

VOLUME 5

PART I

TECHNICAL SPECIFICATIONS CIVIL & SPORTS FINISH

Design, Engineering and Procurement for
Construction of International Cricket stadium at
Patna, Bihar, INDIA on EPC basis

TECHNICAL SPECIFICATIONS

All works shall be carried out as per

PART 1 - CPWD Specifications 2019 Volume I & Volume II with latest amendments for civil works of buildings and roads, external works.

PART 2 - CPWD General Specifications for Heating, Ventilation & Air-Conditioning (HVAC) 2017 including amendments

PART 3 - CPWD General Specifications of Electrical Works SCHEDULE 0 - Part-I Internal 2013 including amendments SCHEDULE 1 - Part-III-Lift & Escalators 2003

SCHEDULE 2 - Part-IV Sub Station 2013

SCHEDULE 3 - Part V Wet Riser & Sprinkler Systems 2020

SCHEDULE 4 - Part VI Fire Detection and Alarm System 2018 SCHEDULE 5 - Part VII D.G. Sets 2013

SCHEDULE 6 - Part VIII Gas Based Fire Extinguishing System 2013

PART 4 - CPWD General Specifications of Horticulture & Landscaping 2020

Refer drawings and schedules: Work shall be carried out with specifications in this document with project specific requirement and most stringent requirements shall be followed in case of discrepancy between documents such as specification, Scope of work., DBR, drawings. The minimum standards required to be achieved are defined here in this document.

SECTION 1 GENERAL REQUIREMENTS

PART 1- GENERAL

1 Information

The General Conditions and Special Conditions of the Contract including the Drawings shall be read in conjunction with these Technical Specifications, and matters referred to, shown or described in one are not necessarily repeated in the other. These Specifications are comprehensive but may exceed the requirements of this project.

Notwithstanding the sub-division of the specification into various headings, every part of it is to be deemed supplementary to every other part and is to be read with it, so far as it may be practicable so to do, or when the context so permits.

It shall be contractual duty and responsibility of the contractor to have his own done in-depth studies by his consultants for proper details, procedure, mode of execution, use of relevant type, form and size of machineries for the works, form and extent of temporary works requirement and providing the works as specified in or necessarily to be inferred from the documents and drawings forming this contract.

The Contractor shall be required to conduct all site tests and tests from authorized testing laboratory, submit all manufacturers' test certificates as called for in the specifications.

The Contractor shall keep at site copies of all relevant standards and codes of practice referred in these specifications throughout the period of contract. These shall be the latest editions and shall include all revisions/addendums thereof.

Reference in the specifications to approved manufacturers shall be construed as establishing a standard of quality and not as limiting competition. The Contractor shall perform the contract works in proper manner and with due competency for the satisfactory completion of the same.

2 Codes, Regulations, Standards and Technical References

A. Regulations:

The whole of the Works and materials are to be in accordance with the Building Control Regulations, other regulations as set out by the authorities having jurisdiction over the works, and the relevant bylaws unless otherwise stated. Ensure that the requirements in the Specification are strictly adhered to when carrying out the Works, unless otherwise directed.

B. Standards and Codes of Practices:

Unless otherwise agreed by the Employer's Representative, ensure all of the Works comply with the relevant requirements of the Standards and Codes referenced in the body of the Specification. Alternative Standards and Codes may be proposed for approval by the Employer's Representative, provided it can be demonstrated that the alternative Standards and Codes comply with the requirements of the standards specified. All Standards and Codes quoted are the current version, unless specific year references are noted.

C. Technical Reference:

Where specified, be guided by the principles and methods as set out in the technical reference when carrying out the works. Alternative methods and principles may be proposed in lieu of the referenced

document, subject to acceptance by the Employer's Representative, if it can be demonstrated that the specified quality or performance of the works can be achieved.

3 Work Preambles

A. Ambiguity

Before commencing any works, obtain clarification or instructions in relation to any discrepancy or ambiguity, which is discovered within and between the Specification Work sections, and one or other contract documents issued by the various parties.

B. Approved Sub-contractors

All sub-contractors for the works are subject to the acceptance of the Employer's Representative. At the time of tender and before the commencement of work, submit the list of subcontractors intended to be engaged for the works. Submit with the list, details such as the relevant track records of the firms, the qualification of the personnel and details of equipment to be engaged for the works.

C. Licences, Permits and Liaison with the Authorities

Be responsible to initiate the application for all necessary licences, permits, etc and to carry out all necessary liaison with the Government Departments and Statutory Boards, etc whenever necessary, for the satisfactory completion of the Works. Be responsible for ensuring that these licences and permits are obtained in good time.

D. Safety Regulations and Temporary Works

Strictly observe all necessary safety requirements and legislation to fully comply with the provisions of the Workplace Safety and Health Regulations and/or any other requirements from the authorities having jurisdiction over the works.

E. Safeguarding Properties Adjacent to Site

Propose and adopt site procedures and methods of working such as to limit to a minimum any disturbance and vibration to the buildings around the Site. Identify and implement protective measures necessary to safeguard the adjacent properties prior to carrying out the works. Indemnify the Employer in accordance with contract conditions against all claims for loss and/or damage to the adjoining properties by reason of the carrying out of the works or by reason of insufficiency of precautionary measures.

F. Site Supervision

Provide personnel with adequate and relevant experience to Employer's Representative's acceptance, to supervise the Work. Submit the CV of the supervisor(s) to the Employer's Representative where directed.

G. Coordination of Works

Ensure that all units, components or assemblies whether from one or different sources, are available in time for incorporation into the Works.

H. Maintenance Manual

Develop and submit for Employer's Representative's acceptance, a strategy in the form of a maintenance manual and logbook, to ensure that elements that are likely to deteriorate significantly can be replaced or rectified.

PART 2- PERFORMANCE REQUIREMENTS

1 General Requirement

Engage methods and resources that will ensure the works achieve the specified quality within the agreed programme and cost.

2 Environment

Ensure the carrying out of the works will not cause un-acceptable pollution, noise, erosion and vibrations to the environment as stipulated by the tender and other relevant authorities.

PART 3- MATERIALS

1 MATERIALS GENERALLY

Products are to be new unless otherwise specified. All materials are to be supplied clean, undamaged and in good condition ready to be used for the Works.

For products with a limited shelf life, ensure no parts or whole are expired. Where a choice of manufacturer or source is allowed for any particular product, supply the whole quantity required as the same type and from the same manufacture and/or source unless otherwise approved. Produce written evidence of sources of supply when requested. Ensure that the whole quantity of each product supplied is of consistent kind, size, quality and overall appearance.

Ancillary products and accessories are to be of a type recommended by the main product manufacturer, unless otherwise specified.

Unless otherwise described, all materials shall be new and in accordance with the latest Indian Standards and the Contractor shall produce all necessary Certificates to substantiate this fact if so required by the Employer's Representative. Unless otherwise described, the description of each item of measured works shall include for supplying and delivering of all materials, unloading, sorting, selecting, storing, carriage and cartage, cutting and all waste on materials, hoisting, all labour setting, fitting and fixing in position, covering up and protecting finished work, clearing away all debris and waste, return of packing, carriage paid, use of plant and equipment, supervision, establishment and overhead charges, profit and all other labour and materials necessary for the due and proper execution of each item.

Use of environmentally friendly products and materials that are certified by approved local certification body and are applicable to non-structural and architectural related building components should be adopted where appropriate or required by this Specification.

2 ORDERING OF MATERIALS

Unless otherwise directed, do not place orders for materials before the sources and samples of the materials have been approved and the results of any preliminary tests required by the Specification have been accepted.

3 CERTIFICATES FOR MATERIALS

All materials and products are to be manufactured and tested in accordance with the appropriate Standard or as specified. All materials and products delivered to the site are to bear the manufacturer's name, brand name or any other data required to verify compliance with the specified requirements. Where appropriate, provide certificates from the supplier or test agencies verifying such compliance. Include, whenever applicable, the location in the Works or the delivery or batch which the certificate represents.

Where certificates of manufacture or tests are not available for materials proposed for use in the Works, carry out independent testing to determine compliance with the specified requirements where directed by the Employer's Representative.

Where applicable or whenever requested by the Employer's Representative, the Contractor shall submit test certificates of materials to be used in the Works certifying that the materials in question comply in all respects with the Specification. The Contractor shall obtain the said certificates either from the materials manufacturers or from an approved testing laboratory. All costs incurred in obtaining the certificates shall be borne by the Contractor.

4 Storage of Materials

Store all materials in a manner, which is not detrimental to their use in the Works and in accordance with any specified requirements.

Ensure that the storage facilities and the loadings resulting from the storage will not adversely affect the construction, the building and other buildings/amenities nearby. Engage specialist advise if appropriate.

Do not permit the storage of materials, components or equipment on new or partially completed work without prior approval.

5 Rejected Materials

Immediately remove from the site, all materials which are unidentified or do not meet the requirement of the specification.

PART 4 WORKMANSHIP

1 WORKMANSHIP GENERALLY

Ensure that all works are carried out:

- In accordance with the specified methods and procedures where applicable;
- In accordance with good building practice;
- In accordance with the manufacturers' instructions where applicable;
- By suitably qualified and experienced personnel.

2 SETTING OUT AND LEVELS

The Contractor shall appoint a licensed land surveyor to check and to confirm the existing levels, location of the existing drains and sewer inverts, existing underground services, alignment and levels of existing roads, etc. before commencing any work. The Contractor shall be deemed to have considered the time and cost to carry out the said works in this tender.

3 DELIVERY, STORAGE AND HANDLING

Deliver materials and products to the site with labels showing brand name, product name and manufacturers batch number.

Store materials in accordance with the manufacturer's recommendations. Use in order of delivery and before expiration of the shelf life date.

4 PROTECTION OF PRODUCTS AND COMPONENTS

Take measures to prevent over-stressing, distortion and other damage to the products.

