution in site that enables voice conferencing, web, and video. This solution must comply with at least the following requirements:	
42.		The solution must be based on Linux and support the deployment in virtual environment	
43.		It must support at least the audio codecs G711, G729, G722 and G726, and the video codecs H.263 and H.264.	
44.		In addition, it must support the cascade functionality. This means to link a group of users of the same locality and belonging to the same audio and/or video conference to a single stream. This will allow reducing significantly the bandwidth transmitted over the WAN.	
45.		It must support the Reverse Proxy functionality.	

46.		It must have a collaboration API, allowing creating customized applications or interfaces.	
47.		It must have capacity to integrate with mobile clients based on Android and iOS.	
48.		It must have the capacity to associate user accounts with an LDAP directory.	
49.		Access to conferencing sessions must be through a web browser with the capacity to extend audio and video to this meeting via HTTPS session.	
50.		It must have the option to dial-out for all participants, thus giving them the ability to participate in the conference. With this option, participants can define a phone number to which they may call to join the conference on audio or video.	
51.		It must have the option such that when the moderator disconnects, the conference can continue.	
52.		Each system user must have their own library in order to upload documents that can be shared and presented in audio or video conferencing, either through the different mobile devices or web interface.	
53.		As part of the moderator features, it must have at least the following: a. Capacity to call someone else from the conferencing session itself for a new participant to join the voice or video conference. b. Able to promote a user in order to receive host permissions. c. Lock the meeting so no other participant can enter in the session. d. Mute the audio or video for all participants, or a particular participant. e. Expel a participant from the conference. f. Recording meeting option, whether voice, video, or web. This option should be available all the time so that the moderator of the meeting can enable, or disable it during the course of a session. g. Ability to distribute the recording to the meeting participants. h. Share an application, desk, blackboard, or a document.	

55		It must have the functionality of public and private chat in the web or video conferencing.	
56		It must have the integration possibility with mobile clients in cellphones and tablets, as well as integration with collaboration clients on the desktop so that a conference session can be generated from these applications, in addition to provide ad-hoc and meet-me (audio-web-video) functions.	
57		It must have the capacity of plug-in with Microsoft Outlook 2013 in which you can generate an invitation to a conference with all the contact details and connection. In a like manner, it must have a plug-in to open the collaboration web interface and to have the option click-to-dial - meet-me, and thus be able to participate in a voice conference.	
58		The solution must integrate through SIP trunks to the IP telephony system.	
59		For the video conference sessions it must support at least 8 video parties in continuous presence, SVC/AVC and have additional video participants on voice activation basis	
60		For mobile users, it should support the integration through a dedicated voice firewall to provide multi-conference audio and video with continuous presence; this integration will avoid the VPN setting up in mobile clients.	
61		It must support audio and video encryption through the SRTP protocol. Likewise, it should have the option of handling security certificates.	
62		It must have the ability to support at least 8 concurrent conferences with each conference supporting 99 participants each in a single conference, with the possibility to scale further.	
63		It must have the capacity from a web interface to control and monitor in real-time the active sessions, bandwidths, video resolutions, users associated with an account, licenses, monitoring of alarms, logs, performance measurements.	
64	Gateway	Should have universal slots in cabinet/chassis.	
65		System shall have power supply redundancy	

66		Environmental Conditions: a. Operational temperature: 0 to 40 Degree C. b. Storage -20 degree C to +65 degree C c. Humidity 10% to 90% without condensation	
67		The exchange cabinet should field replaceable RAM, flash, DSPs, PSUs, fan tray, and main board module for enhanced reliability	
68	VoIP Management	Network support and call details for Voice over IP	
69		Call detail records including current active calls and call history for at least one month.	
70		VoIP quality- Latency, Jitter, packet loss for each call and get historical reports and trend charts.	
71		VoIP Traffic analysis-Monitor a mix of VoIP and other network traffic proactively to understand the network, preferably the bandwidth and capacity bottlenecks of different applications.	
72		It should be possible to centrally take packet captures for in and out of any IP endpoint to help troubleshoot audio quality issues.	
73		It should be possible to trace route to detect DSCP markings to ensure end-to-end markings are provisioned	
74		It should be possible to access the IP phone interface with live screen capture for taking remote control of the phone for faster resolution. It should also be possible to simulate multiple calls from one end node to another	

3.2 IP Phone Type – 1 :

Sr. No.	Description	Compliance
1.	Single-line IP phone, with support for two concurrent calls	
2.	Support for transfer, Forward, Mute, 3-Way-Ad-Hoc-Conference	
3.	Monochrome 128x40 pixel and 2” display with three rows, for calling party information, soft key labels, and status indicators.	
4.	Three context sensitive soft keys	

5.	Fixed hard buttons for Mute, Transfer, Conference, Flash, Voice-Mail, Speaker, Volume, and Directory	
6.	Directory with up to 500 contacts, and Call History with up to 200 entries	
7.	G.722 wideband audio, handset and headset (with wideband headsets)	
8.	Full duplex speakerphone	
9.	Wall-Mount and Desk-Mount stand.	
10.	Headset port (RJ9 connector)	
11.	Message Waiting Indicator	
12.	Navigation buttons for easy manipulation.	
13.	Dual Ethernet port operating at 10/100 Mbps speed.	
14.	TLS and SRTP support	
15.	Power over Ethernet capable	

3.3 Basic CLI Phone:

Sr. No.	**Description**	**Compliance**
1.	No. of Lines-1	
2.	Incoming & Outgoing Call memory Storage	
3.	Flash Programmable	
4.	LCD Contrast adjustable	
5.	Min 16 Digit Single Line Display	
6.	Two Way Speaker supported	

1. Network Unified Threat Management (UTM) Firewall

Sr. No.	Item Description	Compliance
1	Should have support to connect upto 1000 con-current users and 20000000 concurrent connection with unrestricted user license	
2	Should have capability to connect 2,00,000 new connection per second	
3	Should have 8 x 1Gb Ethernet port and 2 x 10 Gb SFP+	

	Port	
4	Should have Antivirus throughput of 6 Gbps or higher	
5	Should have IPS throughput of 8 Gbps or higher	
6	Should have 2 Flexi Port Slots	
7	Should have VPN throughput of 4Gbps or higher	
8	Should have 3 Nos. USB 3.0 and 1 Nos. HDMI Port	
9	Should have firewall throughput of 40Gbps or higher	
10	Should have option of external power supply	
11	Should have integrated inbuilt SSD hard disk for firewall log storage	
12	Should have 3 years OEM support from day 1 to upgrade firmware, virus database, etc	

4. Fire Alarm System Solution: -

General Scenario Of Considering Fire Alarm Devices:-

- In public premise in Hospital Where each and every location should be cover under Fire Alarm Devices with Automatic (i.e., Detectors) and Manual Alarm (i.e., MCP) devices.
- Fire Alarm Panel should be as per latest UL addition.
- Wherever Electric cablling are passing and false ceiling is there, at that locations above ceiling detectors need to be consider.
- Each and every passage should be cover with Above and Below ceiling detector devices need to be consider.
- At every entry and exit point Manual Call Points need to be placed.
- In longer passages Manual Call Points need to be placed at appropriate distance (i.e. not greater than 30 Mtr).
- Sound Initiating devices need to be place that no locations are excluded from the alarming conditions.
- In highly critical locations like Operation Theatres Aspiration Smoke Detection system need to be placed.
- Fire Standards for India (NFPA or whichever applicable) and Local Fire Authority rules need to be strictly followed.
- Fire Alarm Panels need to be placed at locations where Administration / Security / Fire officers can easily access in case of emergency.
- Repeater Panels need to be placed from where Fire officer can easily access the same in case of emergency.
- For each and every building, Fire Alarm Panel need to be place individually and separately to avoid non-working conditions due to damaged
- Fire Alarm Panel should be integrated with critical applications like Lifts, Access Control and at time of emergency trigger should be generated to them.
- Fire Alarm Panel should be integrated with Public Address Systems to evacuate people from premise in case emergency with priority type zoning.
- For higher humidity and dusty locations like pantry, parking, kitchen area Heat Detectors need to be considered.
- For placement of Detector NFPA standard should be followed on strictly basis. However in ideal conditions distance between two detectors should not be more than 7 Mtrs.
- In public gathering place like waiting area, reception area, etc advance smoke detectors need to be considered.

- All Fire Alarm Panels need to be connected with each other in active form.
- An graphical software need to be install at Chief Fire Alarm Officer / Fire Officer office to enable them to observe all Fire Alarm Panels from a single point of location.
- Isolators need to be placed after approved device count as per NFPA standards.

4.1 General Specification:-

Sr. No.	Description	Specification	Compliance
1	General	This section of the specification includes the furnishing, installation, and connection of a microprocessor controlled, addressable fire alarm equipment required to form a complete coordinated system ready for operation. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, control panels, auxiliary control devices, annunciator, power supplies, and wiring as per shop drawings and specified herein.	
2		The system shall be designed such that each loop shall limited to only 80% of its total capacity at initial installation	
3		All equipment/components shall be new & the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective	

		signaling (fire alarm) system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.	
4		All equipment and components shall be installed in strict compliance with each manufacturer's recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc. before beginning system installation. Refer to the riser/connection diagram for all specific system installation/termination/wiring data	
5		All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.	
6	Submittals and Shop Drawings	Sufficient information shall be clearly presented and shall include manufacturer's name, model numbers, power requirements, equipment layout, device arrangement and complete wiring.	
7		Sequence and description of operation	
8		Product Data for each type of equipment, initiating device, signal device, peripheral device	

		and cable provided on the project.	
9		Shop drawings shall include battery calculations, floor plans and wiring diagrams.	
10	Operation Manual	Installation instructions for use by installing contractor	
11		Operational instructions or manual for use by building personnel, including Name and phone number of service representative	
12		Maintenance instructions as required for use by building personnel.	
13		Copy of approved shop drawings.	
14	Basic System	The system shall be a complete, electrically supervised fire detection with microprocessor based operating system having the following; capabilities, features and capacities:	
15		The local system shall provide status indicators and control switches for all of the following functions a. Audible and visual notification alarm circuit zone control b. Status indicators for sprinkling system water-flow and valve supervisory devices. (if any) c. Any additional status or control functions as indicated on the drawings,	

		including but not limited to; emergency generator functions, fire pump functions, door unlocking and security with bypass capabilities	
16		Each intelligent addressable device or conventional zone on the system shall be displayed at the fire alarm control panel by a unique alphanumeric label identifying its location	
17	Specification	This specification is intended to set out in general outline the minimum requirements and standards of installation for the various units of equipment and works it covers. Provision set out, or claim made in the successful tender which are in excess of, or improved upon the basic requirements of the specification shall unless otherwise determined by the client become part of the requirements of the specification whether or not they are subsequently incorporated in addenda to the specification	
18		The client shall be the sole judge of what constitute an improvement upon or exceeds the requirements of the specification	
19		The specification shall be read in conjunction with the tender drawings (as per schedule of drawings) and are intended to be	

		mutually explanatory and complementary to one another. All works and specification called for by one, i.e. specification or drawings even if not by the other shall be fully executed and complied with in total.	
20		The entire system shall be engineered by the contractor based on the guidelines furnished in the specification, various codes / standards, with good engineering practice.	
21		Supplies and services to be covered under this tender specification and the conditions thereof are detailed in the subsequent sections of the specifications. In case of conflict among various sections, subsections, documents, drawings the same shall be referred to purchaser whose decision shall be final and binding to the Bidder	
22	Materials and Workmanship	Unless expressed to the contrary, all materials, and equipment supplied by the contractor shall comply with the applicable Indian standards (I.S) or various codes or specifications with good practice as approved by the Indian standards.	
23		Where a standard is referred to, that standard shall be the latest published edition thereof, unless otherwise stated	
24		All materials and equipment supplied shall be new and of the best type for each particular purpose and of the first quality with regard to design,	

		manufacture and performance	
25		The equipment and materials shall be suitably designed and constructed for safe, proper and continuous operation under all conditions described or implied in this specification without undue heat, strain, vibration, corrosion or other operating difficulties.	
26		Unless otherwise specified, the equipment and material 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.	
27		Unless otherwise specified, the equipment and material 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.	
28		Equipment and equipment components shall be designed and supported to permit free expansion and contraction without causing excessive strains, distortion or leakage	
29		Parts subject to wear, corrosion or other deterioration, or requiring adjustment, inspection or repair shall be accessible and capable of reasonably convenient	

		removal, replacement and repair. All such parts shall be of suitable material for keeping maintenance to a minimum	
30		The equipment shall be designed to permit replacement of parts and ease of access during inspection, maintenance and repair.	
31	Approvals	The system shall have proper listing and/or approval from the internationally recognized UL-Underwriters Laboratories Inc/ FM Factory Mutual	
32	Quality Assurance	The manufacturer of the detection components shall have experience in the design and manufacture of similar types of detection systems and who refer to similar installations providing satisfactory service.	
33		The name of the manufacturer, part numbers and serial numbers shall appear on all major components.	
34		All detection devices, components and equipment shall be the products of the same manufacturer	
35		All devices, components and equipment shall be new, standard products of the manufacturer's latest design and suitable to perform the functions intended	
38	Operation & Maintenance:	The contractor shall train the employer's operating personnel in the operation and maintenance of the plants	