Keep products and components clean and free from contamination. Prevent staining, chipping, scratching or other disfigurement, particularly of products exposed to view in the finished work.

Keep dry to prevent premature setting, moisture movement and similar defects. Where appropriate store off the ground and allow free air movement between stored products.

Prevent excessively high or low temperatures and rapid changes of temperature in the products.
Protect adequately from rain, damp, sun and other elements as appropriate. Ensure that products are at a suitable temperature and moisture content at time of use.
Ensure that sheds and covers are of ample size, in good weatherproof condition and well secured.
Keep different types and grades of products separately and adequately identified.
Keep products in their original wrappings, packings or containers until immediately before they are used. Wherever possible, retain protective wrappings after fixing until shortly before handing over to the owners.
Ensure that protective measures are fully compatible with and not prejudicial to the products and materials.

SECTION 2

TECHNICAL SPECIFICATION FOR CIVIL WORKS & FINISHES

2.1. FLOOR FINISHES

2.1.1 Scope

This Specification describes the general requirements for flooring finishes and rendering on projects. Contractor shall be responsible for clean-up & Housekeeping & shall take every precaution necessary to ensure the protection of the completed works till hand over to Owners representative.

2.1.2 Applicable Codes

IS 269 Specification for ordinary and Low Heat Portland Cement
IS 383 Specification for Coarse and Fine Aggregates
IS 777 Specification for Glazed Earthenware Tiles
IS 1237 Specification for Cement Concrete Flooring Tiles
IS 1443 Code of Practice for Laying and Finishing of Cement Concrete Flooring Tiles
IS 2571 Code of Practice for Laying In-situ Cement Concrete Flooring
IS 457 Specification for Ceramic Unglazed Vitreous Acid-Resisting Tiles

2.1.3 General Materials

Cement shall be ordinary Portland cement conforming to IS 269 for all purposes.
Sand shall conform to IS 1542. For white and/or coloured render only quartz or silica sand shall be used.
For textured finishes and final or finishing coats sand used shall be screened through 3.35mm and 22.36mm IS sieves respectively. For torn texture a slightly larger proportion of sand screened through a 4.75mm IS sieve shall be used.
Water used for mixing and curing shall be clean, clear and free from silt, oil, alkalis, acids, salts and the like.
Coloured cement shall be either ready mixed material or may be obtained by mixing pigments and cement on Site. Pigments mixed with cement shall conform to IS 2114.
Integral waterproofing compound shall conform to IS 2645.

2.1.4 IPS Flooring

General

The flooring shall be of specified thickness and shall consist of 1:2:4 concrete base/ M15 concrete as specified in the finishing schedule and 12mm thick wearing coat. The granolithic flooring shall be laid in alternate panels. The size of panels shall be as decided by the Employers Representatives.

Laying of 1:2:4/ M15 Concrete Base

The 1:2:4/ M15 concrete base shall be of graded course aggregate of 20mm and down size, 10mm course sand & cement. The ingredients shall be thoroughly mixed with sufficient water to obtain the required plasticity. The floor shall be completed with 1:1 cement sand mortar 12mm thick and cement slurry 2.2kg/sqm including Glass divider strips 45/50x4mm thick set in the flooring including necessary levelling, setting, etc.

The free water on the surface of the base shall be removed and a coat of cement slurry of the consistency of thick cream shall be brushed on the surface.

The prepared 1:2:4/ M15 concrete shall be laid immediately after mixing on the fresh grouted base. The concrete shall be spread evenly and levelled carefully. Low places shall be filled, humps removed and the whole surface again levelled. The layer shall be compacted by ramming and trowelled and allowed to set.

Mixing and Laying of Wearing Coat

One part of cement in dry state shall be mixed with 1.5 parts by volume of well graded/crushed granite chips of 6mm maximum size. The ingredients shall be then mixed with sufficient water as for ordinary concrete. The wearing coat shall be laid 12mm thick over 1:2:4 cement concrete base immediately after it has set compacted and levelled with a steel trowel. Just sufficient trowelling shall be made to give a level surface. The surface should not be over trowelled, as excessive trowelling will bring the cement to the surface, which shall be strictly avoided. When the initial set takes place further compaction by steel trowelling shall be done and final brushing shall be made before the topping becomes too hard.

Floor hardeners

Where specified in the drawings, floor hardeners, approved by the Employers Representative or his representative, shall be supplied and incorporated into surface finishes in accordance with the manufacturer's recommendations.

Curing

As soon as the surface is hard enough, it shall be covered with sacking or sand and kept continuously wet for a period of at-least one week.

2.1.5 TECHNICAL SPECIFICATION FOR VACUUM DEWATER FLOORING

This specification covers the method and procedure to be adopted for vacuum dewatering the concrete flooring to improve the quality of concrete floors.

The vacuum dewatering process consists of levelling, compacting and vacuum dewatering the concrete flooring by using vibrating screed, vacuum pumps, suction mats, filter pads, accessories etc. The sequence of operation shall be placing of concrete, vibration, vacuum treatment and floating and the operations shall follow immediately behind each other.

The Contractor shall have persons well experienced in the vacuum dewatering process, and in the operation of all related equipment's. All process equipment to be used shall be in good working condition and shall be subject to the approval of the Engineer.

The work should be planned well in advance with a view to determine areas to be concreted daily, the required number of equipment, size of vacuum mats, length of vacuum hoses, arrangement of rails, screeds etc.

The area to be concreted shall be thoroughly cleaned, reinforcement checked and got approved by the Engineer. Then the specified grade of concrete shall be placed in position without any

segregation and properly vibrated.

Immediately after placement of concrete, the vibrating screed, fixed at the proper position to achieve the required specified finished level, shall be allowed to run over the concrete on a true surface to level the concrete. For better consolidation proper surcharge of concrete should be maintained in front of the leading edge of the screed and the vibrating screed shall be allowed to move forward rapidly. The concrete surface shall be screeded high by 2% of the slab's thickness to compensate for the compaction caused by the Vacuum dewatering process. (Slabs which have an aggregate hardener shall have compensation made to maintain elevation).

Immediately after levelling, the concrete shall be covered with filter pads and suction mats in strict accordance with the recommendation of the Manufacturer to have the slab fully dewatered. The suction mat shall extend 100 mm beyond the edge of the filter pad on all sides. The pads shall extend to within 100 mm of the edges of concrete slab, and the mats shall cover entire slab. Before connecting the hose on the suction mat to the vacuum pump, the edges of the mat shall be smoothed to enable an airtight seal to be created. A vacuum shall then be applied to the mat. After a minute the gauge on the vacuum pump should indicate a minimum vacuum of 0.70 atmospheres (24.0 in Hg) and if not, the mat must be checked for leakage. For concrete that dewateres readily the vacuum should then be maintained at 0.70 0.80 atmosphere (24.0 25.5 in Hg). For concrete which dewateres less efficiently (eg. air entrained concrete) the vacuum shall then be reduced to 0.50 0.60 atmospheres (15.0 18.0 in Hg). After approximately 10 minutes the vacuum can then be increased to 0.80 atmospheres.

The vacuum shall be maintained for at least 3 minutes per 25 mm of concrete thickness at 0.80 atmospheres. (Where aggregate hardeners are specified, sufficient moisture shall be maintained to meet Manufacturer's requirements). The suction mats and filter pads shall then be removed and moved to the next section in a leapfrog manner.

Stop the vacuum dewatering when light foot prints only are left in the concrete when stepped upon. A suitable suction time can also be checked with a Proctor apparatus which should show 1.5 2 Kp/Sqcm.

Upon removal of the suction mats and filter pads the concrete shall be power floated without delay until all imprints from the vacuum process are removed. If crusting occurs, the floating operation must be delayed till the concrete carries the machine.

The higher speed is recommended for the floating operation. The passes with the floating disc should be made in the junction of two mats in order to avoid risk of cracking.

The waiting time after the floating operation depends on concrete temperature and humidity and varies from 10 minutes to 2 hours.

The trowelling operation cannot take place before the concrete has hardened enough to carry the machine i.e. the trowelling blades will not leave any marks on the concrete. Repeated trowelling, with intervals between the passes, which are adapted to the setting of the concrete, greatly improves the surface characteristics. The surface will be more wear resistant and less dusty.

At least two passes are recommended for floors which are not to be covered.

Vacuum dewatered concrete should be cured like any quality concrete in order to achieve a good final result. Use curing compounds, plastic sheets or wet burlap.

The contractor has the responsibility for achieving the quality of concrete specified by controlling the concrete mixes, placing, vacuum process finishing and curing. The concrete technician in charge must be present at the site when work is in progress.

The contractor shall be responsible for mix adjustments, performing necessary tests, correcting deficiencies and trouble shooting in general.

The contractor shall be required to maintain control charts showing individual test results for aggregate gradation, slump, air content, cement content and compressive strength

The surface to receive flooring shall be clean, free from dirt and free from foreign material. Any undulations or mortar remaining on the floor shall be trimmed. Base course shall be trimmed. The base shall be cleaned and watered before laying the floor. Work includes at all depths and heights. The finished surface shall be kept wet for a maximum period of one week.

Concreting shall have a concrete base of M20 of specified thickness. Flooring shall have hardtop on the concrete base.

Materials

Cement	-	Portland				
Sand	-	River sand				
Aggregate	-	Max. size 10 to 20mm				
Water	-	Potable Nito hardener (Optional)				
-	@	3kg/sqm				
Poly Sulphide sealant	-At	all	control	joints	of	size
10mmx6mm at every 200 sqm area						

Mix cement, sand and aggregates in proportion 1:1.5:3 thoroughly with water to get an appropriate consistency.

A coat of cement slurry of the consistency of thick cream shall be brushed on the surface of the base course.

Low areas shall be filled with concrete and humps removed. De-vacuumisation shall be done for removing the voids.

Hardtop to be prepared as per the specifications with Nito hardener and one part of dry cement. The heard top shall be provided over concrete base immediately after it is set, compacted and levelled with a steel trowel.

Final brushing where required (to achieve desired surface finish) shall be made before the floor top becomes too hard.

Curing shall commence as soon as the surface is hard enough to receive the water.

The surface shall be covered with sacks or sand and shall be kept continuously wet for a period of at least one week.

2.1.6 TECHNICAL SPECIFICATION FOR VINYL FLOORING

Product Description:

Supply of 4.5 mm thick Gerflor RECREATION-45 synthetic sports surface consisting of:

- 100% pure vinyl wear layer with a thickness of 1.5 mm.
- Upper surface treated with **Protec sol** to reduce skin burns.
- **Sano sol** treatment to prevent fungal growth.
- Double fiberglass grid for enhanced sound stability.
- Sheet width of 1.5 meters, joined with seamless hot welding.
- Laid with adhesive as per manufacturer's instructions over an existing leveled surface, including game lines marking.

1. Surface Details:

- **Surface Treatment:** PUR PROTECT
- **Surface Composition:** 100% PVC
- **Foam:** Closed-cell foam

2. Dimensions:

- **Thickness:** 4.5 mm (EN 428)
- **Weight:** 2.6 kg/m² (EN 430)

3. Performance Metrics:

- **Shock Absorption:** $\geq 25\%$ (EN 14808)
- **Vertical Deformation:** ≤ 3.5 mm (EN 14809)
- **Energy Return:** ≥ 0.31 m/s (NF P 90 203)
- **Sliding Coefficient:** 80 - 110 (EN 13036-4)
- **Ball Bounce:** $\geq 90\%$ (EN 12235)
- **Ball Speed:** 50 to 65 cm (UEFA standard)

4. Durability:

- **Abrasion Resistance:** ≤ 350 mg (EN ISO 5470-1)
- **Impact Resistance:** ≥ 8 N/m (EN 1517)
- **Indentation Resistance:** ≤ 0.5 mm (EN 1516)

5. Fire Safety:

- **Classification:** Pending (EN 13501-1)

2.1.7 TECHNICAL SPECIFICATION FOR SKIRTING (GYM AREA)

Description

This skirting is made from high-density polystyrene foam, which is 100% recyclable, and features a protective varnish. It is designed to be placed over existing skirtings in renovation projects, eliminating additional handling costs. Ideal for both aesthetic and functional purposes, it provides a neat finish and reduces installation time.

Key Features

- Elegant visual finish
- Ideal for renovation projects
- Reduced installation time

Technical Information

Product Size (mm) 2000 length x 22 width x 110 height

Unit Weight (g) 660

Cleaning & Maintenance

- **Installation:**
 1. Ensure the surface is clean, dry, and free of grease.
 2. Apply adhesive to the backside of the skirting.
 3. Use polymer adhesive or acrylic glue-filler with a caulking gun.
 4. A primer may be required depending on the substrate.

Daily Cleaning: Use standard neutral detergents (pH 7) and damp mopping for routine maintenance.

2.2. ALUMINUM EXPANDED MESH CLADDING WORKS:

Design, Fabrication, Supply, installation, protection, cleaning & handover of Aluminum Expanded mesh cladding of approved make in solid or metallic colours as per architect's approval using grid work of prefabricated aluminum tube structure to withstand the design wind pressure confirming to IS -875 part III. The fastening brackets of Aluminum alloy 6061 T5 / MS with HDG with serrations and serrated washers to arrest the wind load movement, fasteners and anchor bolts of approved make in SS 316, Nylon separators to prevent bi-metallic contacts, non staining weather sealant between grooves all complete required to perform as per specification and drawing in conjunction with BOQ.

Aluminium mesh panel shall have subframe all around panel and aluminum stiffener profile as per structural requirements. Aluminium expanded mesh shall have open area less than 40%.

Prefabricated grid mullions are fixed on to the RCC and concrete masonry walls with SS 316 anchor bolts as

recommended by approved supplier to support given design loads. The brackets shall have provision movement to

accommodate the construction tolerances with +25mm plumb in case of RCC structure and + 20mm plumb in case of

steel structure . Use of aluminium brackets with serration and serrated washers to prevent wind direction movement

after final position. Use of Hot Dipped galvanised brackets with serrations and serrated washers on to structures. The

design shall accommodate the building movements, thermal expansion and seismic movements.

The extruded aluminium sections of Alloy 6063 T5 / T6 & tolerances confirming to DIN / EN standard from approved

extruder. 2 mm thk. aluminium mesh shall be of 3003-H14 or 5005-H14 grade & shall be pre-coated having high

Durability (Akzonobel) / Super durable (Jotun) Powder coating of 60 - 80 micron confirming to AAMA 2604 on either side.

2.3. ALUMINUM LOUVERS/VERTICAL FINS

GENERAL

2.3.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

2.3.2 SECTION INCLUDES

B. The Work of this Section includes all labor, materials, equipment and services necessary to complete the aluminum Louvers as shown on the drawings and/or specified herein, including but is not necessarily limited to the following:

- i. Aluminium Louvers

2.3.3 RELATED SECTIONS

A. Sealant work -Section 07900.

2.3.4 QUALITY ASSURANCE

A. Performance Requirements

i. Structural Performance: Provide exterior metal Louvers capable of withstanding the effects of loads and stresses from wind and normal thermal movement without evidencing permanent deformation of louver components including blades, frames, and supports; noise or metal fatigue caused by louver blade rattle or flutter or permanent damage to fasteners and anchors.

a. Wind Load: Uniform pressure (velocity pressure) of 2.1 Kpa, acting inward or outward.

ii. Thermal Movements: Provide Louvers that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, and other detrimental effects.

a. Temperature Change (Range): 29°C to 45°C, ambient; 45°C to 85°C, material surfaces.

B. Comply with SMACNA "Architectural Sheet Metal Manual" recommendations for fabrication, construction details and installation procedures, except as otherwise indicated.

C. Field Measurements: Verify size, location and placement of louver units prior to fabrication.

D. Shop Assembly: Coordinate field measurements and shop drawings with fabrication and shop assembly to minimize field adjustments, splicing, mechanical joints and field assembly of units. Preassemble units in shop to greatest extent possible and disassemble as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

2.3.5 SUBMITTALS

A. Product Data: Submit manufacturer's specifications, certified test data, where applicable, and installation instructions for required products, including finishes.

B. Shop Drawings: Submit shop drawings for fabrication and erection of louver units and accessories. Include plans, elevations and details of sections and connections to adjoining work. Indicate materials, finishes, fasteners, joinery and other information to determine compliance with specified requirements.

C. Samples: Submit 1 sq.ft. Samples of each required finish. Prepare samples on metal of same gauge and alloy to be used in work. Where normal color and texture variations are to be expected, include 2 or more units in each sample showing limits of such variations.

2.3.6 PRODUCT HANDLING

- A. Protection: Use all means necessary to protect the materials of this Section before, during and after installation and to protect the installed work and materials of all other trades.
- B. Replacements: In the event of damage, immediately make all repairs and replacements necessary.

2.3.7 LOUVRE MATERIAL

- A. Provide storm resistant extruded aluminum Louvers (ASTM B221), of profiles shown on drawings and approved by Architect.
- B. Heads, sills, jambs and mullions to be one piece structural members of 6063-T6, alloy, 20.04mm min. thick, with integral caulking slot and retaining beads. Blades to be minimum 20.04mm min. thick. Closed cell PVC compression gaskets to be provided between bottom of mullion or jamb and top of sill to insure lead tight connections. Concealed structural supports to be designed by the louver manufacturer to carry a wind load of not less than 2.1 Kpa. All fasteners shall be of stainless steel.

2.3.8 Finishes

Where not installed in curtain wall framing, provide anodized finish to match Architect's sample.

- A. Fastenings: Fasteners for exterior application shall be stainless steel. Provide types, gauges and lengths to suit unit installation conditions. Use Phillips flat head machine screws for exposed fasteners, unless otherwise indicated.
- B. Anchors and Inserts: Use non-ferrous metal or SS 316 grade anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use steel or lead expansion bolt devices for drilled in place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

2.3.9 FABRICATION, GENERAL

- A. Fabricate frames including integral sills to suit adjacent construction with tolerances for installation, including application of sealants in joints between Louvers and adjoining work.
- B. Include supports, anchorages, and accessories required for complete assembly.
- C. Provide sill extensions made of same material as Louvers, where indicated, or required for drainage to exterior and to prevent water penetrating to interior.
- D. Join frame members to one another and to stationary louver blades by welding, except where indicated otherwise or where field bolted connections between frame members are necessary by size of Louvers. Maintain equal blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

2.3.10 INSPECTION

- A. Examine the areas and conditions where aluminum Louvers are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

2.3.11 PREPARATION

- A. Coordinate setting drawings, diagrams, templates, instructions and directions for the installation of anchorages which are to be embedded in masonry construction. Coordinate the delivery of such items to the project site.

2.3.12 INSTALLATION

- A. Locate and place louver units plumb, level and in proper alignment with adjacent work.
- B. Use concealed anchorages wherever possible. Provide stainless steel 316 grade washers fitted

to screws where required to protect metal surfaces and to make a weather tight connection.

C. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers, as indicated.

D. Repair finishes damaged by cutting, welding, soldering and grinding operations required for fitting and jointing. Restore finishes and prime coats of paint so that there is no evidence of corrective work. Return items which cannot be refinished in the field to the shop, make the required alterations, and refinish the entire unit, or provide new units, at Contractor's option.

E. Protect aluminum surfaces from corrosion by application of a heavy coating of bituminous paint on surfaces which will be in contact with concrete, masonry or dissimilar metals.

F. Provide concealed gaskets, flashings, joint fillers and insulations, and install as the work progresses to make the installations weather tight.