39	Scope of work	This section of the specification includes the furnishing, installation, and connection of a microprocessor controlled, addressable fire alarm equipment required to form a complete coordinated system ready for operation. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, control panels, auxiliary control devices, annunciator, power supplies, and wiring as per shop drawings and specified herein.	
40		The system shall be designed such that each loop shall limited to only 80% of its total capacity at initial installation	
41		All equipment/components shall be new & the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling (fire alarm) system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.	
42		All equipment and components shall be installed in strict compliance with each manufacturer's recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc. before beginning system installation. Refer to the	

		riser/connection diagram for all specific system installation/termination/wiring data. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load	
43	Operation Manual:	Operation manual shall include: a. Installation instructions for use by installing contractor b. Operational instructions or manual for use by building personnel, including c. Name and phone number of service representative d. Maintenance instructions as required for use by building personnel e. Copy of approved shop drawings	
44	Fire Alarm Condition:	Sound an audible alarm and display a custom screen/message defining the building in alarm and the specific alarm point initiating the alarm in a graphic/LCD 600 character display.	
45		Log to the system history archives all activity pertaining to the alarm condition	
46		Sound a pre announce tone followed by a field programmable digitized custom message as required for the system. The visual signals operate in a similar pattern	

47		An automatic announcement or tone evacuation signal shall be capable of interruption by the operation of the local system microphone to give voice evacuation instructions overriding the preprogrammed sequences	
48		Status lights next to speaker selection switches on the control panel shall indicate speaker circuit selection	
49		Print to system printer (where required) alarm condition information.	
50		Audible signals shall be silenced from the fire alarm control panel by an alarm silence switch. Visual signals shall be programmable to flash until system reset or alarm silencing, as required	
51		Activation of any detector in a single elevator lobby or an elevator equipment room shall indicate at fire alarm control panel, cause the recall of that bank of elevators to the ground/stilt floor and the lockout of controls.	
52		HVAC shut down shall, be accomplished by system operated duct detectors as per local requirements. PAC units will be	

		shut down by control relay modules in the loop	
53		Door closure devices shall operate by floor	
54		Activation of stairwell pressurization fans, smoke purge and damper control shall be as required	
55		Supervisory Condition a. Display the origin of the supervisory condition report at the fire alarm control panel graphic/ 600 character LCD display b. Activate supervisory audible and dedicated visual signal c. Audible signals shall be silenced from the control panel by the supervisory acknowledge switch d. Record within system history the initiating device and time of occurrence of the event e. Print to the system printer (where required) the supervisory condition.	
56		Trouble Condition a. Display at the Fire alarm control panel graphic/600 character LCD display, the origin of the trouble condition report. b. Activate trouble audible and visual signals at the control panel and as indicated on the drawings. c. Audible signals shall be silenced from the fire alarm control panel by a trouble	

		acknowledge switch d. Trouble conditions that have been restored to normal shall be automatically removed from the trouble display queue and nor require operator intervention. e. Record within system history, the occurrence of the event, the time of occurrence and the device initiating the event. f. Print to the system printer (where required) the trouble condition	

4.2 Fire Alarm Control Panel (FACP):-

Sr. No.	Description	Specification	Compliance
1	General	The fire alarm control panel shall be microprocessor based system providing rapid processing of smoke/ heat detector and other initiation device information to control system output functions. The panel shall communicate with each other on peer to peer network. The panel shall have graphics/600 character LCD display. The control panel shall have onboard programming keypad. The panel shall be capable of "ADD", "EDIT" & "DELETE" field devices like detectors & module without need of any special tool/software/programmer to avoid dependency on specific system integrator. 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.	
2		Maximum system capacity shall be at least 2500 intelligent Addressable detectors & devices	
3		The basic system shall have capabilities for up to 125 intelligent Addressable detectors & 125 devices per loop and can be expanded up to 2500 intelligent Addressable detectors & devices. The system shall employ a flexible number of detection loops to reach maximum system capacity. Systems which, have a fixed number of device addresses per node based on a fixed number of device circuits (loops) shall provide 20% of loop maximum spare capacity on all loops to meet this requirement.	
4		Any trouble on one circuit shall not affect the other circuit. This module controls the signaling from the initiation devices reporting alarms and troubles to the control panel. This module shall also provide the signaling to the field devices for controlling the output of specific initiation devices.	
5		The circuits shall have the ability to be wired, Style 4, Style 6. Any of all of the connected devices on the loop card shall be capable of activating up to two devices (relay base, audible base or remote lamps). Systems which, require unique addresses for SLC circuit accessories shall provide 20% spare	

		capacity for each loop to provide for system expansion. The panel shall have built-in Degraded Mode operation, the system is capable of general alarm if a fire alarm condition is present even if the central processing unit (CPU) fails. In case degraded mode not available in CPU then secondary CPU must be considered.	
6		The System will consist of Central processor with 4000 Event History capacity in nonvolatile memory plus separate 1000 alarm event. Degrade mode operation, operate all notification appliances and auxiliary devices as programmed. In the event of CPU failure, all SLC [Signal Line Circuit loop modules shall fallback to degrade mode. 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 devices for notification	
7		The Signal Line Circuits shall be tested for opens, shorts before connection to the control panel. Systems without this capability shall have a test panel installed for initial testing to eliminate any possible damage short term or long term to the control panel.	
8		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	
11	Network Card:	The Network Interface Card shall provide communication between network nodes. The network card supervises the network to insure proper operation. Any faults that are detected shall be reported to the display for annunciation. The network card shall minimum 256.5 Kbaud transmission rate for smooth data transmission between network node to node.	
12	Power Supply:	The system Power Supply/Charger shall be a 4-5 amp supply with battery charger. The power supply shall be filtered and regulated. The power supply shall be rated for 240V AC 50 Hz.	
13		The battery charger shall be able to charge the system batteries up to 200 AH batteries. Transfer from AC to battery power shall be instantaneous when AC voltage drops to a point where it is not sufficient for normal operation	
14	System Enclosure	Provide the enclosure needed to hold all the cards and modules as specified. The enclosures shall be black. System enclosure doors shall provide where required ventilation for the modules or cards in the enclosure.	
15		Provide system enclosure for all amplifiers. Where required by the manufacturer, provide means for venting heat from the enclosure either by having enclosure sides and top vented or the doors vented	
16	System Printer:	The system printer shall be operated from a Remote Printer Module, which shall be mounts outside the enclosure. This module shall provide a parallel port and 2 serial ports for RS 232 protocol.	

		(Optional)	

4.3 Network Repeater Panel:-

Sr. No.	Description	Specification	Compliance
1	General	The network repeater panel shall be minimum 8" in color touch screen or 600 character LCD shall have control keys. The network repeater panel shall be supplied with suitable mountings back box of same OEM. A network repeater panel shall have the ability to view events, acknowledge, silence and reset networked Fire alarm systems. A network repeater panel shall have the ability to be configured for control of the entire network. At least 32 globally configured network control display shall be supported in a network. The LCD screen displays events in colors corresponding to the event type. Alarm events appear in red; Trouble events appear in yellow; Supervisory events in blue.	

4.4 Intelligent Initiating Device:-

Sr. No.	Description	Specification	Compliance
1	General	All initiation devices shall have user friendly addressing. Devices shall not require any special tool/ programmer/ software to set address to each device. Dual bi-color LED design providing	

		360° viewing angle. LEDs blink green in normal condition and illuminate steady red on alarm. The spot type detectors shall have common pluggable mounting base.	

4.5 Multi Sensor/ Multi-Criteria (Photo-Thermal) Detector:-

Sr. No.	Description	Specification	Compliance
1	General	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 smoldering fires and thermal properties all within a single sensing device. The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes). The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort 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.	
2		The detector shall be designed to meet UL268 7th edition.	

4.6 Thermal Detector:-

Sr. No.	Description	Specification	Compliance
1	General	The intelligent Aspiration type Air Sampling Smoke Detector shall be Short wave length laser-Based Absolute Smoke Detection system with single pipe inlet, 1000 m2 coverage; Wide sensitivity range - 0.005%–20% obs/m; 4 alarm levels ; High efficiency aspirator; Clean air barrier optics protection; Easy to replace dual stage filter with memory; 7Nos of inbuilt potential free relay outputs; supports linear pipe length of 100m or branched pipe up to 130m per pipe; supports 30 Nos of EN54 Class A sampling points, Auto-Learn for automatic setup of alarm threshold, Referencing & Event log; The VESDA unit shall be fully monitored & controlled by FACP. The VESDA unit shall be seamlessly integrated with fire alarm system. The	

		unit shall be provided with suitable power supply unit with battery backup. The required sampling pipe for aspiration type air sampling smoke detector shall be 25mm OD, 18 to 21mm ID smooth bore PVC/UPVC/CVPC/ABS Plastic Pipe.	

4.7 Air Sampling Detector:-

Sr. No.	Description	Specification	Compliance
1	General	The intelligent thermal detectors shall be addressable devices rated at 135 degrees Fahrenheit and have a rate-of-rise element rated at 15 degrees F per minute.	

4.8 Detector Base:-

Sr. No.	Description	Specification	Compliance
1	General	Detector bases shall be low profile twist lock type with screw clamp terminals and self-wiping contacts. Bases shall be installed on an industry standard, 4" square or octagonal electrical outlet box.	

4.9 Monitor Module: -

Sr. No.	Description	Specification	Compliance

1	General	Addressable monitor modules shall be provided to connect & monitor any N.O. dry contact device.	
2		The device shall have an LED which shall blink in normal state & get steady on activation to monitor the health status of the device. Module shall be supplied with mounting plate from OEM for ease of installation & maintenance.	

4.10 Addressable Control/Relay Module:-

Sr. No.	Description	Specification	Compliance
1	General	The Addressable control modules shall provide supervised NAC output rated at 24V DC, 1A to connect sounder, sounder cum strobes. The device shall have an LED which shall blink in normal state & get steady on activation to monitor the health status of the device. Module shall be supplied with mounting plate from OEM for ease of installation & maintenance.	
2		The Addressable relay modules shall provide DPDT dry contact rated at 24V DC, 1A for AHU tripping, Access Control integration etc. The device shall have an LED which shall blink in normal state & get steady on activation to monitor the health status	

		of the device. Module shall be supplied with mounting plate from OEM for ease of installation & maintenance.	

4.11 Isolator Module:-

Sr. No.	Description	Specification	Compliance
1	General	Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on a loop Class A. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the loop segment or branch. At least one isolator module shall be provided for each set of detectors (max 20 numbers).	
2		If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the loop. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.	
3		The isolator module shall not require any 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.	

4		The module shall have an LED which shall blink in normal state & get steady on activation to monitor the health status of the device. Module shall be supplied with mounting plate from OEM for ease of installation & maintenance.	

4.12 Notification Appliances:-

Sr. No.	Description	Specification	Compliance
1	General	Sounder cum Strobe rated at 75 dBA @ 3m for Audible annunciation and 75cd flashing at 1 Hz for visual indication.	
2		The sounder cum strobe shall be available with adjustable strobe intensities of 15, 75, and 110 candelas. The appliance shall be red for wall mounted and white for ceiling mounted. Ceiling mounted appliances shall be listed for that application.	

5. Public Addressing System:-

General Scenario Of Considering Public Address Points:-

- Public Address system should be cover in all the passages of the buildings, internal roads of campus.
- Wherever false ceiling is available at that locations ceiling speakers need to be consider and except that locations wall mount cabinet speaker need to be consider.
- Speaker's intensity and placement should be like that it should not disturb the patients or study of doctors. However no area in Hospital and College should be out of reach as it will also work as Emergency Evacuations System.
- Zoning should be done in such a way that common passage, public gathering place (i.e. reception, case register area, waiting area, etc) should be in common zone and wards, rooms, offices in a common zone.
- Building wise common locations should be identify to place zone based microphone.

5.1 Network Controller:

Sr. No.	Description	Specification	Compliance
1	System Features	The network controller shall have 4 analogue audio inputs. The controller shall be digital & IP based.	
2		There shall be 8 control inputs, which are freely programmable. These can be programmed for actions to be done in the system and assigned priorities	
3		The network controller shall have 4 analogue audio line outputs.	
4		The audio line outputs shall have a monitoring signal.	
5		The control output shall be freely programmable for faults and calls.	
6		The network controller shall connected with another IP based controller or IP	

		based amplifier on TCP/IP network without any third party convertor.	
7		The network controller shall have a redundant network wiring capability	
8		The network controller shall have the capability to handle 256 priorities and 256 zones.	
9		The front panel shall have a LED display/ separate touch screen interface to monitor the health status of system. The controller shall support N+1 amplifier redundancy.	
10		The network controller shall be provided with a storage facility for the last 50 fault messages in the system	
11		The network controller shall have inbuilt 1GB flash memory, which is available commercially as the storage device for the pre-recorded audio messages. The network controller shall be capable of playing four messages simultaneously. The status of the digital audio storage and the messages shall be monitored. The audio messages (stored as a set of wav files) can be downloaded from a computer via the Ethernet link.	
12		The network controller shall monitor the status of all equipment in the system and report status changes.	
13		The network controller shall monitor the microphone capsule of a call station microphone and report any fault.	
14		The external cables connected to the control inputs shall be monitored for short and open circuits.	
15		Attention and alarm tone definitions shall be stored in the network	

		controller. These tones can be accessed by any call stations or control inputs for announcement broadcast or alarm broadcast	
16		The network controller shall have an internal real time clock	
17		The network control unit shall have extensive audio processing possibilities for audio inputs and audio outputs.	
18	Interface	Ethernet interface for connection to a PC or any external devices/systems.	
19	Inputs	8 x control inputs.	
20		4 x selectable analogue line audio inputs	
21	Outputs	8 x control outputs	
22		4 x analogue audio line outputs	
23		1 x internal speaker	

5.2 Power Amplifier (500W) :

Sr. No.	Description	Specification	Compliance
1	System features	The unit shall be a digital Class D amplifier certified to be compliant to EN54-16	
2		It shall be possible to select the output voltage between 100V, 70V or 50V by changing jumpers.	
3		The amplifier shall have digital signal processing for audio.	