2.4. EPOXY COATINGS & FLOORINGS

Scope

This Specification describes the general requirements of Epoxy coatings & flooring to be executed on projects.

1. Concrete coating for Light duty use

Where indicated, a solvent free, self-smoothing, epoxy coating shall be applied to the concrete at a thickness of between 0.5-1.5 mm, so that it forms a hygienic surface for light to medium duty industrial use after preparing the surface using a vacuum assisted shot blasting machine or scarifying and priming the surface Application of coating shall only be carried out by an approved specialist applicator.

The product shall meet or exceed the following performance criteria:

Density	: 1.53
Absorption (ASTM C413-80)	: 0.06%
Bond strength (DIN ISO 4624)	: 1.5N/mm ² (concrete failure)
Abrasion resistance (DIN Taber 53754)	: 98 mg
Compressive Strength (ASTM C 579-93)	: > 79N/mm ² @14 days
Flexural Strength (BS 6319 Part 3)	: 19 N/ mm ²
Tensile Strength (BS 6319 Part 7)	: 15 N/ mm ²
Slip resistance (TRRL rubber)	: 104

2. Epoxy overlay/ coating for concrete for Medium duty use

Where indicated, a solvent free, self-smoothing, epoxy coating shall be applied to the concrete at a thickness of between 2-4 mm, so that it forms a hygienic surface to the concrete for medium to heavy use after preparing the surface using a vacuum assisted shot blasting machine or scarifying and priming the surface Application of epoxy overlay shall only be carried out by an approved specialist applicator. The product shall meet or exceed the following performance criteria:

Density	: 1.758
Bond strength (DIN ISO 4624)	: 1.5N/mm ² (concrete failure)
Compressive Strength (ASTM C 579-93)	: 75 N/mm ² @ 14days
Flexural Strength (BS 6319 Part 3)	: 30 N/ mm ²
Tensile Strength (BS 6319 Part 7)	: 17 N/ mm ²
Slip resistance (TRRL rubber)	: 99

3. Epoxy overlay for concrete for medium duty (4mm)

Where indicated, an epoxy overlay shall be applied to the concrete slab so that it forms a hygienic surface for medium to heavy duty industrial use after preparing the surface using a vacuum assisted shot blasting machine or scarifying and priming the surface.

Approved epoxy screeds shall be suitable for application on damp or green concrete or concrete with moisture content greater than 5%. Application of epoxy overlay shall only be carried out by an approved specialist applicator.

The product shall meet or exceed the following performance criteria:

Density	: 1.74
Bond strength (DIN ISO 4624)	: Concrete failure
Compressive Strength (BS 6319 Pt 2)	: 40 N/mm ²
Flexural Strength (BS 6319 Part 3)	: 20 N/ mm ²
Water va	

pour permeability (DIN 52615)	: 6,000
Abrasion resistance (Taber C517 1kg/1000rpm)	: 110 mg

4. Epoxy screed & overlay for concrete for heavy duty use (5mm)

Where indicated, a solvent free, self-smoothing epoxy coating shall be applied to the concrete at a thickness of not less 5mm, so that it forms a durable surface for medium to heavy duty industrial use after preparing the surface using a vacuum assisted shot blasting machine or scarifying and priming the surface. Application of epoxy overlay shall only be carried out by an approved specialist applicator.

The product shall meet or exceed the following performance criteria: Density : 2.086

Compressive Strength (ASTM C 579-93)	: 81 N/mm2 @ 14 days
Flexural Strength (BS 6319 Part 3)	: 24 N/ mm2
Tensile Strength (BS 6319 Part 7)	: 14 N/ mm2
Slip resistance (TRRL rubber)	: 88
Abrasion resistance (ASTM C501-84)	: 0.50mg/cycle

2.5. TOILET CUBICLES

2.6.1 SCOPE: -

Providing and fixing Toilet cubical as under with door, pilaster and divider of 18mm thick board both side decorative compact laminate of required colour, shade and sizes including stainless steel accessories (SS-304 grade) like square top rail, box, knob, thumb turn and indicator, twin coat hook, door stopper, gravity hinges, and locking arrangement, SS channel etc. as desired. all complete as per drg. and direction of Engineer in charge. (Cubical size = (1050x1500) mm, Cubical Height =2100mm, External Laminate finish = Metallic)

2.6.2 APPLICABLE CODES: -

IS: 2046 for Compact Laminate.

2.6.3 MATERIAL: -

The Modular Toilet cubical shall be of size and shape as shown on drawings for a unit of 3/4/5 WCs, erected at locations enclosed by corner masonry walls. Division, frontal and nib panels shall be of 18 mm thick solid grade compact high-pressure laminate as per IS:2046 and BS- 476 class 1 fire retardant in Suede finish, manufactured under high specific pressure > 5 MPa and temperature >120oC with bunch of kraft papers impregnated with thermosetting phenolic resin and decorative papers made of Alpha cellulose fiber impregnated with thermosetting melamine resin which provide superior scratch, abrasion, heat, chemical, impact, graffiti & moisture resistance along with anti-bacterial properties. Panels have a black core that when machined, presents a distinctive black edge. Panel is anchored to the wall with SS 304 grade U & F Channel. The top fitting should consist of SS square top rail which will get fixed with pilasters. All screws will be of SS 304 Grade in stainless steel. All pilasters are supported with Adjustable Palm Design Pedestal Footing made from Stainless steel grade 316 giving a clearance height of 150 mm from the floor. The base will be anchored to the floor. Compact laminate should be Green guard and IGBC certified.

The following stainless steel (SS 304) accessories to be used : Door Knob; coat hook with rubber stopper; self closing (gravity) hinges; privacy Thumb turn with occupancy indicator, top rail and Adjustable Palm Design Pedestal Footing SS 316 Grade Design no. as specified by Arch. / Engineer-in-charge in suede finish. Size of panels to be as per drawing.

The mock-up shall be approved by the Engineer-in-Charge before starting the installation of toilet cubicles. Vendor shall submit the certificate of warranty for a term of 5 years on moisture related damages (partitions), 1 years for toilet cubicles workmanship and accessories. All the material supplied and installed shall be as per the description and specifications in the item. The following information shall be submitted by the contractor for obtaining approval of the Engineer-in-charge before start of work.

Product Data	:	Manufacturer's data sheets on each product to be used including preparation instructions and recommendation Storage and handling requirements and recommendation Details of construction and fabrication. Installation method
Shop Drawings	:	Detailed plans and elevations, details of frame members, anchoring methods, clearances, hardware, and accessories clearly shown.
Name of fabricator installer	:	Approved by the manufacturer, specializing in performing work of this section with minimum two years experience.

Manufacturer's Warranty	:	Components of the toilet cubical for 5 years against breakage, corrosion, and defects in factory workmanship.

2.6.4 DELIVERY, STORAGE, AND HANDLING:-

Toilet cubical material and hardware shall be delivered and stored in manufacturer's unopened packaging until ready for fabrication and installation. It shall be protected from damage.

2.6.5 FABRICATION:-

The substrates shall be prepared including but not limited to blocking and supports in walls and ceilings at points of attachment using methods recommended by the manufacturer for achieving the best result. Area shall be inspected to receive toilet cubicles for correct dimensions, plumbness of walls, and soundness of surfaces that would affect installation of mounting brackets. Spacing of plumbing fixtures shall also be verified to assure compatibility with installation of compartment. Installations shall not be preceded until substrates have been properly prepared with blocking and supports in walls and ceilings at points of attachment and deviations from manufacturer's recommended tolerances are corrected. All the fabrication work shall be carried out as per approved shop drawings.

2.6.6 INSTALLATION:-

All installation shall be carried out by the fabricator/installer approved by the PMC. Installation shall be in accordance with manufacturer's written instructions approved by the Engineer-in-charge.

Blocking and supports in walls and ceilings shall be verified that they have been installed properly at points of attachment. Location should not interfere with door swings or use of fixtures. Installation of cubical units should be rigid, straight, true to plumb, and level. Evidences of drilling, cutting, and fitting to room finish shall be concealed by capping / shoe box plate etc. U-channels and noise deafening tapes shall be provided as per drawing. All the units shall be tested for proper operation. The following fittings shall be provided in each toilet cubical.

1. Gravity hinge – 3 Nos.
2. Coat hook cum Door stopper – 1 No.
3. Door knob cum vacant / engaged position showing device – 1 No.
4. Lock set – 1 No

2.6.7 INSTALLATION:-

Adjustment of hardware for proper operation after installation may be permitted provided it does not damage the unit either structurally or aesthetically. Hinge cam may be set on in- swinging doors to hold doors open when unlatched and on out-swinging doors to hold unlatched doors in closed position.

Touch-up, repair or replacement of damaged products shall be done with prior approval of the Engineer-in-charge, whose decision shall be final and binding.

Exposed surfaces of compartments, hardware, and fittings shall be cleaned thoroughly.

2.6.8 TESTING:-

Required numbers of tests shall be performed on Decorative Thermosetting Synthetic Resin Bonded Compact Laminated Sheets as per provision of IS: 2046. Hardware and fittings shall be of grade 304 stainless steel shall also be tested based on relevant IS codes as decided by the Engineer-in-Charge. Testing charges shall be paid by the department.

2.6. TECHNICAL SPECIFICATIONS FOR BLOW MOULD HDPE BUCKET SEATING SYSTEM

Double-wall hollow blow mould bucket type seat having minimum dimensions

Material – HDPE Virgin Grade

Side Depth - 480 mm

Width - 440 mm

Height - 420 mm

Cell thickness - 3 mm on each wall.

Minimum density of 0.95 gram/cm³,

Weight of plastic chair should not be less than 2.6 kg.

Colour fading guarantee for 5 years.

Chair should withstand in high temperature not less than 70°C with ultraviolet stabilizer and colour fastness, having ergonomic design, seat to be fixed on aluminum floor mount frame by the process of grouting with bolt.