4		The amplifier shall support connecting of 1 loudspeaker lines (zones) supporting up 500watts.	
5		The equipment can be used as tabletop or 19" rack mounting.	
6	Safety and Emergency Standard	According EN 54-16	

5.3 Multi-Channel Interface :

Sr. No.	Description	Specification	Compliance
1	System Features	It shall be IP based & communicate with PAVA controllers on TCP/IP network. It should provide minimum 2 configurable audio output channels	
2		It should provide the audio signals to PAVA controllers over TCP/IP network.	
3		It should be mounted in a 19"-rack with the included mounting brackets.	
4	Interconnection	One system network connector	
5		1 RJ45 jacks	
6		32 control dry contact inputs	
7		8 control dry contact outputs	

8	Mains power supply	Mains socket Voltage 230 VAC ±10%, 50/60 Hz	
9	Performance	Frequency response 60 Hz to 16 kHz S/N >85 dB (without pilot tone)	
10	Control inputs	Connectors Removable screw terminals Operation Closing contact (with supervision)	
11	Control outputs	Connectors Removable screw terminals Operation Change over contact (SPDT) voltage free relay Rating 24 V, 1 A Physical characteristics	
12	Safety and Emergency Standard	EN54-16	

5.4 Digital Call Station :

Sr. No.	Description	Specification	Compliance
1	System features	The call station shall be IP based touch screen with 7" TFT LCD screen. The call station shall support up to 256 zones.	
2		Analogue-to-digital audio conversion shall be performed at the call station.	
3		The call station shall also have a digital signal processor, which can be used for audio processing.	
4		The inbuilt monitoring loudspeaker shall be on when that particular call station activates a chime or pre-recorded message and will be switched off when its own live audio channel is open.	
5		System shall be in free topology to connect call station with any equipment Controller or with a call	

		station over TCP/IP network.	
6		The call station shall have a gooseneck microphone to transmit speech over the network and a press-to-talk key	
7	Interfaces	1 x system network connection	
8	Safety and Emergency Standard	EN54-16	

5.5 Digital Call Station Expansion Keypad :

Sr. No.	Description	Specification	Compliance
1	System features	The digital call station extension keypad should have 8 keys	
2		Control system functions: recall of selection, live speech call, cancel selection, BGM off, BGM volume control, programmable key for any action.	
3		Select resources: BGM selection, pre-recorded message selection, attention and alarm tone selection.	
4		Zone selection, system control output selection	
5		Each key at the call station keypad shall have 2 color LEDs.	
6		The call station keypad shall be provided with in and out connections for serial data and power supply.	
7		The keys are to be provided with a label slot for indicating the name of the action assigned to that particular key.	
8		The power supply for the call station keypad shall be provided from the call station basic unit.	

9		The call station keypad key can be programmed for momentary or toggle operation.	
10	Interfaces	Serial data and power supply interfaces for call station keypad units/call station basic.	
11	Indications and controls	The call station keypad has one 2-color LED per key for providing status indication.	
12	Remote Call Station	It Should Connects to call station interface via CAT-5 /CAT-6 cable.	
13		Up to 1 km from digital public address optical network.	
14		Uses standard keypads for extension.	
15		Built-in limiter.	
16		Powered via CAT-5 and/or local power supply and complete supervision.	
17	Safety and Emergency Standard	The unit shall be certified to be compliant to IEC60849 and compliant to other relevant local standards	

5.6 Volume Controller :

Sr. No.	Description	Specification	Compliance
1	System features	Volume Controllers have the following variants available: 6W, 30W	
2		It should support minimum 3 Volume level control	
3		It should applicable 3-wire & 4-wire system	

5.7 Network Cable Assemblies / Fiber Interface:

Sr. No.	Description	Specification	Compliance
1	System features	The whole PA System should support so inclusive of all types of cables, terminations and accessories so as to provide the complete required functionality.	
2		This should include, but not limited to, all types of copper and any optical fiber interfaces, junctions, network cable splitters depending on system Design	

5.8 Ceiling Mount Speaker:

Sr. No.	Description	Specification	Compliance
1	System features	It should come with excellent speech & music reproduction	
2	Rated Power	It should support power tapping 6/3/1.5W	
3	Frequency Range	It should be in the range between 150 Hz to 15KHz	
4	SPL Rated Power	It should be 93dB at (1KHz at 1m)	

5.9 Cabinet Speaker:

Sr. No.	Description	Specification	Compliance

1	System features	It should come with excellent speech & music reproduction	
2	Rated Power	It should support power tapping 10/5W	
3	Frequency Range	It should be in the range between 200 Hz to 15KHz	
4	SPL Rated Power	It should be 93dB at (1KHz at 1m)	

5.10 Software:

Sr. No.	Description	Specification	Compliance
1	General	It should support Software Application for System Configuration, Management & Diagnostics. The failure of monitoring software shall affect the operation of PAVA system.	

6. Time Attendance & Access Control System

General Scenario of Considering Access Control Locations:

- Access Control should be installed at locations like Operation Theatre, ICUs, NICUs, Blood Bank Storage, critical laboratories, etc locations to maintain hospital environment and hygiene.
- Access Control should be considered in higher office bearers like Dean, Medical Superintendent, HODs, etc to maintain privacy of them.
- At the entrance locations of Hospitals, devices should be put for Time Attendance purpose. For Time Attendance device count need to be considered as per 200 user 1 device.
- For different department, if entrance locations is at far distance individual Time Attendance device need to be considered.

6.1. Finger & Card Based Controller:

Sr. No.	Description	Specifications	Compliance
1.	CPU	1.2G Quad Core	
2.	Memory	2GB Flash + 256 MB RAM	
3.	Fingerprint Sensor	Optical Sensor	
4.	Template	ISO 19794-2 / ANSI 378	
5.	Max. User	100,000 [1:N] (One fingerprint per user)	
6.	Max. FP Template	9,600 [1:N]	
7.	Logs	50,000(text)	
8.	Live Fingerprint	Supported	

	Detection（LFD）		
9.	RF Option	125kHz EM, HID Prox & 13.56MHz MIFARE, MIFARE Plus, DESFire EV1/EV2, FeliCa, iCLASS SE/SR/Seos	
10.	Authentication Modes	Finger only, Card only, Finger+Card	
11.	Ethernet	10/100 Mbps	
12.	RS-485	OSDP Supported	
13.	Wiegand	Supported	
14.	Ethernet	10/100Mbps	
15.	TTL	2 input	
16.	Relay	1 door relay	
17.	LED	Multi-Color	
18.	Sound	Multi-Tone Buzzer	
19.	Tamper	Supported	
20.	Power	12V DC（Max.600mA）	
21.	Operating Temperature	-20°C ~ 50°C	
22.	POE	Required	
23.	Operating Humidity	0% ~ 80% (Non condensing)	
24.	Ingress protection	IP65 or better	
25.	Impact Protection	IK09	
26.	Certification	CE, FCC, RoHS, REACH, WEEE	

6.2. Card based Reader:

Sr.	Description	Specifications	Compliance
1.	Credential	Smart card reader 13.56 MHz	
2.	LED Indication	Tri Color LED	
3.	Buzzer	Yes	
4.	Communication	Wiegand/OSDP	
5.	Temper Detection	Yes	
6.	IP55 (Weather	Yes	

7.	Operating Temperatures	- 10 °C to + 50 °C	
8.	Humidity	5% to 95% RH Non-Condensing	
9.	Certifications	CE and RoHS	

6.3. Access Control & Time Attendance:

Sr. No.	Specifications	Compliance
1	The Integrated Access Control System (ACS) shall function as an electronic access control system and shall integrate the alarm monitoring, CCTV, digital video, ID badging and database management into a single platform. It shall function as a one-stop gateway for all the access control needs. A modular and network-enabled architecture shall allow maximum versatility for tailoring secure and dependable access and alarm monitoring solutions	
2	Multi-User/Network Capabilities: The ACS shall support multiple operator workstations via local area network/wide area network (LAN/WAN). The communications between the workstations and the server computer shall utilize the TCP/IP standard over industry standard IEEE 802.3 (Ethernet).	
3	The communications between the server and workstations shall be supervised, and shall automatically generate alarm messages when the server is unable to communicate with a workstation.	
4	The operators on the network server shall have the capability to log on to workstations and remotely configure the devices for the workstation. Standard operator permission levels shall be enforced, with full operator audit.	
5	All the control components of the ACS shall utilize “Distributed-Processing” concepts. The distributed processing shall include the ability to download operating parameters to any field panel, thus allowing the field panel to provide full operating functions independent of the access control system computer.	
6	In case communication link failure between host software & controller all the access decision should be taken by the control panel with fully verifying Card No, access level, Date & Time of validity etc, and store the transactional data in local memory and send the data to database once communication re-establish	
7	Web Access: Using the Web interface, any operator from any	

	customer location can access the Access database server from any computer on the network.	
8	The operators at the customer sites must be granted appropriate access rights for accessing the database server through the Web interface. These access rights are granted by the ACS Administrator using the dedicated host application.	
9	Operators should be able to manage day-to-day access control tasks including but not limited to: Card and Cardholder (Names, Notes fields, Note Field creation and Note Field templates); Badge Printing; Door Schedules; Lock Control; Panic Door control; Schedules; Holidays; Access Level; Reports; Report Templates and Schedules; Messaging, viewing live card activities and Locate functions.	
10	Operating Environment: The ACS shall be a true 32-bit or 64-bit, 3-tier client/server, ODBC compliant application based on Microsoft tools and standards. The ISMS application shall operate in the following environments: Microsoft Windows® Server 2016, Windows Server 2012 R2, Windows Server 2008 R2 SP1, Windows 10, Windows 8.1 and Windows 7 SP1 (64-bit).	
11	Multi-level Password Protection: The ACS application shall provide multi-level password protection, with user-defined operator name/password combinations. Name/password log-on shall restrict operators to selected areas of the program. The application shall allow the assignment of operator levels to define the system components that each operator has access to view, operate, change, or delete.	
12	Encryption: The ACS shall provide multiple levels of data encryption. a. True 128-bit AES data encryption between the host and intelligent controllers. The encryption shall ensure data integrity that is compliant with the requirements of FIPS-197 and SCIF environments. b. Transparent database encryption, including log files and backups. c. SQL secure connections via SSL.	
13	Graphical User Interface: The ACS shall be fully compliant with Microsoft Graphical User Interface (GUI) standards, with the look and feel of the software being that of a standard Windows application, including hardware tree-based system configuration.	

14	Online Help: The ACS user interface shall include an Online Help which shall require only one click to activate. The standard special function key “F1” shall have the capability to be programmed to provide access to the help system.	
15	Database Partition: The ACS application shall allow support for multiple Partitions allowing separate access to the card database, badge layout, operator access, and reporting. Physical hardware may be filtered by operator level into sites. Sites may reside in multiple Partitions. The system shall allow control of common areas between Partitions. Access levels and time zones shall be global to allow for easy administration.	
16	Relational Database Management System: The ACS System shall support industry standard relational database management systems. This shall include relational database management system Microsoft SQL Server 2016 Standard Edition. The RDBMS shall provide edit, add, delete, search, sort, and print options for records in the selected databases	
17	Access Control Functions: The ACS shall include the following access control functions: validation based on time of day, day of week, holiday scheduling, site code and card number verification, automatic or manual retrieval of cardholder photographs, and access validation based on positive verification of card, card and PIN, card or pin, pin only and Site Code only.	
18	Hardware Configuration Changes: After installation of ACS application, the customer shall be able to perform hardware configuration changes.	
19	These hardware configuration changes shall include, but not be limited to, door open time, door contact shunt time, point and reader names, when and where a cardholder is valid, and the ability to add or modify card databases as desired.	
20	Levels of System Operation: The ACS shall include a feature to define the levels of system operation for each individual operator using passwords. System operation for individual operators shall restricted time periods for login, available accounts and default language selection at login.	
21	Operator actions range from no view or control rights to basic monitoring including the ability to block the viewing of card and or personal identification numbers, to full control of the system including programming.	
22	Alarm Events: The system shall include a feature where alarm events with defined priorities pop-up automatically in an Alarm event window for operator attention. An event counter shall also display the number of times the event was reported to the Alarm event monitor prior to Acknowledgement or Clearing the event. Event instructions shall be made available by double clicking on the event.	