The chair should be fixed with Metal Inserts moulded inside seat to connect seat with Galvanized pipes 25 Nominal Bore running under the chairs. The pipes are resting above Aluminum bracket at c/c distance from 1.5 to 1.7 mtr and all open ends of all pipes are to be closed by PVC cap.

Structure:

Supporting structure should be made with castor aluminum with powder coating.

The back end seat should be attached with steel nuts and bolts.

QC Standards:

The product should pass the EN 12520:2015 Furniture Test methods and requirements for strength and durability standard for Strength, durability, and safety- Requirements, specifically the seat static load and back static load tests as well as the impact test.

Should have ANSI/BIFMA certification for the Furniture Sustainability Standard, specifying the applicable edition.

Should have CE certification.

Should pass the ASTM D 3418:2021 Standard for Transition Temperatures and Enthalpies of Fusion and Crystallization of Polymers by Differential Scanning Calorimetry, and the melting peak temperature should not be less than 100 degrees Celsius. Proof of NABL accreditation Lab test report should be submitted along with the technical bid.

Plastic parts of the chair should have undergone xenon-arc exposure testing as per ISO 4892-2:2013, Cycle-1. for and the Grey Scale Rating (GSR) should be greater than 4 Proof of NABL accreditation lab test report should be submitted along with the technical bid.

The material is fully color compound, which ensures that all the additives are fully dispersed, and uniform. On accounts of aesthetic, uneven distribution of colors shall not be permitted.

Built-in UV inhibitors ensure no significant colour or plastic deterioration for period of five years meeting the BS EN IOS 4892 or ISO 4892-2:2013 for U.V Stabilization standard. On accounts of durability, manufacturer must be able to furnish xenon arc report in compliance of UV Stabilization standard.

2.7. TECHNICAL SPECIFICATIONS FOR SPORTS LIGHTING WORKS

Luminaire Specifications:

The LED Floodlights for Cricket Pitch and Field illumination as per ICC Standards with DMX Controls for different playing levels (International/National etc) comply to following technical & functional specifications.

The High-Power LED Floodlight shall be made of 100% recyclable single piece high pressure die cast non-corrosive aluminum housing should be IP66 & IK 08 suitable for driver unit having in built DMX-RDM protocol for easy integration with external lighting dynamic control. Solution comprising of multiple lower wattage Luminaire mounted/clubbed together shall not be accepted.

The light source used shall be reliable high-power LED Chip should be $>3W \leq 5W$ of reputed approved makes having SDCM (Mac Adam ellipse): < 5 .

The optical cover shall be made of polycarbonate lens plate.

The floodlights and external driver unit shall Comply to Class I electrical insulation class, IP66 degree of ingress protection without using glue, impact resistance of IK08.

Driver unit should be suitable for 230V/50 Hz (mains supply voltage fluctuations $\pm 10\%$). Inrush current 20 A during 160 μs at 230 V mains. The power factor shall be > 0.95 at full power. Internal surge protection of minimum 10KV must for all floodlights.

The driver shall have Over Temperature, Under Voltage / Short Circuit, Over Voltage / Open Circuit & Output failure protections, with an Efficiency of $>90\%$.

Luminaire connections should be through toolless openings for easy installation & maintenance purpose.

The driver must have control interface compatible with DMX-RDM protocol and shall have suitable RJ45 ports in electrical compartment of the driver box for integration with Dynamic Lighting Control Systems and 3rd Party A-V Systems.

The LED Floodlight Luminaire* life class /lumen maintenance L70B50: 50,000 hr.

The luminaire shall be suitable for outdoor application, mounting on mast head frame, catwalk, walls, canopy structures etc. with the help of a sturdy U-shaped mounting bracket, it shall have slot/s to temporarily affix a precision aiming device for proper rotation and tilt aiming according to approved lighting plan.

All plastic parts, cables used etc shall be preferably UV protected.

The driver shall have separate cable gland suitable for DMX cable entry and outgoing.

Quantitative Parameter:

Luminaires shall be suitable for HDTV broadcast with Colour Characteristics, Lumen package and Efficacy.

The High-power LED Floodlight luminaire shall have CRI >90 . CCT $> 5500K$ (tolerances on CCT: $\pm$ as per ANSI C78:377A) .TLCI shall be 90 or more. flicker free $<1\%$ performance meeting the HDTV Broadcast standard for professional sports requirements. The System Efficacy shall be typical 100lumen/watt with CRI >90 , higher system efficacy is acceptable but without compromising CRI.

2.8. TECHNICAL SPECIFICATIONS FOR POLYCARBONATE PANEL SYSTEM

1. Product Description

Supply and installation of a 16mm thick, 600mm wide polycarbonate panel system, designed to provide natural daylight, thermal insulation, and resistance to environmental conditions.

2. Material

- Material Type: Extruded polycarbonate
- Thickness: 16 mm
- Width: 600 mm nominal
- UV Protection: Co-extruded UV protective layer on the exterior surface
- Color: Uniform color throughout; manufacturer’s standard or as approved by the consultant
- Surface Finish: Smooth, translucent, or light-diffusing finish

3. Panel Jointing System

- Joint Type: Vertical standing seam edges with snap-on connector system
- Connector:
 - Snap-on type with double tooth grip-lock mechanism
 - Color-matched to the panel for aesthetic continuity
 - Designed to prevent water ingress and resist wind uplift
- Sealing: Compatible EPDM gaskets or silicone sealants as per manufacturer’s recommendation

4. Structural Framework

- Supporting Framework:
 - To be fabricated and supplied by the steel fabricator (separate scope)
 - Made of galvanized steel sections or powder-coated steel as per structural drawings
 - Framework to be raised 200mm above roof pan level to allow for proper drainage and installation alignment

5. Performance Requirements

Parameter	Requirement
Solar Heat Gain Coefficient (SHGC)	≤ 0.30 (as per DGU equivalent)
U-Factor (Thermal Transmittance)	≤ 0.75 W/m²·K (maximum for skylight)
Light Transmission	Typically 45–65% (depending on color)
Wind Load Resistance	As per local building codes and structural design (consult structural engineer)
Fire Rating	Class B (or better) per ASTM D635 / EN 13501-1 or equivalent standard

6. Installation Guidelines

- Installation shall be performed by trained personnel as per manufacturer’s guidelines
- All necessary aluminum or steel accessories, trims, fasteners, and sealants to be included
- Ensure proper overlap, ventilation, and expansion space
- Use anti-dust tape and U-profiles at ends to avoid ingress of dirt and insects

7. Warranty & Compliance

- Minimum 10-year warranty on material against discoloration, loss of impact strength, and UV degradation
- Product must conform to relevant ASTM / EN / BIS standards
- Manufacturer must provide technical datasheets, installation manual, and compliance certificates with the supply

2.9. TECHNICAL SPECIFICATIONS FOR ALUMINIUM LOUVER SYSTEM

1.Product Description

Design, supply, and installation of Aluminium Louver System for pipe coverings in stilt areas and vertical shafts on typical floors. The system shall consist of fully prefabricated and assembled aluminium louvered units, equivalent to Hunter Douglas “Galvalume 84R” Louvered System or approved equivalent.

2. Material & Finish

- Material: Aluminium alloy extrusions (minimum grade 6063-T5 or equivalent)
- Type: Roll-formed or extruded aluminum louvers, blade type "84R" or equivalent
- Finish:
 - Powder coated white colour, oven baked finish, minimum 60–80 microns
 - Finish to be UV-resistant and corrosion-resistant
- Surface Protection: Pre-treatment for enhanced bonding and corrosion protection (chromating/ anodizing before coating)

3. Fabrication & Assembly

- Prefabricated Units: Louvers shall be factory-assembled with a consistent pitch and spacing.
- Mounting System:
 - Installed using brackets and site-fixed aluminum channels
 - Includes necessary sub-frame or secondary structure as required
- Fire Safety Interface:
 - Provide fire-seal at junctions with fire-rated walls/floors
 - Install with compatible flashing, weather-sealants, and insulation
- Extruded Aluminium Capping: To be provided on top edges or where required to conceal fasteners and provide neat finish
- Fixings: All screws, anchors, and rivets to be stainless steel or hot-dip galvanized, concealed wherever possible

4. Installation Requirements

- Installation shall be as per approved shop drawings and manufacturer’s installation guidelines
- Ensure secure alignment, level, and proper spacing
- Substructure alignment and interface with civil work shall be verified prior to installation
- Mock-up sample may be required for Engineer’s approval before bulk installation

5. Performance Criteria

Parameter	Specification
Wind Load Resistance	As per IS 875 (Part 3) or local wind code
Thermal Expansion Control	Brackets and panels shall allow thermal movement
Fire Rating Compliance	Shall not contribute to spread of fire – Class or better
Durability	Minimum 10 years of external exposure resistance

Water Resistance	Joints sealed with compatible silicone or EPDM gasket

6. Compliance & Approvals

- Product must comply with relevant ASTM, EN, or IS standards
- Hunter Douglas or equivalent product must be certified for durability and weather resistance
- All materials and accessories to be approved by the Engineer prior to installation

7. Finish & Color

- Exposed aluminium surfaces to be finished in white polyester powder coating
- Coating thickness: Minimum 60 microns
- Gloss level: Matt/Satin finish as approved by the Engineer

2.10. TECHNICAL SPECIFICATION FOR MOVABLE CRICKET SIGHT SCREEN

1. General Description

This specification outlines the technical requirements for the supply, fabrication, and installation of **Movable Cricket Sight Screens** for use in professional cricket grounds. The sight screen shall be of robust construction, weather-resistant, and designed for easy mobility. It must ensure optimal

visibility for players by providing a visually consistent background, aiding in ball tracking under varied lighting and environmental conditions.