23	The Alarm event window shall allow the operator to initiate a physical response to the event as well as a written response. Responses shall include but not be limited to: acknowledge, clear, open a pre-programmed floor plan, energize, de-energize, pulse, time pulse, add comment, retrieve event video, and bring up live video, shunt, or un-shunt	
24	Shall provide the ability for manual operator control of system inputs, outputs, and groups of outputs. The manual functions shall include the ability to energize, de-energize, return to time zone, or pulse the output relay and shunt/un-shunt or return to time zone options for input points The pulse time shall be a programmable setting.	
25	Shall provide an option for taking scheduled automatic backups of any or all database system files. A means to restore these files from a simple menu shall exist	
26	General: 1.1 All the databases shall have the ability to add, delete, report, view, and edit information. 1.2 All the system transactions shall be saved in a retrievable file. 1.3 All the events shall be logged by date and time. 1.4 All the system transactions or selected system transactions shall be saved in a disk file.	
27	The end-user shall have the provision to make any system configuration changes such as, but not limited to door open time, door contact shunt time, point and reader names, when and where a cardholder is valid, and the ability to add or modify card databases at any time	
28	Shall provide a mode of system operation that requires the operator to enter a response to an event when acknowledging it from the alarm view window	
29	Shall provide the ability to automatically display stored “video image” of cardholder, and switch real-time camera from CCTV or digital video server to card reader location for specific card usage	
30	ACS Shall provide a simple card and card holder database import utility. The utility shall be password protected and accessible only to administrators of the access control system. Information that can be imported shall include but not be limited to: First Name, Last Name, Card Number, Activation Date, De-activation Date, Status, up to 30 user definable fields and Photo Images. A simple CSV (comma separated value) file shall be used for the importing of data and image file names	
31	Cardholder information shall include unique card number up to 20 digits and optional Personal Identification Number	

	up to 10 digits	
32	Shall allow multiple cards, mobile access credentials or finger print enrollment per cardholder.	
33	Shall allow multiple cards per cardholder. Every card can be assigned with 32 Access Levels	
34	Upon editing card information, the updated information shall be sent automatically to the appropriate access control panel, when hardwired, with no other user intervention	
35	Shall provide a card “Trace” function. The Trace function shall allow normal access control, but will provide a tracking alarm at the system monitor	
36	Shall provide the ability to store digital images of cardholder or other digital images such as property or family members	
37	Integrated biometric enrollment functions shall be managed directly inside the ACS UI without the need to use a 3rd party software	
38	Integrated assignment/managing/enrollment of mobile access credentials shall be accomplished inside the ACS UI without the need to external or 3rd party portals or software	
39	ACS shall have a separate Alarm Monitoring screen, which shall display alarms in real time, incoming alarms shall display in the upper pane according to priority and time. Once an alarm is received by Alarm monitor it should pop up the alarm window and continuous to beep the sound until it is acknowledged or operator can silence the beeper for 60 seconds without acknowledging the alarm, this feature can be enabled or disabled as per requirement for every client station	
40	Shall provide color and icon shapes for each specific alarm point action of “Alarm”, “Normal”, “Trouble”, and “Shunted”	
41	Shall provide the ability to access the default floor plan graphic for any active alarm point by a right click option	
42	ACS shall have a capability to force the operator to enter an acknowledge message while processing an alarm and it shall be possible to print or export these reports for later analysis if required	
43	Shall provide the ability to access the default floor plan graphic for any active alarm point by a right click option	
44	ACS shall have a provision that allows acknowledge alarms to be automatically cleared	
45	Shall provide a mode of system operation that does not allow the operator to clear an alarm before prior to it being restored to normal	
46	Floor Plan: Shall provide the ability to import floor plan	

	graphics stored in a WMF format	
47	Shall provide the ability to import floor plan graphics.	
48	Shall provide the ability to associate all devices to floor plan graphics allowing the user to control and monitor the system	
49	Shall provide the ability to link floor plan graphics together in a hierarchy fashion	
50	Shall allow multiple floor plan views to be displayed simultaneously	
51	Operator Database: Shall allow the assignment of operator levels to define the system components that each operator has access to view, operate, change, or delete	
52	Shall have the ability to view, edit, or delete cardholder sensitive information such as note fields, card number, and PIN shall be definable by field per operator	
53	Shall provide the ability to define the accounts that the operator has access to	
54	Shall provide specified time periods for the operator to logon	
55	Shall provide the ability to select if access to the Web browser is allowed	
56	The application shall allow support for multiple accounts allowing separate access to the card database, badge layout, operator access, and reporting. Physical hardware may be filtered by operator level into sites. Sites may reside in multiple accounts	
57	Sub-Accounts allows management of spaces, credentials and card holders relative as a separate group (subaccount) within the account. You should be able to add multiple sub-accounts to an account. Administrators can create and manage sub-accounts within their parent account	
58	Shall provide Card holder report capability with filter options to define door(s) that a card holder has access to, reporting card holder name, Card(s), Access Level/schedules, Activation/Expiration. Available in the Browser and workstation	
59	Shall provide reporting capability for selected card number displaying an audit trail of card changes detailing from-to when and by who. Changes shall include but is not limited to access level changes, activation/expiration dates, card number edits, and card holder name changes. Available in the Browser and workstation	
60	Shall provide complete database reporting of all data programmed into the system data files	
61	Shall provide a feature to generate a history report for – 1. Alarm point(s) state: defined as Normal, Alarm, Trouble, or Ajar.	

	2. System alarms: defined by panel and include information: communication, ground fault, power, panel reset, low voltage, panel tamper, and loop communication. 3. Card(s) state: defined as Normal, Trace, and Not Found, Anti-Passback Violation, PIN Violation, Time Zone Violation, Site Code Violation, or Expired card, Verification Failed. 4. Operator(s) activities: defined as acknowledged and cleared transactions, camera control, door mode, door and relay control such as unlock, lock; door and input control such as shunt, Un-shunt; login, logout, panel initialization, panel buffer and panel Un-buffer.	
62	Shall provide feature to generate a report based on the frequency of usage of a card defining a minimum and maximum usage limit. The cards meeting the filtering criteria shall be acted upon based on but not be limited to: Report only, De-activate the card or Re-assign to a specified an access level. This report shall be available in the event scheduler	
63	Shall provide an option to create report templates. Report templates available in the Browser and Workstation shall include, but not be limited to, Access Level, Card, Card History, Door, Holiday, Time Schedules and Card Holder information. The templates shall be able to be assigned to a scheduler to run automatically per the scheduler settings	
64	Tracking/Muster Report • A tracking feature shall allow the system operator to identify an area and the person(s) in that area. • Areas shall be defined by readers representing an IN or OUT read status. • Defined areas shall provide an automatic update of how many cardholders are in the area. • An area defined as an exit shall remove the person from the tracking area. • A Muster area shall be defined by a reader(s) used to “muster” individuals in the event of an emergency.	

	• Reports can be generated for the defined muster or tracking area. Available in the Browser and Workstation. • Reports shall be generated for all muster or tracking areas in the system • Tracking areas shall include "nested" areas. Nesting allows for various reports from a large area to smaller areas within the large area. • A Tracking and Muster area screen shall be continually updated with the most recent card activity, therefore minimizing the time required generating a report	
65	Guard Tour • ACS shall have an inbuilt Guard Tour Module; it shall allow the operator to program a series of guard check points that must be activated to accomplish the task of a Guard Tour. • The check point shall be either reader points or alarm contact points or a mixture. Existing Access Control readers can also be used as Guard Check point so eliminating the need of dedicated readers for Guard Tour. • The Guard Tour shall be timed sequential allowing travel time between points with +/- tolerance. This type of tour shall allow alarms to be generated for early, missed, or late events. • It shall be possible to monitor the guard's movements at the various check points. As the guard tour progresses, alarms and events are displayed in the Alarm or the Event window for the various action states of a check point. It shall also be possible to print or export Guard Tour reports showing the details of alarms like, early, Late, Missed or out of sequence.	
66	The System shall have an existing standard API for integration with other 3rd party applications. Alarms/Events can be exported to 3rd party application if required with the help of these API. Card Holder enrollment and de enrollment can be done from a 3rd part application with the help of	

	these API	

6.4. Time Attendance Module:

Sr. No.	Specifications	Compliance
1.	The attendance module shall work as a report generation module for the employee's / swipes data acquired by Access Control System along with Employee Leave Management System clubbed with it as an independent module	
2.	It should have a utility to import all masters and swipe data from various swipe card and biometric systems to its own database automatically	
3.	It shall allow complete flexibility in defining the rules for attendance facilitating data keeping with a range of reports, catering to user requirements on a regular or periodic basis. It shall allow the attendance rules logic to be set dynamically by the administrator	
4.	The system will allow visually setting rules relating to swiping data, attendance record (Present, late etc.), shifts and leave and over time etc. It shall be a Web browser-based application with password protection for security	
5.	The application shall support multiple shifts and shall take due care of the shifts which cross during the midnight	
6.	The application shall be capable of supporting unlimited cardholders	
7.	Shift allocation employee and department wise, defining periodic rotation pattern shall also possible	
8.	Manual updating of attendance / leaves / Outdoor duty shall be possible	
9.	Reports can be sorted one or all shift / date / employees' wise etc. The system shall be capable of exporting the data into *. csv, *.xls, *.xlsx & HTML formats	
	The software shall have the following features:	
10.	Employee Management Employee Joining Details, Employee Date Of Birth, Employee Resignation Details, Employee Reporting Details, Employee Access Card Details Weekly Off Details	
11.	Leave Management (Online Application & Approval) o Leave definitions with different criteria Leave administration by Admin / HR Leave adjustments by Admin / HR. o Auto generation of mails for each activity (apply, sanction & rejection)	

12.	Employee Out Duty Management (Online Application & Approval) o For a duration in case of on site. o Facility to define Out Duty for a day with specific duration	
13.	Shift Management o Shift Creations with Lunch Break o Night Shift (Day Cross) definition o Shift Rotation pattern (regular) o Employee Shift Allocation o Employee wise o Department wise o Through standard Excel sheet format	
14.	Attendance regularization facility in case of no swipe details found with authorization by reporting person.	
15.	Compatible with MS SQL 2000 database/MSDE database	
16.	Implemented with Software Lock	
17.	Location wise Holiday definition	
18.	Secure with separate user name and password for all employees	
19.	Reports o Master Reports o Employee List o Department List o Designation List o Holiday List o Shift List o Status List	
20.	Attendance Reports (Status Wise) o Employee Present List o Employee Late Status List o Employee Half Day Status List o Employee Error Status List o Employee Early Go Status List o Employee Single Swipe Status List o Employee Late & Early Go Status List o Employee Weekly Off Present Status List o Employee Holiday Present Status List	
21.	Employee Shift Allocation Report	
22.	Attendance Muster	

23.	Employee Attendance Status Report	
24.	Employee Overtime Report	
25.	Employee Wise Attendance Report	
26.	Leave Reports o Leave Applications o Leave Sanction Applications o Leave Rejected Applications o Leave Summary o Leave Balance	
27.	Attendance Regularization Reports o Attendance Regularization Applications o Attendance Regularization Sanction Applications o Attendance Regularization Rejected Applications	
28.	Out Duty Reports o Out Duty Applications o Out Duty Sanction Applications o Out Duty Rejected Applications	
29.	Employee Working Hours Report	

7.Video Surveillance Solution(CCTV)

General Scenario Of Considering Video Surveillance Points (CCTV):-

- Every entry and exit locations of each building need to be consider with bi-directionally (i.e. Entry and Exit).
- Every entry and Exit locations (i.e. Staircase and Lifts) of each floor of each building need to be consider.
- For longer passages of premise either inside or outside of building, should be cover with identification distance.
- Public gathering place like reception, case register window, pharmacy, waiting area, etc need to cover.
- All cameras should be equipped with inbuilt Infrared (IR) with appropriate range as per installation locations.
- Varifocal Motorized camera need to be considering where field of observation is not fixed or larger in size.
- Mission critical locations like Server Room, BMS Room and Fire Safety Officer Room need to be cover.

7.1 4MP IP Varifocal Dome Camera

Sr. No.	Description	Specification	Compliance
1	Type	IP IR Dome Camera	

2	Image sensor	1/3-inch CMOS Progressive Scan	
3	Lens	2.8 ~ 12 mm, Motorized	
4	Iris	DC-IRIS	
5	Resolution (No of Pixels)	4 MP (2592x1520)	
6	Minimum illumination	Color: 0.01 Lux @F1.6	
		B/W: 0Lux @F1.6 (IR on)	
7	IR Illumination	Internal or External	
8	IR Illumination Range	50 mtr distance from Camera to object	
9	Electronic Shutter	1/100000 ~ 1/3	
10	Back Light Compensation (BLC)	Required	
11	High Light Compensation (HLC)	Required	
12	Wide Dynamic Range (WDR)	WDR up to 120 dB	
13	Signal to Noise ratio	50dB	
14	Video compression	H.264 High Profile / JPEG	
15	Frame rate	20/30 fps	
16	Angle of View	H: 110° - 30°, V: 53° - 18°	
17	Protocols supported	HTTP; HTTPs; TCP; ARP; RTSP; RTP; UDP; SMTP; FTP; DHCP; DNS; DDNS; PPPOE; IPv4/v6; QoS; UPnP; NTP; Bonjour; 802.1x; Multicast; ICMP; SNMP	
18	Number of Streams supported	Triple video streams; Each stream independently configurable with different resolution and frame rate @ H.265. Should support minimum 2 streams at 4MP, 25 fps	
19	Features	Automatic white balance, Gain control, Color, Brightness, Sharpness, Contrast, fine tuning of behavior at low light, Rotation, Character overlay and all other Image Settings in Web UI	
20	Privacy Masking	Required, 4 areas	
21	Region of Interest	Required, 4 zones	

22	Edge Intelligence	Motion Detection, Camera Tampering, Audio Detection, Object Abandoned, Object Missing, Tripwire, Intrusion	
23	Event Type	SD card warning (Not present, Error, Capacity warning), Network disconnection, IP conflict, Illegal access, Alarm Input	
24	Event Linkage	Event notification using digital output, Email and MicroSD card recording, Snapshot (full resolution)	
25	Security and Encryption	User account and password protection, Digest authentication	
		AES 256 (Advanced Encryption System), TLS 1.2 (Transport Layer Security), HTTPS, IEEE 802.1x	
		Hardware chipset for private key	
		PCI-DSS (Payment Card Industry Data Security Standard) compliant	
26	Prohibited Protocols	The Camera should not be complying to GB28181, GB/T 28181-2011; GBT 28181-2011; GB/T 28191 standards. There should not be any provision to enable or disable these protocols in the default firmware from manufacturer. Any special firmware developed to disable these features will not be allowed.	
27	Local storage	There shall be no loss of recording during an event of connection failure between the edge device i.e. CCTV camera and the backend system. Each camera should support 128GB Micro SDHC Card	
28	Ethernet	10 Base-T / 100 Base-TX Ethernet (RJ-45)	
29	Audio	Two way (Line IN/OUT), supporting G.711 / G.726	
30	Alarm	2 IN/ 1 OUT	
31	Environment	IP67 rated Ingress protection	

32	Impact Protection	IK10 rated Vandal resistance	
33	Heater and Fan	Required	
34	Defog	On/Off	
35	Input voltage	12 VDC, 24 VAC, POE (802.3at, Class 4)	
36	Aux. Power Out	12VDC, 2W	
37	Power Consumption	Max 15W	
38	ONVIF Compliance	ONVIF Profile S	
39	Operating Temperature	-30°C to 60°C	
40	Operating Humidity	less than 95% (non-condensing)	
41	Compliance	UL 60950-1, CE (EN 50130-4, EN 55032), FCC Part 15, UL CAP/PCI-DSS & RoHS	

7.2 IP Varifocal Bullet Camera

Sr. No.	Description	Specification	Compliance
1	Type	IP IR Bullet Camera	
2	Image sensor	1/3-inch CMOS Progressive Scan	
3	Lens	2.8 ~ 12 mm, Motorized	
4	Iris	DC-IRIS	
5	Resolution (No of Pixels)	4 MP (2592x1520)	
6	Minimum illumination	Color: 0.01 Lux @F1.6	
		B/W: 0Lux @F1.6 (IR on)	
7	IR Illumination	Internal or External	
8	IR Illumination Range	60 mtr distance from Camera to object	
9	Electronic Shutter	1/100000 ~ 1/3	
10	Back Light Compensation (BLC)	Required	
11	High Light Compensation (HLC)	Required	
12	Wide Dynamic Range (WDR)	WDR up to 120 dB	
13	Signal to Noise ratio	50dB	
14	Video compression	H.264 High Profile / JPEG	
15	Frame rate	20-30 fps	
16	Angle of View	H: 110° - 30°, V: 53° - 18°	
17	Protocols supported	HTTP; HTTPs; TCP; ARP; RTSP; RTP; UDP; SMTP; FTP; DHCP; DNS; DDNS; PPPOE; IPv4/v6; QoS; UPnP; NTP; Bonjour; 802.1x; Multicast; ICMP; SNMP	
18	Number of Streams supported	Triple video streams; Each stream independently configurable with different resolution and frame rate @ H.265. Should support minimum 2 streams at 4MP, 25/30 fps	

19	Features	Automatic white balance, Gain control, Color, Brightness, Sharpness, Contrast, fine tuning of behavior at low light, Rotation, Character overlay and all other Image Settings in Web UI	
20	Privacy Masking	Required, 4 areas	
21	Region of Interest	Required, 4 zones	
22	Edge Intelligence	Motion Detection, Camera Tampering, Audio Detection, Object Abandoned, Object Missing, Tripwire, Intrusion	
23	Event Type	SD card warning (Not present, Error, Capacity warning), Network disconnection, IP conflict, Illegal access, Alarm Input	
24	Event Linkage	Event notification using digital output, Email and MicroSD card recording, Snapshot (full resolution)	
25	Security and Encryption	User account and password protection, Digest authentication	
		AES 256 (Advanced Encryption System), TLS 1.2 (Transport Layer Security), HTTPS, IEEE 802.1x	
		Hardware chipset for private key	
		PCI-DSS (Payment Card Industry Data Security Standard) compliant	
26	Prohibited Protocols	The Camera should not be complying to GB28181, GB/T 28181-2011; GBT 28181-2011; GB/T 28191 standards. There should not be any provision to enable or disable these protocols in the default firmware from manufacturer. Any special firmware developed to disable these features will not be allowed.	
27	Local storage	There shall be no loss of recording during an event of connection failure between the edge device i.e. CCTV camera and the backend	

		system. Each camera should support 128GB Micro SDHC Card	
28	Ethernet	10 Base-T / 100 Base-TX Ethernet (RJ-45)	
29	Audio	Two way (Line IN/OUT), supporting G.711 / G.726	
30	Alarm	2 IN/ 1 OUT	
31	Environment	IP67 rated Ingress protection	
32	Impact Protection	IK10 rated Vandal resistance	
33	Heater and Fan	Required	
34	Defog	On/Off	
35	Input voltage	12 VDC, 24 VAC, POE (802.3at, Class 4)	
36	Aux. Power Out	12VDC, 2W	
37	Power Consumption	Max 18W	
38	ONVIF Compliance	ONVIF Profile S	
39	Operating Temperature	-30°C to 60°C	
40	Operating Humidity	less than 95% (non-condensing)	
41	Compliance	UL 60950-1, CE (EN 50130-4, EN 55032), FCC Part 15, UL CAP/PCI-DSS & RoHS	

7.3 2MP High Definition PTZ Camera with IR

Sr. No.	Description	Specification	Compliance
1	Type	IP IR Outdoor PTZ Camera	
2	Image sensor	1/1.9-1/2.8 inch CMOS Progressive Scan	
3	Focal length	4mm to 180 mm Autofocus, MFZ lens, F1.5-F4.0	
4	Optical Zoom	30X	
5	Iris	DC-IRIS	
6	Resolution (No of Pixels)	2MP (1920 x 1080)	
7	Minimum illumination	Color: 0.005 Lux @ F1.6	
		B/W: 0Lux @F1.6 (IR On)	

8	IR Illumination	Internal or External	
9	IR Illumination Range	200 mtr distance from Camera to object	
10	Electronic Shutter	1/100000 ~ 1/1	
11	Back Light Compensation (BLC)	Required	
12	High Light Compensation (HLC)	Required	
13	Wide Dynamic Range (WDR)	WDR up to 120 dB	
14	Signal to Noise ratio	55dB	
15	Video compression	H.264 / MJPEG	
16	Frame rate	25/30 fps	
17	Angle of View	H: 70.3° - 1.8°; V: 37° - 1°	
18	Protocols supported	HTTP; HTTPs; TCP; ARP; RTSP; RTP; UDP; SMTP;NFS; FTP; NTP; DHCP; DNS; DDNS; PPPOE; IPv4/v6; QoS;UPnP;NTP; Bonjour; 802.1x; Unicast ; Multicast; ICMP; SNMP	
19	Number of Streams supported	Primary, secondary and tertiary video streams; Each stream independently configurable with different resolution and frame rate @ H.265	
20	Features	Automatic Tracking White Balance, Automatic Gain control, 3D Noise reduction, Cropping, Color, Brightness, Sharpness, Contrast, fine tuning of behavior at low light, Rotation, On-Screen Display, Picture Overlay and all other Image Settings in Web UI	
21	Built-in Intelligence	Motion Detection, Camera tampering	
22	Event Type	SD card warning (Not present, Error, Capacity warning), Network disconnection, IP conflict, Illegal access, Alarm Input	
23	Event Action	Trigger Relay Output, SD card Recording, Email, Snapshot	

24	Security and Encryption	User account and password protection, Digest authentication	
		AES 256 (Advanced Encryption System), Stream Encryption, TLS 1.2 (Transport Layer Security), HTTPS	
		Hardware chipset for private key	
		PCI-DSS (Payment Card Industry Data Security Standard) compliant	
25	Prohibited Protocols	The Camera should not be complying to GB28181, GB/T 28181-2011; GBT 28181-2011; GB/T 28191 standards. There should not be any provision to enable or disable these protocols in the default firmware from manufacturer. Any special firmware developed to disable these features will not be allowed.	
26	Defog	On/Off	
27	Electronic Image Stabilization	Yes	
28	Privacy masking	24, Programmable	
29	Region of Interest	8, Programmable	
30	Pan Range	350° rotation	
31	Tilt Range	-16° to 90° (view above horizon) with auto flip	
32	Pan Speed	Very High Speed and quick response rotation upto 300°/sec (manual) and 400°/sec (preset)	
33	Tilt Speed	Very High Speed and quick response Tilt upto 200°/sec (manual) and 300°/sec (preset)	
34	Presets	500	
35	Auto Pan Mode	Required	
36	PTZ Scan Tour and Patterns	5 each	
37	Idea Action	Tour/Preset/Pattern/Scan	
38	Auto Tracking	Required	
39	Local storage	There shall be no loss of recording during an event of connection failure between the egde deivce i.e. CCTV camera and the backend system. Each camera should support 256GB Micro SD Card	

40	Ethernet	10 Base-T / 100 Base-TX Ethernet (RJ-45)	
41	Audio	Two-way (Line IN/OUT) supporting G.711 / G.726 / G.729	
42	Alarm	2 In and 1 Relay out	
43	Environment Protection	IP66 rated outdoor protection	
44	Impact Protection	IK10 rated vandal protection	
45	Circuit Protection	TVS 6000V, Lightning/Surge protection	
46	Heater	Yes	
47	Fan	Yes	
48	Input voltage	24 VDC / 24 VAC, PoE+ (802.3at)	
49	Power Consumption	Max 21 W (IR and Heater On)	
50	ONVIF Compliance	ONVIF Profile S	
51	Operating Temperature	-40°C to 60°C	
52	Operating Humidity	0-95% (non-condensing)	
53	Compliance	UL, CE, FCC	

7.4 Video Management Software

Sr. No.	Description	Specification	Compliance
1	Platform	VMS should support and run on 64-bit Windows® Server 2019/ Server 2016 / Server 2012 STD	
2	Scalability	VMS shall include a fully scalable enterprise-class media management system to enable simultaneous live monitoring from multiple stations and be configurable for storage both on and off site	
		The number of recorders and switchers shall be scalable within a network to handle any size of installation.	

3	License	License for cameras and clients should be bundled with the software as per the BOQ, keeping in view of future expansion. Any additional server / hardware required to cater to these licenses must be provided at no extra cost. All Camera firmware upgrades to be free during warranty period as well as CAMC period.	
4	Compatibility	Latest standard of ONVIF Profile S, G	
5	Redundancy	VMS should support Database redundancy for unforeseen/maintenance scenarios	
		Support for N+1/N+M Recorder failover and failback automatically or manually	
		Application should have at least 11 configurable failover modes with custom threshold levels against each parameter to activate failover of Recorders. These failover modes should be in addition to network failover	
6	Functionality	Capable of managing pentaplex user operations of attached recording devices simultaneously, including live viewing, recording, playback, archiving of video data to an external storage device, and handling the exchange of data between the server and a remote workstation. Should also be able to perform System configuration and Alarm management from operator workstation	
7	Configurator	The operator (with Administrator privileges) shall have the option to configure VMS. VMS shall support live updates of all configurations. The following configurations shall be possible:	