2. Dimensions and Configuration

Overall Size:

40' Length X 20' High (From Ground Level)

Base Frame Size:

10ft x 40ft GI Pipe structure of 75mm Dia & 4mm Thickness.

3. Panel Construction

- **Material:**

- Panels shall be constructed from unbreakable **GI sheets**.

- **Design:**

- Each panel must be **perforated** to allow air passage and reduce wind load, thereby increasing stability during outdoor use.

- **Surface Finish:**

- Panels shall be laminated on both sides with **weatherproof vinyl film**.
- **Color Coding:** One side shall be coated in **black vinyl**, and the other in **white vinyl** to accommodate different match ball types.
- The vinyl finish must be **durable, UV-resistant**, and provide a **smooth, maintenance-free surface**.

4. Supporting Structure

- **Base Frame:**

- Fabricated from **heavy-duty GI pipes** structures.

- **Structural Integrity:**

- The frame must be designed to support the panel load evenly and remain stable under typical ground and weather conditions.

5. Surface Coating

- All metal components, excluding the vinyl-clad panels, shall be **finished with automotive-grade paint**.
 - The paint used must be corrosion-resistant and suitable for prolonged outdoor exposure.

VOLUME 5

PART II

TECHNICAL SPECIFICATIONS

MEP WORKS

Design, Engineering and Procurement for
Construction of International Cricket stadium at Patna, Bihar,
INDIA on EPC basis

1 TECHNICAL SPECIFICATIONS

1.1 Sanitary Fixture & Fitting

1.1.1 Scope of Work

Work under this section shall consist of furnishing all labour as necessary and required to completely install all Sanitary Fixtures, Brass and Chromium plated fittings and accessories as required.

Without restricting to the generally of the foregoing the Sanitary Fixtures shall include all Sanitary Fixtures, C.P. fittings and Accessories etc. necessary and required for the Building.

Whether specifically mentioned or not all fixtures and appliances shall be provided with all fixing devices, nuts, bolts, screws, hangers as required.

Testing of all fixture and fittings as per relevant IS codes.

1.1.2 European Water Closet General

The item pertains for providing white or colour glazed vitreous chinaware European water closet with seat and cover of size and colour as specified in the schedule including fixing.

Material

European type water closet shall be washing down pattern unless otherwise specified. Water closet shall be vitreous china conforming to IS 2556 (Part-I & II). The closet shall be of one piece construction and shall have minimum two hole of 6.5 mm diameter for fixing closet to floor. Closet shall have an integral flushing rim of self draining type. Each water closet shall have an integral

Trap with either 'S' or 'P' outlet, and trap shall be uniform and smooth in order to enable an efficient flush. Plastic seat and cover shall be of black colour or as specified, they shall have conformity to IS2548 Part I & II.

Fixing

The water closet pan shall be placed in position. If the pan trap is damaged during handling or fixing, it shall be replaced by the contractor at his own cost. The pan, soil pipe shall be jointed in 1:1 Cement Mortar with hemp yarn caulked. The gap between

W.C. and floor shall be finished with white/matching cement and sand as directed. Seat and cover shall be fixed to the Pan by two corrosion resistance hinge with 65 mm shank and threaded to within 25 mm from of flange. Seat shall be fixed in level by providing the washers of rubber with non ferrous or stainless steel washer to bolt.

1.1.3 Indian Water Closet

General

The item pertains for providing white or colour glazed vitreous chinaware Indian 84 water closet of size and colour as specified in the schedule including fixing.

Material

EWC is of white or colour glazed vitreous China conforming IS 2556 Part III. Pan shall have flushing rim and be inlet of self draining type. It shall have weep hole at the following inlet to the Pan. The flushing inlet shall be in front unless otherwise specified. The inside of the bottom of the pan shall have sufficient slope from the front to the outlet and surface shall be uniform and smooth to enable easy and quick disposal while flushing. The exterior surface of the outlet below the flange shall be an unglazed surface which shall have groove at right angle to the axis of the outlet. In all the cases pan shall have be provided with 100 mm Glazed Vitreous China 'P' or 'S' trap with 50 mm water seal and 40 mm size vent harm

Fixing

The water closet pan shall be placed in position. The EWC shall be supported on brick masonry in CM 1:4 or as directed by the Engineer-in-charge. The pan shall be fixed slightly lower than the floor level. If the pan or trap is damaged during handling of fixing, it shall be replaced by the contractor at his own cost. The pan, trap and C.I. pipe shall be jointed in 1:1 Cement Mortar with hemp yarn caulked. The gap between W.C. and floor shall be finished with white/matching cement as directed.

1.1.4 Lavatory Basin General

The item pertains for providing colour or white glazed vitreous chinaware wash basin with or without pedestal of size and colour as specified in the schedule including fixing.

Material

Wash basins shall be of vitreous china conforming to IS : 2556(Part-IV) of flat back or angle back as specified shall be of one piece construction including combined over flow, basin shall be provided with single or double tap holes of size 28 mm square or 30 mm rounded. Each basin shall have circular waste hole, or 5 sq.cm slot type over flow. Pedestals for wash basin shall be exactly same glazing that of basin. Pedestal shall be capable of supporting the basin and completely recessed at the back to accommodate supply and waste pipes and fittings. The basin shall be supported on pan of C.I Cantilever brackets conforming to IS 775. Use of MS angle or Tee Section as bracket is not permitted.

Fixing

The wash basin shall be fixed in position. Basin shall be supported on a pair of C.I brackets which is embedded in cement concrete (1:2:4) block 100 x 75 x 150 mm. Oval shape or round shape wash basins are required to be fixed in RCC platform with stone tapping either fully sunk in stone top or flush with stone topping. The wall plaster on seat shall be cut to rest over the top edge of the basin so as not to leave any gap for water seepage through between wall plaster & skirting of basin. The gap between basin and wall shall be finished with white matching cement.

1.1.5 Urinal

General

The item pertains for providing colour or white glazed vitreous chinaware urinal in single or range (1, 2 & 3) and size as specified in the schedule with necessary fittings and appliances including fixing.

Material

Bowl Type with Flushing Rim: Urinal basin shall be flat back or corner wall type lipped in front. The vitreous china conforming to IS 2556 (Part VI). Urinal shall have and integral flushing rim and inlet or supply horn for connecting flush pipe. Flushing rim and inlet shall be of the self-draining type. at bottom of basin and outlet horn for connecting outlet shall be provided. The inside surface of the urinal shall be uniform and smooth throughout to ensure efficient flushing.

Bowl Type Flat Back without Flushing Rim: They shall be of vitreous china Conforming to IS: 2556 (Part-VI) constructed in one piece with providing slot or alternative fixing Arrangement at flat back and where the integral flushing rim is not provided, they shall be provided with ridges inside the bowl to divert towards the front line of the urinal.

Stall Urinals: The stall urinal and its screen shall be glazed fire clay conforming IS: 771(Part-III, Sec-2).

The inside surface of stall and screen shall be regular and smooth throughout to ensure efficient flushing.

CP Brass Flush Pipe: The flushing arrangement to urinals for single or in range shall be of CP brass with CP brass spreader of 15 mm dia conforming to IS: 407. The capacity of flush pipe for urinal in a range shall be as follows:

Nos. of urinals in range	Capacity of flush tank	Size of C.P. brass Flush pipe	
		Main	Distribution
One	5 litres	15mm	15mm
Two	10 litres	20 mm	15 mm
Three	10 litres	25 mm	15 mm

Fixing

Bowl Type Flat Back without Flushing Rim: Urinal shall be fixed in position by using raw plug, wooden plug, C.P screws etc. It shall be fixed at height of 65 cm from the standing level to the top of the lip of urinal or as directed by the Engineer-in- charge. Each urinal shall be connected with 32 mm size waste pipe which shall discharge into channel or a floor trap.

Stall Urinals: The stall urinal shall be flush with the finished floor level. The stall urinal shall be laid over a fine sand cushion on average 25 mm thickness. The gap between wall surface, finished floor level and urinals shall not be more than 3mm and filled with water proofing plastic compound.

CP Brass Flush Pipe: The flushing arrangement to urinal in single or range shall be of CP brass from 25 mm dia. to 15 mm dia. and CP brass spreader of 15 mm size to each urinal including the cost of CP brass elbows, tees, coupling, crosses, clamps, clips, union CP brass check nut and screws etc. CP brass

G.I. Pipes: Waste pipes may be exposed on wall or concealed in chase as directed by the Engineer-in-Charge. Specifications for waste pipes shall be same as given in Sub Section.

1.1.6 Flushing Cistern

General

The item pertains to provide white or colour glazed chinaware / PVC flushing cistern with all inside symphonic fitting including fixing.

Material

The flushing cistern shall be automatic or manually of rates high level or low level as specified for water closets and urinals. Cisterns shall be of cast iron, vitreous china, enamelled pressed steel conforming to IS 774 for Flushing Type and IS 2326 for Automatic flushing cistern and Plastic (IS 7231). Cistern shall be mosquito proof. All working parts shall be designed to operate smoothly and efficiently. the cistern shall have removable covers which shall fit closely on it and be screwed against top displacement where operating mechanism is attached to the cover. This may be made in two section, but the section supporting the mechanism shall be securely fitted or screwed to the body. The outlet fitting of the cistern shall be securely connected to the cistern. The nominal internal diameter of the cistern outlet shall not be less than 32 mm and 38 mm for high level and low level respectively. Length of outlet cistern shall be 37 +/- 2 mm. Ball valve shall be screwed type 15 mm in diameter and shall confirm of IS 1703. The flat shall be made of polyethylene as specified in IS 9762. A high level cistern is intended to operate with minimum height of 125 cm and a low level cistern with maximum height of 30 cm between the top of the pan and under side of the cistern. A G.I chain strong enough to sustain a sudden applied pull of 10 kg or a dead load of 50 kg without any apparent or permanent deformation of the chain rings shall be attached to the ring or hook of the level manually operated high level C.I cistern. In case of low level cistern handle shall be of CP brass. In case of Plastic cistern, operation of cistern shall be through Push Button at the top for dual system and beyond plastic handle. The discharge rate of the cistern as per IS 774 shall be 10 +/- .5 litres 6 second and 5 +/- .5 litres in 3 second for cistern capacity 10 ltrs. and 5 ltrs. respectively. Flush pipe shall be of class 'B' G.I pipe of 32 +/- mm diameter for high level. Polyethylene flush pipe shall be low density confirming to IS 3076

or high density confirming to IS 4984 or UPVC pipe confirming to IS 4965 of 40 mm outer diameter. Over flow pipe shall not be less than +/- 5mm 'B' diameter. It shall be of G.I valve with mosquito proof jalli of 1.25 mm dia.

Fixing

The chinaware flushing cistern shall be placed over a pair of C.I. brackets. C.P. brass flush pipe shall be fixed to cistern and W.C. pan using check nut, spun yarn, cement mortar etc. The cast iron flushing cistern shall be placed over a pair of C.I. or

G.I. or PVC flush pipe of specified diameter shall be fixed to cistern and W.C. pan by using check nut, white zinc, spun yarn, cement mortar etc. The PVC flushing cistern shall be placed or fixed as recommended by the manufacturer, PVC flush pipe of specified diameter shall be fixed to cistern and W.C. pan by using check nut, white zinc, spun yarn, cement

1.1.7 Stainless Steel Sinks

General

Item includes providing the stainless steel sink with or without drain board of size as specified in the schedule including fixing.

Material

The sink shall be manufactured from stainless steel of Salem or equivalent steel conforming to IS: 13983. Stainless steel sink shall be of one piece construction moulded out of 19 SWG (1mm) stainless steel sheet of grade AISI 304 (18/8) with stainless steel choke – stop strainer (waste coupling) check nuts conforming to IS 13983.

Fixing

The sink shall be fixed in position. The sink shall be placed over the brackets or on the platform. Gap between sink and platform / wall shall be finished.

1.1.8 Glazed Fire-Clay / Vitreous China Sink

General

Item includes providing white or colour glazed -fire clay sink for kitchen or vitreous china sink for lab as specified in the schedule of quantities including fixing.

Material

Laboratory sink shall be of vitreous china confirming to IS 2556 (PART-V) and kitchen sink shall be of glazed fire-clay conforming to IS 771 (Part-II) and shall have combined over flow of the weir type and invert shall be 30 mm below the top edge. These shall be of one piece construction and floor of sink shall gently slope towards the outlet. The outlet of sink should be suitable for waste fitting having flanges 88 mm diameter and waste hole of 65 mm diameter. The waste hole shall be either rebated or bevelled having the depth of 10 mm. C.I brackets for supporting sink shall confirm to IS: 775.

Fixing

The sink shall be supported on C.I cantilever brackets, embedded in cement concrete 1:2:4 block of size 100 x 75 x 150 mm. Bracket shall be fixed in the position before dado work is done. The height of front edge of sink from floor level shall be 80 cm or as directed by the Engineer-in-charge. The gap between floor/wall and sink shall finish with white cement.

1.1.9 Half Round Channel

General

The item pertains for providing colour or white glazed vitreous chinaware half round channel of size and colour as specified in the schedule including laying and fixing.

Material

The half round channel shall be of white or colour glazed vitreous chinaware of size as mentioned in the schedule with or without dead end and shall conform to IS 2556 part VII.

Fixing

The channel shall be laid to the correct alignment to required slope. It shall be fixed on 80 mm thick bed of 1:2:4 cement concrete. The channel shall be used in standard length. Pieces are not allowed except where it is necessary to make up exact length.

1.1.10 Glass Mirror

General

The item providing bevelled or plain edges mirror with or without frame of size as mentioned in the schedule including fixing.

Material

The mirror shall be of superior sheet glass with edges rounded off or beveled, size 600 x 450 mm unless specified in the schedule. It shall be free from flaws, specks or bubbles and thickness plated and should not be less than 5.0 mm. The back of mirror shall be uniformly silver plated and should be free from silvering defects. Silvering shall now have a protective uniform covering of red lid paint, where beveled edge mirror are not available. Fancy looking mirrors with PVC beading/border or aluminum beading on stainless steel beading/border based on manufacturer's specification, provided nothing extra shall be paid on this account. The backing of mirror shall be provided with 6mm thick marine plywood or environmentally friendly material other than asbestos cement sheet.

Fixing

Mirror shall be fixed in position with 6mm thick marine ply wood backing. It shall be fixed by means of 4 nos. of CP brass screws & caps over rubber washers and rawl plug or as per the manufacturer's specification unless specified otherwise the longer side shall be fixed horizontally.

1.1.11 Shower Rose & CP Fittings

General

The item pertains to provide chromium plated brass shower rose of specified diameter with accessories including fixing.

Material

The shower rose & CP fittings shall be CP brass of approved and heavy quality. Its accessories shall conform to IS 1239 Part II.

Fixing

Shower rose & CP Fittings shall be fixed to be water supply pipe line with necessary G.I fittings etc. as required by the Engineer-in-charge. Jointing shall be done with the zinc, spun yarn etc. A few turns of fine hemp yarn dipped in linseed oil shall be taken over the threaded ends to obtain complete water tightness. Leaky joint shall be remade to make it leak proof at his risk & cost.

1.1.12 Accessories

Accessories shall be of any of the following types:

- Towel rails
Towel rail shall be C.P brass of size 610mm long and 20mm dia., and fixing with C.P brass brackets fixed to wooden cleats with C.P. brass screws.
- Towel rings
Towel rail shall be C.P brass of size 150mm dia, and fixing with C.P brass brackets fixed to wooden cleats with C.P. brass screws.
- Toilet paper holder
Toilet paper holder shall be of Satin finish stainless steel AISI 316 grade wall mounted type fixed to wooden cleats with C.P. brass screws.
- Hand Dryer
Hand dryer shall be of best quality, to be operated with 230 volts, single phase, with fully hygienic condition, with all accessories and fixing in the wall or as directed by Engineer-in-Charge.

- Coat hooks
Coat hooks shall be of satin finish stainless steel AISI 316 grade wall mounted coat hooks fixed to wooden cleats with C.P. brass screws or as directed by Engineer-in-Charge.
- Soap dispensers
Soap dispensers shall be of satin finish stainless steel AISI 316 grade wall mounted liquid soap dispenser with indicator having bottom trough of soap fixed to wooden cleats with C.P. brass screws or as directed by Engineer-in-Charge.
- Soap dispensers
Soap dispensers shall be of satin finish stainless steel AISI 316 grade wall mounted liquid soap dispenser with indicator having bottom trough of soap fixed to wooden cleats with C.P. brass screws or as directed by Engineer-in-Charge.
Accessories shall be fixed with stainless steel half round head screws and cup washers in wall with rawl plugs or nylon sleeves and shall include cutting and making good.
Porcelain accessories shall be fixed in walls and set in cement mortar 1:2 (1 cement : 2 coarse sand) and fixed in relation to the tiling work. The flange of the recessed fixture shall cover the recess in the wall fully.
Contractor shall install all Chromium Plated and porcelain accessories.
All C.P. Accessories shall be fixed with C.P. brass half round head screws and cup washers in wall with rawl plugs or nylon sleeves and shall include cutting and making good as required or directed by Engineer-in-Charge.
Porcelain accessories shall be fixed in walls and set in cement mortar 1:2 (1 cement: 2 coarse sand) and fixed in relation to the tiling work.

1.1.13 Urinal Partitions

Urinal partitions shall be white glazed vitreous china or 25mm/40 mm thick marble of size of 690x325mm.
Porcelain partitions shall be fixed at proper heights with C.P. brass bolts, anchor fasteners and M.S. clips as recommended by the manufacturer and directed by Engineer-in-Charge.

1.1.14 Toilet for The Disabled

Where specified, in washroom facilities designed to accommodate physically disabled , accessories shall be provided as per the NBC Norms for Disable Persons. Stainless steel grab bars of 600mm long suitable for expose mounting and penned non-slip gripping surface shall be provided in washroom for disabled persons. The flushing cistern shall be provided with chromium plated long handles.

1.1.15 Testing and Acceptance

Testing is done as per BS-5572

1.2 Internal Drainage Soil, Waste & Vent Pipes

1.2.1 Scope of Work

Work under this section shall consist of furnishing all labour, materials, equipments and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes. Without restricting to the generally of the foregoing, the soil, waste, vent and rainwater pipes system shall include the followings:-

- Vertical and horizontal Soil, Waste and Vent Pipes, Rainwater Pipes and Fittings, Joints Clamps and connections to Fixtures.
- Connection of pipes to Gully Traps & Manholes etc.
- Floor and urinal traps, cleanout plugs, inlet fittings and rainwater heads as specified.
- Waste pipes connections from all Fixtures e.g. wash basins, sinks, urinals and kitchen equipments.

- Testing of all pipes.

1.2.2 General Requirements

All materials shall be new and of the best quality conforming to specifications and subject to the approval of Engineer-in-Charge.

Soil, waste and vent pipes in shafts, ducts and in concealed areas i.e. (false ceiling) shall consist of hub less centrifugally cast (Span) iron pipes epoxy coated in sides and outside as per IS code 15905 with SS 304 grade coupling with EPDM rubber gasket & fittings (for Soil, waste, anti-siphon age pipes)

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

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

Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified. Pipes shall as far as possible be kept 50mm clear of wall.

Access doors for fittings and cleanouts shall be so located that they are easily accessible for repair and maintenance.

Every waste pipes shall discharge above the grating of properly trapped gully. Contractor will ensure that this requirement is adequately met with. Wherever floor traps are provided it shall be ensured that at-least one washbasin/washing trough is connected to such floor traps to avoid drying of water seal in the trap.