		· Option to add/edit/delete Recorders, Cameras, Monitors, Keyboard, Site, Workstation, Partition and Event group. · Associate cameras to a recorder or switcher and map to a site, partition or event group. · Add monitor to a site, partition, event group or keyboard. It shall provide an option to add a digital monitor and associate it with a workstation with provision to configure a digital monitor with a default salvo and startup in full screen. · Support of bulk event association to enable/disable and adjust events for recorders and inputs in bulk. · System Macro Configuration: Option to add/edit/delete macros. Option to restore macros. Execute button option to trigger selected macros provides mechanism for testing written macros.	
8	Recording	Should support Audio / Video recording.	
		Continuous, scheduled, manual, event and alarm-based recording. All modes shall be disabled and enabled using scheduled configuration.	
		Different recording speeds (fps) and resolution for each recording mode for each camera shall be possible.	
		Software Should support ANR (Automatic Network replenishment) Feature where camera should Record to Camera SD card during it gets disconnects from Storage. Once connection is established recording in SD card can be replenished automatically to storage.	
		The Recording System, once configured, shall run independently	

		of the Video Management system and continue to operate if the Management system is off-line.	
9	Video Compression	Simultaneous use of multiple video compression including H.264, H.265 (including camera dependent smart codec support), MPEG-4 and MJPEG	
		VMS should support H.265 GPU rendering.	
10	Storage	Multi-level storage: should support multi-level storage (live recording on primary disk, archiving on secondary, and so on). Should delete video after configurable duration (FIFO based). Provision to configure different retention periods for every camera. Should Support NAS/IP SAN through iSCSI transfers.	
11	Archiving	Support for Custom Video Archival period for every camera maximum upto 5 years on FIFO basis	
12	User Logins	VMS Server and Workstation shall have the option of two modes of user logins · Windows Authentication: Uses the Windows logged-in user name. Active Directory user authentication · User DB Authentication: Uses a preconfigured user name and password	
13	User Management	Users and Roles: Option to add/edit/delete roles and associate to predefined privileges. Add/edit/delete users and associate users with roles	
14	Viewer	Simultaneous Live view and Playback from different cameras by multiple users.	
		Viewing screen should be capable of showing 1x1, 2x2, 3x3, 4x4, 5x5, 6x6, 7x7,8x8,1x5, 2+8, and 1+12 layouts of video	

		Capable of saving current View as a Salvo and/or Shared Salvo to be accessible to other operators.	
		Capable of selecting a particular camera or salvo by using the mouse to drag it onto the main video viewing screen	
		Perform Motorized Zoom and focus for all supported cameras (ptz, bullet, dome etc…) remotely from client workstations or control room	
		Capable of independently adjusting the contrast, brightness, and saturation settings for each camera.	
		Remote Monitor: This facility shall allow operators to control a remote monitor connected to another workstation and perform review capabilities so that both the local operator and the remote viewer can simultaneously watch the same video	
		Innovative “One-Click” or “Mouse Drag” 3D PTZ control experience that does away with legacy PTZ controls of continuous clicking	
		Support for 360° de-warping of fisheye camera into multiple tile views from operator work station	
		Operator messaging: allowing operators to communicate with each other. Operators can exchange text, images and annotated video sources. Operators can hand over a video source to another operator using messaging	
		Surrounding Camera View: VMS Client application shall have facility of surrounding camera view. · In a surround view, video from a specific/intended device shall be playing in the Centre and the other videos will be from surrounding devices.	

		· Every video device can be mapped with 12 cameras. · It shall support setting presets in surrounding cameras.	
		Scan Sequences: Capable of configuring and running scan sequences. Sequence view shall consist of camera view, which can be cycled on a timed basis. There shall be no limit to number of cameras that can be assigned to a single sequence. There shall be no limit on the number of available sequence views.	
		Create and save virtual cameras in layout for live viewing by digitally zooming into the field of view of camera. These virtual cameras should not require any additional license and operators should be able to create multiple such views.	
		Adaptive Network Throttling by auto-switching of camera streams to lower resolution / FPS	
		Body pixilation and blurring in live view to protect customer and employee privacy from abuse of surveillance data	
		Option to perform various other operations through the context menu on a particular video (live/recorded/sequence). These operations include: Full screen, point and drag, maintain aspect ratio, toggle text, digital PTZ, start/stop recording, save image.	
15	Bookmarks	Operator should be add/delete bookmarks for Live, Recorded videos	
		Should have provision to add comments to Bookmarks	
		Support for bookmark searches based on cameras, time duration, and comments	

16	Time Line	Ability to display/manage the timeline of the recording device, which provides camera recording statistics with Min 8 color recording indications,	
		Mark in/out (with looping facility), snapshot, time slider, time search, time jump, and play controls.	
		Timeline control shall also include dedicated buttons for step reverse and step forward and keyboard shortcuts for playback operations.	
17	Event Management	Register event associated video and alert operator	
		Motion detection and camera tampering events should be alerted to the operator	
		Ability to slue PTZ cameras to alarm-generated areas	
		In case of an alarm operator should be able to view the video during pre-alarm, on-alarm, post-alarm, and also view live video from the camera which triggered the alarm through a single 2x2 salvo	
18	Search and Playback	Should be able to search video based multiple filters like Recorders, Cameras, Date/Time, Type/Event	
		Calendar Search with thumbnail image preview of recording and quick export of video clips	
		Should have advanced, smart search function performing quick Motion Detection search on recorded video for multiple user defined region of interest	
		Should support sync playback between multiple recorders	
		Playback with speeds ranging from 1/64X to 256X.	
		Support for smooth reverse playback at 2x (Recorder Dependent)	

		4-Eye dual user authentication for playback of original video record	
19	Export Clip/Video	The VMS shall export video and audio data optionally in ASF/MOV/WMV format to a CD/DVD drive, a network drive, or a USB drive. The exported data in ASF/MOV/WMV format may be played back using standard software such as Windows Media Player.	
		The VMS shall export video and audio data optionally in its native recording format to a CD/DVD drive, a network drive, or a direct attached drive. Viewer software shall be included with the export.	
		The video management system shall write a digital signature to the exported video. This shall allow the viewing client to verify, that the imported video has not been tampered. The utility/verification tool shall provide a warning in case that the video has been tampered. This shall be done by means of the checksum of the digital signature.	
		It shall be possible to password protect the video export. The export can then only be opened and viewed when the corresponding password is entered.	
		Salvo clip export provide a clip export option to create an instant clip while maintaining the salvo information	
		Incident management mode: allows export of recording by selecting multiple cameras at different times to create a single clip to play the cameras back in order (sequentially)	
20	Maps	System shall support Map based surveillance.	

		· Maps navigation with site / building / floorplan hierarchy · Easy configuration: Drag and drop a camera on to a floorplan · Provision to Zoom In or Zoom Out the map · Camera alarm indication and alarm status (latest 10) on map · Analyze the alarms and playback the associated video · Perform PTZ and preset actions on relevant cameras · Instant Playback with easy forward/reverse enhanced with calendar selection · Undock Popup View: Drag freely across map to avoid overlapping / covering other icons and views · Full Screen View of Cameras to capture details of HD video	
21	Cyber Security	· Enhanced password security – non-recoverable passwords, enforcing complex passwords, password expiry, and no default passwords. · Secured firewall configuration. · Secured Web client – enabled HTTPS and TLS 1.2, and protection from CSRF and XSS attacks. · Restricted folder and Registry access to operators. · Secured Assemblies – Digital signing. · Secure communication with Cameras using TLS 1.2	
22	Report	It shall be possible to get reports on past events by querying the databases.	

		· System Report - Event history reports for cameras, Monitors, Recorders · Operator Log reports based on operator activities like log In / Log Out , creating clip, adding bookmark etc	
		Health Report	
		Failover Reports	
		Configuration reports	
		Create and save custom reports as per pre define and frequent format with in VMS or Various other format	
		Log reports shall be exported in RPT, XLS, DOC, RFT, PDF formats and	
		Email for alarms and failover	

7.5 Video Management Server

Sr. No.	Description	Specification	Compliance
1	Processer	1 Intel Xeon Gold 6130 2.1G	
2	Operating System	Windows Server 2019 x64 Standard/Datacenter	
3	Memory	16G DDR4	
4	Storage	Up to 400GB SSD SATA Read Intensive 6Gbps	
5	RAID	Should Supports RAID 0,1,5,6 & 10	
6	NIC	1GbE	
7	Chassis	Rack Mount or Tower	
8	Power Supply	Should be Redundant from Day 1	
9	Hypervisor support	Microsoft Windows Server with Hyper-V® VMware® vSphere® ESXi®	

7.6 Video Recording Server

Sr. No.	Description	Specification	Compliance
1	Make& Model	Vendor has to specify, data sheet to be supplied.	
2	Processor	Intel® Xeon Silver 4210R, 2.4GHz	
3	RAM	32 GB	
4	OS Hard Drive	2 * 250 GB SATA/SSD HDD; Protected by RAID 1	
5	Operating System	Win 10 IoT/Enterprise 64 Bit/ Windows Server 2016 R2 Microsoft SQL Server/Express 2019, Server/Express 2017	
6	Graphics Card	Minimum In-built Processor Graphics (GPU): Intel® HD Graphics 630 or equivalent	
7	Video Output	VGA / HDMI	
8	Maximum bandwidth	Total (Input +Output) 800 Mbps	
9	Networking	4x1GbE LAN ports	
10	Accessories	Keyboard, Mouse	
11	Video Storage Drive	Video rated or Enterprise drive, 7200 RPM SATA/SAS recommended	
12	Storage	Internal SAS/ SATA/ SSD drives supporting Up to 12 bays, 16TB each HDD. - The Contractor has to submit the storage calculation Simultaneous play back and recording at full duplex operation.	
13	RAID Controller	Supported RAID levels 0, 1, 5, 6, 10, 50, 60; Hot Spare support	
14	Power Supply	1+ 1, Hot Plug, Redundant Power Supply	
15	Chassis with locking bezel	2U, including rack mounting kit	

16	Regulatory	CE/EN, FCC, UL	

7.7 Centralized Storage

Sr. No.	Description	Specification	Compliance
1	Type	19” Rack mount.	
2	No of channels	Minimum 300 Camera	
3	Number of Drives	Minimum 500 GB SSD x 48 BAY OR AS PER NAS. SERVER	
4	Max Storage Per Drive	Maximum supported up to 500 GB SSD	
5	Max internal storage	up to 128TB	
6	RAID Level	Should support RAID 0, 1, 5, 10. Should support Raid Hot Backup Disk as well as Hot Standby i.e. N + 1 Hot Spare.	
7	I/O Interface	2 x HDMI Port (Resolution 3840x2160), 1 x VGA Port with FHD Resolution, 1 x eSATA (for DAS), 2 x USB3.0 and 1 USB2.0.	
8	Network Interface	2 x 10/100/1000Mbps Gigabit Ethernet Port which can be used as Load Balance, Redundancy.	
9	Network Protocols	TCP (IPV4, IPV6), UDP, Multicast, UPnP, HTTP, HTTPS, DHCP, PPPoE, DDNS, NTP, Alarm Server etc.	
10	Capacity	Should support minimum 300 Nos of Camera Recording per Storage.	
11	Codecs	Should support multiple codec like H.265 +, H.264, MJPEJ, MPEG4 etc.	
12	Camera Edge	Should support Camera Edge Motion Detection, WDR, HLC, BLC, AGC, 3D DNR Privacy masking and recording.	
13	Recording Schedule	Should support multiple schedules like Continuous Recording, Scheduled, Event Based and I/O based Recording.	
14	Voltage	100-240V	

15	Power Consumption	Maximum 200W	
16	Operating Temperature	0°C-40°C	
17	Operating Humidity	5%-95%	

7.8 Client PC

Sr. No.	Description	Specification	Compliance
1	Processor	Min Intel core i7-2600 or higher	
2	Clock Speed	3.4 GHz or higher	
3	RAM	Min 8 GB DDR4	
4	OS	WIN 10 Ent 64- Bit or latest	
5	Display Adaptor (GPU)	Integrated Intel UHD graphics 630 and/or NVIDIA GTX 570	
6	Video Output	HDMI	
7	Optical Drives	DVD Writer (Optional)	
8	HDD	1 TB SATA/SSD	
9	Ethernet	min 1 nos of 10/100/1000, Auto Negotiating Ethernet controller	
10	USB Port	2 USB 2.0 and 2 USB 3.0	
11	Audio	Line In / Line Out, 3.5mm jack	
12	Regulatory	CE/EN, FCC, UL	

2. Display for 3 x 3 Video Wall with required Wall Controller

Sr. No.	Description	Specification	Compliance
1.	Screen Size	55”	
2.	Panel Technology	IPS	
3.	Aspect Ratio	16:9	
4.	Native Resolution	1,920 x 1,080 (FHD)	

5.	Brightness	450 cd/m2 or above	
6.	Contrast Ratio	1400:1	
7.	Viewing Angle	178 x 178	
8.	Connectivity	DVI-D (1), HDMI (1) with HDCP for all input, RGB (1), Component (RGB Shared), AV (RGB Shared), RS232C (1), RJ45 (1), IR Receiver (1), USB 2.0 (1), DVI-D (1), RS232C (1)	
9.	Safety	UL / cUL / CB / TUV / KC	
10.	EMC	FCC Class "A" / CE / KCC	
11.	ErP / Energy Star	NA / Yes (Energy Star 6.0)	
12.	Wall Mount Kit	Wall Mount Kit for 3 x 3 Video Wall	
13.	Video Wall Controller	Video Wall Controller for 3 x 3 Video Wall	

9. Video Conference and Interactive Display Solution

9.1. 86” Interactive Display Solution

Sr No	Parameter	Specifications	Compliance (Yes/No)	Remarks
	Make			
	Model			
1	Active Screen Size ("inch)	86"		
2	Display Backlight	DLED		
3	Display Area	1893*1069mm		
4	Display Ratio	16 : 9		
5	Resolution	3840*2160 or better		
6	Display Colors	10 bit or better		
7	LCD Brightness	500cd/m2 or better		
8	Contrast Ratio (Typical)	15000:1 or better		
9	Response Time (Typical)	4ms or better		
10	Viewing Angle	178◦		
11	Life time (working hours)	>50,000 hours or better		
12	Display Orientation	Landscape		
13	Reference Frequency	120Hz		
14	Speakers	Shout be SEAMLESSLY build-in the display		
15	Max.Power Output	2x15 Watts or above		
16	Speaker Position	Seamlessly mounted in lower side of the display. Front facing, Forward through		
17	Rated Impedance	8Ω		
18	Freq.Response	180Hz-20kHz		

19	Output S.P.L.	84 ± 3dB		
20	Touch Technology Deployment	Touch feature should be seamlessly build-in the display and NO overlay is allowed		
21	Touch Sensor	Advanced IR		
22	Surface material of touch surface	Anti-Glare & Anti-Finger Print Glass		
23	Protection	3M antigalre		
24	Haze	2%~5%		
25	Touch Screen Writing Tools	Nano Pen (>3mm width) included or Finger		
26	TOUCH Response time	≤4ms or better		
27	Positioning Accuracy	±1mm or better		
28	Transmission Range	5M		
29	Transparency	>88% or better		
30	Surface Hardness	H7 or More than H7		
31	Glass thickness	4 mm		
32	HID Support	Must have a provision to connect with any external sources		
33	Touch Points in Windows	Must have a touch capability of MINIMUM 20 points		
34	Touch Points in Embedded OS	Must have a touch capability of MINIMUM 10 points		
35	Writing Tool	Shall use with Nano Pen (>3mm width) included or Finger		
36	Scan Speed	133Hz or better		
37	Communication Interface	inbuilt - USB-A type		
38	Requirement of Front	For the purpose of ease access the display must have the following ports in		

	access ports with flip	the front side and must have flip cover to close when not in use		
39	Minimum required Input ports at Front side of the display	1 x HDMI(1.4 , 4K@30Hz):- To connect with any resources 1 x Exclusive USB1 for Touch :- To connect with any resources and operate 2 x Exclusive USB for Media Play function:- To directly view the contents from USB 1 x Microphone(3.5mm):-To connect any external microphone		
40	Minimum Requirement of AV Inputs at rear side	HDMIx1(2.0,4K@60Hz) + USB for Touch Port 1 while using HDMI port HDMIx2 (2.0,4K@60Hz)+ USB for Touch Port 2 while using HDMI port DPx1 (4K@60Hz)+ USB for Touch Port 3 while using Display port VGAx1 (1920x1080@60Hz) + USB for Touch Port 4 while using VGA port		
41	Minimum requirement of AV Outputs at rear side	HDMIx1(4K@60Hz)- Transmit the signal to other display with equipment with High definition 3.5mm Line out x 1 DC Out (5V 2A) x1 SPDIF out x 1		
42	Minimum Requirements for other ports at rear side	USB 2.0 x2 : - To directly view the contents from USB RS232 x1 :- Device Controlled by any third party controller RJ45 x1 :- Input port of Local area network RJ45 x1 :- Output port of Local area network USB 3.0 x1 :- To connect external USB camera OPS Slot (4K@60Hz):- To connect OPS PC for windows function		
43	Multimedia File Formats Supported	Support all major types of multi-media files		
44	GUI - Graphic User Interface	The display must have GUI for ease access of resources, functions and shortcuts. This GUI shall be any proprietary OS but must be computable with Android coding.		
45	Discussion / White Board	Build-in white board (seamless writing) with inbuilt browser		

46	Cast	A wireless presentation software comes with inbuilt for inroom presentation Maximum connectivity of BYOD devices - 4 / 6 users (Android 4 user / Win 6 user) **Control** - The setup should be in such a way that the presenter should have control of the GUI of this Remote Interactive Presentation Kit from the Touch Interactive Flat Panel Display **Display capability** - Equipment should have capability to display 4 /6 sources at a time system Supported - Win/Mac/ios/Android		
47	Display Management	CENTRALLY MANAGE ALL YOUR INTERACTIVE DISPLAYS : Easily manage and deploy apps, configure display settings, add licences, use digital signage features or broadcast emergency messages to all interactive displays, without ever having to leave your desk.		
48	Broadcast	SHARE CONTENT TO AUDIENCES OF ANY SIZE HASSLE-FREE BROADCASTING Joining the broadcast is simple: Access the Broadcast webpage and Share your screen in real-time from your display to any participant connected. Easily invite up to 200 participants to connect their own device from the meeting room, classroom, lecture theater or any other place in the world with a network connection.		
49	Other features	The onboard system supports….Annotation, saving and send email of annotation files and selecting the inputs and changing the volume , Scheduling function for meeting room schedules , Buildin wifi(2.4G/5G) and so on		
50	File Commander	Helps to easily open your USB drive and access your documents / files . **Additional features in File commander** : **Add Cloud** : Cloud Based file storage services are availbale . User can directly download their docummets or files and access during presentation.		

		FTP : File Transfer Protocol (FTP) is the commonly used protocol for exchanging files over the Internet **Local Area Network** : A local area network (LAN) is a group of computers and associated devices that share a common communications line or wireless link to a server.		
51	Email support	Pre loaded Aqua mail - you can easily email your whiteboard content to anyone		
52	Business calendar	A pre loaded business calenser is available you can set schedules and synchronize with Google calendar for meeting room schedules		
53	Customized GUI	User can easily customized their own background and logo's		
54	Multimedia File Formats Supported	Support all major types of multi-media files		
55	Object Regonisation	This product supports object recognition and produces different effects according to the diameter and size of the input objects. ● Fist/palm: identified as an eraser (100 pt). ● Fine Pen (3mm): suggested to use while writing. ● Thick Pen (≥ 8 mm)/ finger: suggested to use when you want to highlight		
56	OTA (Over-the-Air) Update	Upgrade the latest firmware for your displays through our OTA Update support and keep them running smoothly at all times		
57	Smart Eye production	Smart Eye Protact keep your eye vision safe from IFPD's light		
58	Blue light filter	Blue light contributes to digital eye strain; IFPD's glasses that block blue light may increase comfort for users		
59	Chipset	MTK8386 or higher		
60	CPU	ARMv8 A73*2+A53*2 (A53 : 1.05-1.3GHz; A73 : 1.15-1.5GHz) or higher		
61	GPU	Mali-G51MP2 650 MHz or higher		
62	RAM	3GB or higher		
63	ROM	16GB build in or higher		
64	External Memory	32GB TF card (build in) or higher		

65	Total In-built Memeory	48GB (Inbuilt TF Card slot support max 64GB) or higher		
66	Android Version	8.0.0 or higher		
67	Android resolution	4K		
68	Working Voltage	AC 100-240V, 50/60Hz		
69	Power Consumption	Maximum ≤450W Standby Mode ≤0.5W		
70	Storage Temperature/Humidity	-15℃~55℃/20～90%RH(Non coagulation)		
71	Working Temperature/Humidity	0℃-40℃/20～80%RH(Non coagulation)		
72	Mounting Capabilities	Display must have facility to mount on floor stand or wall brackets		
73	Self shutdown	Must self shutdown during abnormal temperature		
74	Inbuilt Soft features	The touch interactive display must have inbuilt onboard writing software. Thus, this software shall has the capability to write some thing on the display and store in on-board system even WITHOUT any PC/Laptop/External device		
75		The display must have the facility of send the written contents by mail, take printout and transfer to pen drive as well		
76		This software which is embedded in the On-Board system shall have capability to write(Annotate) on top the contents that are shown from Pen drive direct / External PC / Any such sources		
77	External software	Touch interactive display shall also be supplied with specialised software which shall be installed in PC/Laptop. This software should have features of different writing capabilities like Pen, Highlighter, laser pen, geometric pen, text pen and so on. The software shall also have features of Screen record, screen capture, import files, export files and saving the content in different versions and so on.		
78	Inbuilt Internet access	The touch interactive diplay mush have inbuilt WiFi (2.4G/5G). So that the presenter shall visit the internet to		

		show/access the conten/information even withoput PC/LAPTOP		
79	Suitable wall mount kit with accessories	Equipment has to be supplied with suitable wall mount kit and accessories		
80	Installation	Horizontal installation		

9.2. Video Conference Solution

Sr. No.	Description	Compliance
1.	Device system should be standard based with separate camera system and HD audio video Interfaces with all required Cables and Accessories.	
2.	Device Should support 30 fps & 60fps (frames per second) with 1080p resolution from day one.	
3.	Device Should have Ability to send and receive two live simultaneous video sources in a single call, so that the image from the main camera and PC or document camera can be seen simultaneously.	
4.	Device Should support H.239 and BFCP protocols	
5.	Device must have the ability to pair mobile devices such as Tablet and Smartphones based on iOS or Android platforms so that these devices can be used for: 1) View the Presentation that is being shown in the VC call. 2) Add and disconnect call. 3) Take snapshot of the Presentation being shown	
6.	Device must have the ability to pair with laptop for sending content without any wires to the VC system. In case this feature is not available natively, then additional components can be provided to achieve this.	
7.	Device Should have at least One FHD video Input to in the form of HDMI/HDCI/3G SDI to connect FDH cameras with full functionalities as mentioned in the camera specifications.	
	Device Should have Should have HDMI/DVI (Digital Video Interface) input to connect PC / Laptop directly to the Video conferencing system and display resolutions 1080P/HD 720P along with PC Audio	
8.	Device Must have 2 HDMI inputs support formats up to maximum UHD (3840 x 2160) at 30 fps, including HD1080p60.	
9.	Device Should support the ability to view and share presentations at a resolution of 3840 × 2160 (4K)	
10.	Device must have the ability to pair with laptop for sending content without any wires to the VC system	
11.	Device Should have at least 2 no.'s of HDMI output to connect Full High Definition display devices such as plasma and projectors for both Video and Content.(Dual Monitor Support)	
12.	Device should support Call Swapping.	

13.	Device should able to view presentation from two laptops on each of the screen so that users can collaborate when not in a VC Call.	
14.	Device Should support G.711, G.722, G.722.1, 64 kbps MPEG-4 AAC-LD.	
15.	Device Should support Noise Reduction, Automatic Gain control, Acoustic Echo Canceller, Active Lip synchronization	
16.	Device Should support 3 Microphone inputs to connect 3 microphones and Should supply 02 Microphones from Day 1.	
17.	Device should have the pickup of the microphones at least 10 feet from the microphone.	
18.	Device Should have Echo Cancellation for every input.	
19.	Device Should support audio output.	
20.	Device Should have 01 x Gigabit Ethernet Interface.	
21.	Device should have Min. upto 6 Mbps H323/SIP on point-to-point Calls.	
22.	Device Should Support Packet Loss Based Down speeding.	
23.	Device Should Support QoS—Diff Serve, IP adaptive bandwidth management (including flow control), Auto Gatekeeper discovery, Auto Network Address Translation (NAT), Standards based- Packet Loss Recovery feature.	
24.	Device must support IPv4 and IPv6 from day one on both H.323 and SIP.	
25.	Device Should support URL Dialing.	
26.	Device Should support for H.245 DTMF tones in H.323.	
27.	Device Should have Password protected system menu.	
28.	Device Should have ITU-T standards based Encryption of the video call.	
29.	Device Call should be encrypted end-to-end on IP.	
30.	Device Should support Standards-based: H.235 v3 and AES Encryption via Automatic key generation and exchange. The same should be available in a call with Video with presentation (dual video).	
31.	Device Should have Ability to manually turn encryption ON/ OFF should be there.	
32.	Device Must have Capability to Block the Spam Calls.	
33.	Device Should support Automatic key generation and exchange.	
34.	Device Should have System Management using HTTPS and SSH.	
35.	Device Should have PTZ camera with 1080p60 or better, 12x Zoom (12x Optical Zoom and 12x digital Zoom), 1920X1080 Resolution @60FPS, Field View 70 degree or better, Interface USB 3.0 port/HDMI/3G SDI Port.	
36.	Device cameras should be suitable for a large conference room of about Min. 7m in length with 15 people.	
37.	Device Camera should have Min. 1920 x 1080 pixels progressive @ 60fps.	
38.	Device Camera and codec should be from the same manufacturer.	
39.	Device Camera Should have at least 71 degrees horizontal field of view.	

40.	Device Should support Local and Global directories.	
41.	Device Should support LDAP and H.350 protocols for directory transfer.	
42.	Device Should support built-in Multi conference capability to connect at least 1+3 sites at 720p30fps in a continuous presence mode	
43.	Device Should have Capability to view all sites in a continuous presence mode with rate matching and transcoding such that different sites may connect at different speeds and protocols and still maintain a resolution of at least 720p.	
44.	In order to provide a good user experience, the unit must be equipped with an intuitive Touch Screen/Panel for controlling the VC unit.	
45.	Device Must have ability to browse the directory, search a contact, Enable / disable speaker tracking, change layouts, mute/ unmute, increase-decrease volume.	
46.	Device user should have the ability to select between two presentation sources such as a fixed PC and a laptop from the user interface. Users should also have the ability to share presentation wirelessly.	
47.	Must have the capability to integrate with external control systems to control Blinds, Lights, air conditioning using the API's. The User interface must have the necessary icons for controlling the external devices	
48.	Device Should be with 1 Years OEM Support.	
49.	Bidder should submit OEM Authorization certificate of the quoted device.	

Audio/ Video / Web Conferencing Services:

Sr. No.	Description	Compliance
1.	Proposed Solution should be Cloud-based Audio / Video / Web conferencing services	
2.	Proposed Solution should be Opex based / Subscription licensing model.	
3.	Proposed Solution provided should be simple, secure collaboration and scalable.	
4.	Proposed Solution Should Support for up to 1,000 concurrent users in a single meeting: ◦ Up to 200 SIP or H.323 video conferencing devices. ◦ Up to 500 additional Meetings video participants. ◦ Up to 1,000 additional Audio-only users.	
5.	Proposed Solution Should support One Button to Push join from On-Prem registered video systems, controlled by On-Prem Management and cloud registered apps and devices.	
6.	Proposed Solution should be have interoperability with Skype for Business and Lync from Day 1.	

7.	Proposed Solution should have Video IVR with visual cues for a more intuitive join experience.	
8.	Desktop, Mobile and Browser Apps -- Click-to-join from invitations. Enter meeting number for ad-hoc join. Use your computer or a telephone for audio. Or, have the cloud call your SIP based video system for full audio, video, content share experience.	
9.	Proposed Solution should have following features In-meeting controls using Dual-Tone Multi-Frequency (DTMF) controls, Mute and unmute self , Mute and unmute all (host), Lock/unlock meeting (host), Record meeting (host), Change own video layout, SIP video systems require at least one of the following capabilities: RFC 2833 RTP Payload Type, In-band DTMF audio tones, Key Press Markup Language (KPML), H.323 video systems require at least one of the following capabilities: H.245 User Input Indicator, RFC 2833 RTP Payload Type, In-band DTMF audio tones, Users on video systems that cannot negotiate DTMF will only be able to join a meeting after the host starts it Recording status indicator Audio line mute state change prompts.	
10.	Proposed Solution should have Desktop, Mobile and Browser Applications with Following features - Full participant list, Recording status indicator, Meeting lock status indicator, Mute/unmute audio of participants (host), Expel participant from meeting (host), Lock/unlock meeting (host), Record meeting (host), Transfer host role to another participant (host).	
11.	Proposed Solution should support Min. Main video at up to 720p at 30 frames per second (fps), Content sharing up to 1920x1200 at 3 fps, Video Aspect Ratios - 16:9 widescreen, 4:3 standard.	
12.	Proposed Solution should support Video Codec - H.261, H.263, H.263+, H.264 AVC, H.263 (CIF) or H.264 UC (720p/30) for Skype for Business and Lync clients.	
13.	Proposed Solution should support Audio for Video Systems - G.711 (m-law and a-law), MPEG-4 AAC-LD, Opus, G.722, G.728, G.722.1, G.729 (with and without Annex B), MPEG-4 AAC-LC (TIP calls only).	
14.	Proposed Solution should support Audio Codec for Applications – Opus, Internet Low Bitrate Codec (iLBC), G.722.	
15.	Proposed Solution should support Audio Access Methods for Applications - Call-in (dial into the meeting), Call-back (meeting calls you) and video call-back, VoIP (use your computer microphone and speakers or your smartphone data connection).	
16.	Proposed Solution should support Advanced Encryption Standard (AES) 128-bit encryption, Signaling protocol support: SIP, SIP Transport Layer Security (TLSv1.2), Binary Floor Control Protocol (BFCP), Content share (dual video) protocol support: BFCP for SIP Video Systems.	
17.	Proposed Solution should support ITU-T H.323 standards-based video systems, AES 128-bit encryption, Signaling protocol support:	

	H.323, H.323 with H.235, H.225.0, and H.245, Media protocol support: RTP, sRTP, and RTCP, Content (dual video) share protocol support: H.239, Annex-O dialing: Ability for standalone H.323 video systems not registered to a gatekeeper to dial and join meetings for H.323 Video Systems.	
18.	Proposed Solution should support AES 128-bit encryption, PIN-protected access into personal rooms from video systems, Meeting lock and unlock for added privacy, Authenticated access into meetings on desktop and mobile apps, SIP TLSv1.2 and H.235 for signaling security, sRTP for media security, Data at rest encryption for recordings in Cloud data centers.	

10. Passive Security System

10.1 WALKTHROUGH FRAME METAL DETECTOR

The Multi zone Door frame Door Frame Metal detector shall have following specifications:

S.N.	Technical Specifications
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 though 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 shapes in all the zones simultaneously from head to toe
2	**PASSAGE DIMENSION** Height – Min 200 cm Breadth – Min 72 cm Width – Min 57 cm
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 Max.
5	**POWER SUPPLY** 100-260 VAC, 50-60Hz, 12-24 VDC, should be provided with internal battery back-up for 6 hours minimum in operational conditions.
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 theaudible alarm to overcome the ambient noise present in the vicinity
7	**SENSITIVITY** DFMD should have multi-zone capability with uniform sensitivity in all zones
8	**ZONES: -** Not less than eight real horizontal detection zones, covering full height of the equipment
9	**CALIBRATION: -** DFMD shall have inbuilt feature of both manual and automatic calibration
10	**SECURITY: -** i) There should be 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

	onemtr from the archway without causing spurious alarms. ii) Moving metal beyond 1 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 TEMP:-** DFMD shall work satisfactory without any deterioration in performance within the temperature range -20 degrees to (+)55 degrees, 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. **iii)**Should have a ruggedized polypropylene shock proof container for safe transportation of product compliant to IP-65 and latest Mil Std.

10.2 HANDHELD METAL DETECTOR

Handheld Metal Detector shall have following specifications:

S. No.	Parameter	Specifications
1	Dimensions	
	Length	Maximum 500mm
	Probe width	Maximum 120mm
	Body width	Maximum 65mm
2	Weight	Maximum 500gms
3	Power source	Alkaline battery 3 volt (1.5x2) volt, should run minimum 550 hrs on 10% detection rate
4	Battery protection	To be provided against damage due to reverse polarity
5	Indication	a) Single LED based audio and visual multiple indication for- i. SWITCH ON ii. METAL DETECTION iii. LOW BATTERY INDICATION
6	Operation	Single push button operation
7	Construction	Should be rugged and impact resistant ABS moulded casing
8	Scan rate	Minimum 3” to 24”/sec
9	Detection	Should be able to detect Ferrous and Non-Ferrous metals

		- Pistol .22 at min 6” - Cartridge .22 at min 2” - Razor blade at min 1”
10	Tuning	Automatic to ensure equal results on wide range of metals and alloys
11	Miscellaneous- The firm should be able to provide the following, as applicable, along with the equipment: -Cleaning kit technical manual giving full description of the item. User’s handbook A. Battery charger with spare rechargeable battery set B. Technical manual giving full description of the item. C. User’s handbook D. Battery charger with spare rechargeable battery set	

10.3 LARGE SIZE BAGGAGE INSPECTION SYSTEM

2.1. Minimum Tunnel size– 100cmW (Width) x 100cm H (Height)(+/-10%)
2.2. Conveyor belt speed should be between 0.18 and 0.3meter per second. Conveyor movement bidirectional.
2.3. All machines should operate on 230 VAC, 50 Hz power supply and should be able to withstand voltage fluctuations in the range of 170V to 260V. Single Phase, 3 to 5 Amp
2.4. Conveyor capacity – 200kg or more
2.5. Through put should be 200 bags per hour or more
2.6. Sensors >1000 diodes, L-shaped detector (Folded array type), In case defective diode arrays, scanning should be disabled, and error message should be displayed on the screen.
2.7. X-ray voltage – 160 kV or more
2.8. X-ray Source/Generator – It should be capable to operate smoothly for a period of at least six years.
2.9. Duty Cycle- 100%
2.10. The X-ray beam divergence should be such that the complete image at maximum size of bag is displayed without corner cuts
2.11. 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
2.12. The operating temperature should be -10deg C to 50 deg C.
2.13. Storage Temperature -20 Degree C to 50 degree C
2.14. Humidity- 90% non-condensing
2.15. Resolution: The machine should be able to display single un-insulated tinned copper wire of 42-SWG or 38 AWG. All penetration and resolution condition should be met without pressing any functional key and should be online.
2.15. Resolution: The machine should be able to display single un-insulated tinned copper wire of 42-SWG or 38 AWG. All penetration and resolution condition should be met without pressing any functional key and should be online.
2.16. Penetration should be 27 mm thickness of steel (Guaranteed) or more.
2.17. 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.

2.18. Video display – 17′ ′ or better LCD Monitor SVGA High resolution, low radiation, flicker free, resolution at least 1280 x 1024, 24-bit colour real time processing.
2.19. The machine should have features of Multi-energy X-ray imaging facility where materials of different atomic numbers will be displayed in different colours 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 closure scrutiny. All suspicious items (Explosives, High density, material narcotics) should be displayed in one mode and that should be online.
2.20. 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.
2.21. Film Safety: - Guaranteed safety for high-speed films upto ISO1600. The machines should be film safe. In other works, photographic films must not be damaged due to x-ray examination.
2.22. Machine should be properly sealed from all sides for pest proof. Dust proof cover is to be provided for covering when system is not in use.
2.23. Facility of variable contrast must be incorporated to allow enhancement of lighter and darker portion of the image.
2.24. The machine should be so designed that the software enhancement can be easily implemented to take care of new technique in image processing and pattern recognition.
2.25. Full diagnostic built in test facility. All models should have software controlled diagnosis report facility and system should give printout if printer is connected
2.26. All software features of the machine should be online and password protected.
2.27. Machine should be capable of recalling 15 or more previous images
2.28. It should have the capability of archiving 2000 or more images with date & time stamp.
2.29. 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.
2.30. Facility of image enhancement should be available
2.31. 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.
2.32. Lead impregnated safety screen 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 the placing of baggage at input and output
2.33. All software features should be controlled from key board of machine only. Keyboard function should be user friendly. To enable/ disable the software features system should not be rebooted.
2.34. If the machine fails to penetrate a particular item then an alarm video and audio both should be generated to notify the operator.

2.35. The threat Image projection (TIP) system software to be incorporated in all X-ray BIS operation as
per details given in Cl No 4.
2.36. Copy of all software including X-Ray Software with recovery CD must be provided.
2.37. Operational Training- Operating staff has to be provided free training.
2.38. Operating & service manual shall be provided with each machine.
2.39. Other Features:

a) Edge & variable edge enhancement
b) Inverse Video
c) Set up time not more that 10 minutes
d) Pseudo colour
e) Date & Time Display

2.40. Minimum Computer configuration:

a) CPU: Should be able to deliver the output to meet the specifications mentioned as above.
b) Hard Disk Drive: 320 GB 7200 rpm serial ATA HDD or Better
c) Mouse: Optical
d) Ports: 6 USB Ports (with at least 2 in Front, 1 serial Port, 1 Parallel port, 1 PS/2 Keyboard and 1PS2 Mouse Port, audio ports for microphone and headphone in front
e) CD R/RW Drive: DVD Writer
f) Networking Facility: 10/100/1000 on board integrated Network port with remote booting facility, remote system installation, remote wakeup, out of band management using any standard management software

2.41. UPS: 3 KVA online with backup time of 30 minutes.

10.3 BOOM BARRIER

S.No.	Description	Technical details
1.	Application	Outdoor
2.	Drive	Hydraulic type with piston & Hydraulic pump
3.	Version	Left hand or right hand as per site requirement
4.	Opening time or Closing time	Less than 5 seconds
5.	Logic control	Included/624 BLD
6.	Drive	Hydraulic type with piston & Hydraulic pump
7.	Power supply	230+/- 10%VAC, 50 Hz
8.	Boom specification	Electromechanical, Aluminium and anti UV rays epoxy powder coated barrier complete with 24 VDC motor, with control unit box, with encoder, double built-in LED flashing light and fitted to take additional accessories. Anti-UV rays epoxy powder coated Aluminum barrier 6m barrier round aluminum boom L = 8550mm dia 60/90 mm, with counter weight, joints and fixed support including a pair of

		photocells with anodized aluminum vertical mountings. Colour shall be RAL standard light colours, with reflective tapes/strips, if required. The boom shall be swing away type or shall be detachable boom. Vehicle and the housing. The boom shall be reinstated in a simple manner by any individual without affecting the functionality of the system. The boom shall have RED LED lighting for enhancing the visibility to the driver while opening & closing of boom barrier.
9.	Housing dimension	IP 44 protection of Barrier body & IP 54 Control Unit. All housing and internal parts shall be rust & corrosion free metals or alloys of high strength with suitable epoxy/ powder coating as applicable.
10.	Finish	Housing - Epoxy/ Powder coated (colour RAL standard light colours, orange preferred).
11.	Power-off	Configurable/Adjustable to 1. Remain open/ closed. 2. Automated opening and closing
12.	Safety	Buried loop sensor shall be used to prevent boom barrier from closing on the vehicle. If the vehicle comes over the loop, the barrier shall not fall over the vehicle. If a vehicle crosses over the loop while the boom is closing, the barrier shall go up so that it will not hit the vehicle. Even if the boom barrier accidently hits a vehicle while closing down, the barrier shall immediately go up. The bidder has to take all the precautionary measures to ensure that the barriers will not fall on a vehicle even through
		manual operation by operator mistakes.
13.	Certification	Shall be CE or ISO 9001
14.	Mean time between failures (MTBF):	1 million cycles. System does not require any greasing / oiling for 1 million operations.