All traps on branch soil and waste pipes shall also be ventilated at a point not less than 75mm or more than 300mm from their highest part and on the side nearest to the soil pipe or waste pipe.

All works shall be executed as directed by Engineer-in-Charge.

1.2.3 Soil, Waste & Vent Pipes

- The Soil & Waste pipe system above ground has been planned as a "two pipe system" as defined in IS: 5329, having separate pipes for waste from kitchen sinks, showers, washbasins, AHU's condensate drains and floor drains . Waste stacks have been provided with a "P" trap at basement ceiling.
- All waste water from AHU's, A.C. plant and pump rooms, floor channels in basements will be provided with a deep seal trap before connecting to the main drain or vertical stack.
- Vertical soil & waste stacks shall be connected to a common horizontal drain pipe at basement ceiling or to an external manhole directly wherever feasible.
- All soil and waste from areas below general ground level (Basements) will be collected in sumps and pumped into sewer lines.
- Anti-siphon age pipe (ASP) shall be provided for soil fittings on vertical stacks. It may also be provided for waste lines.
- Vent pipes shall be provided at all sewer lines at the starting manholes.

1.2.4 Rainwater Pipes

- All terraces shall be drained by providing down-takes rainwater pipes.
- A separate piped drainage system for slopping roof with ladders shall be provided.

- c) Rainwater pipes are separate and independent connected to the external storm water drainage system.
- d) Rainwater in enclosed courtyards shall be collected in catch-basins and connected to storm water drains.
- e) Any dry weather flow from waste appliances, AHU's pump rooms, shall be connected to the sewerage system only.

1.2.5 Balcony / Planter drainage

Open balconies, terraces, planters and formal landscape areas will be drained by a separate pipe connected to external storm water drainage system.

1.2.6 C.I pipe for Soil & Waste

Soil, waste, vent and anti-siphon age pipes, fittings and accessories shall be cast iron pipes. All pipes shall be straight and smooth and their inside free from irregular bore, blow holes, cracks and other manufacturing defects. Pipes shall be centrifugally cast (spun) iron hub less soil pipes conforming to IS: 15905-2011.

1.2.7 Standard weight, dimensions and pig lead required for joints

For pipes conforming to IS: 15905-2011 (centrifugally spun soil hub less pipes)

Nominal Size	Diameter	Pipe Thickness Nominal	Pipe Thickness Minimum	Fittings Thickness Nominal	Fittings Thickness Minimum
In	mm	mm	mm	mm	mm
2	50	3.5	3.0	4.2	3.0
3	75	3.5	3.0	4.2	3.0
4	100	3.5	3.0	4.2	3.0
5.	150	4.0	3.5	5.3	3.5

1.2.8 Tolerance

Acceptable tolerance for pipes to IS: 15905-2011 shall be as follows:

Nominal Size	Diameter	External Diameter, DE	Tolerance on External diameter DE
In	mm	mm	mm
2	50	58	+2 -1
3	75	83	+2 -1
4	100	110	+2 -2

5.	150	160	+2 -2

1.2.9 Fittings

Fittings shall conform to the same Indian Standard as for pipes. Contractor shall use pipes and fittings of matching specifications.

Fittings shall be of the required degree of curvature with or without access door or as directed.

Access door shall be made up with 3mm thick insertion rubber washer and white lead. The bolts shall be lubricated with grease or white lead for easy removal later. The fixing shall be air and water tight fitting shall be SS 304 coupling as per manufacture with EPDM gaskets.

1.2.10 Fixing

All vertical pipes shall be fixed by MS clamps truly vertical. Branch pipes shall be connected to the stack at the same angle as that of the fittings. No collars shall be used on vertical stacks. Each stack shall be terminated at top with a cowl (terminal guard).

Horizontal pipes running along ceiling shall be fixed on structural adjustable clamps of special design or as directed. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully rest on them.

Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the building Contractor for making such provisions in the structure as necessary. All damages shall be made good by the Contractor at his own cost to restore the surfaces.

1.2.11 Clamps

Holder bat clamps shall be of standard design fabricated from MS flats 40x3mm thick and 12mm dia. MS rod and 6mm nuts and bolts; painted with two coats of black bitumen paint before fixing. The clamps shall be fixed in cement concrete 1:2:4 mix (1 cement : 2 sand : 4 stone aggregate 20mm nominal size) blocks 100x100x100mm deep.

Where holder bat clamps are to be fixed in RCC column or slotted angles, walls or beam they shall be fixed with 40x3mm flat iron "U" type clamps with anchor fasteners of approved design.

Structural clamps shall be fabricated from MS structural members e.g. rods, angles, channels, flats or as directed. Contractor shall provide all nuts, bolts, welding material and paint the clamps with one coat of red oxide and two or more coats of black enamel paint to give an even shade.

Wherever MS clamps are required to be anchored directly to brick walls, concrete slabs, beams or columns, nothing extra shall be payable for clamping arrangement, RCC block and making good with cement concrete 1:2:4 mix (1 cement : 2 sand : 4 stone aggregate 20mm nominal size) as directed by the Architect/Consultants.

1.2.12 uPVC pipes for rain water system Pipes

- All pipes shall be straight and smooth and inside free from cracks and other manufacturing defects. Pipes shall be conforming to I.S. 4985 class 3(6kg/cm²) for rain water.

- Pipes shall be joined by approved type of socket and ‘O’ rubber ring (confirms to I.S. 5382) joints with rubber lubricant.

Fittings

- Fittings shall conform to the Indian Standard recommended for the pipes. Pipes and fittings must be of matching I.S. Specification. Interchange of pipes of one standard with fittings on the other standard will not be permitted.
- Fittings shall be of the required degree of curvature with or without access door.
- Connection from a vertical stack or position to a horizontal line shall be made only by a “Y” junction.

Fixing

- All vertical pipes shall be fixed truly vertical to walls with approved type of uPVC saddle clamp. Branch pipes shall be connected to the stack at the same angle as that of the fittings. No collars shall be used on vertical stacks. Each stack shall be terminated at top with a cowl (terminal guard). However in shaft where more vertical pipes run, the pipes may be fixed to the slotted angle/channel supports fixed to walls at intervals specified here under:-
 - Horizontal pipes running along ceiling shall be fixed on **galvanized structural adjustable clamps** (Clevis clamps) of special design or as directed. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully rest on them.
 - Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the Engineer-in-charge for making such provisions in the structure as necessary. All damages shall be made good to restore the surfaces at no extra cost.

Clamps

- Holder bat clamps shall be of standard design and fabricated from **galvanized M.S. standard flats** 40x3 mm thick and 12 mm dia. M.S. Rod and 6 mm nuts and bolts. Holder bat clamps shall be fixed in cement concrete 1:2:4 mix blocks 10x10x10 cms deep.
- Where holder bat clamps are to be fixed in RCC column or slotted angles, walls or beam they shall be fixed with **galvanized** 40x3 mm flat iron "U" type clamps with anchor fasteners of approved design or 6 mm nuts and bolts.
- Structural clamps shall be fabricated by electro-welding from M.S. structural members e.g. rods, angles, channels flats. Contractor shall provide all nuts & bolts, welding material. All fabricated clamps, nuts, bolts and washers shall be not dipped galvanized.
- Galvanized slotted angle/channel supports on walls shall be provided wherever shown on drawings. Angles/channels shall be of sizes as required. Angles/channels shall be fixed to brick walls with bolts embedded in cement concrete blocks and to RCC walls with suitable anchor fasteners. The spacing of support bolts horizontally shall not exceed 1 m.
- Wherever M.S. clamps are required to be anchored directly to brick walls, concrete slabs, beams or columns, nothing extra shall be payable for clamping arrangement and making good with cement concrete 1:2:4 mix (1 cement :2 coarse sand :4 mm stone aggregate 20 mm nominal size) as directed by the Engineer-in-Charge.
- For sleeves, anchor fasteners and clamp spacing chart shall be as follows:

Clamp and Pipe Support Spacing

		<----- Commercial Pipe Dia.(Spacing in m) ----->						
S.No.	Type of Pipes & Position	15/20	20/25	32/40	50	75/80	100/110	150/160
1	Vertical Pipes							

1.1	GI /MS Pipes	2.4	2.4	3	3.6	4.5	5.4
1.2	uPVC Pipes						
	Soil & Waste CI Pipes	x	x	<----- 1 m----->			
1.3	uPVC /cPVC Pipes						
	IS 4985 for Water Supply	x	x	x	<----- 1 m----->		
	IS 13585 for SWR	x	x				
2	Horizontal Pipes						
2.1	GI /MS Pipes	<-----2.0 m----->					
2.2	uPVC pipes			<----- 1.0 m----->			
	Soil & Waste Pipes						
	IS						
	Water Supply Pipes uPVC						
	IS 4985						
2.3	Fittings						
supported on both sides		All traps and tees and fittings running below ceiling shall be					

1.2.13 Traps

Floor traps

Floor traps shall be siphon type full bore P or S type cast iron having a minimum 50 mm deep seal. The trap and main waste pipes in toilets having 150 mm sinking shall run below slab and shall be supported from the ceiling below. The trap and waste pipes in sunken area (where required) shall be set in cement concrete blocks firmly supported on the structural floor. The blocks shall be in 1 : 2 : 4 mix (1 cement :2 coarse sand :4 stone aggregate 20 mm nominal size) and extended to 40 mm below finished floor level. Contractor shall provide all necessary shuttering and centering for the blocks. Size of the block shall be 30x30 cms of the required depth.

Urinal traps

Urinal traps/horn shall be cast iron P or S traps with or without vent shall be fixed as specified for floor traps.

Floor trap inlet

Bath room traps and connections shall ensure free and silent flow of discharging water. Where specified, Contractor shall provide a special type inlet fitting of CI hubless pipe without, with one, two or three inlet sockets fixed on side to connect the waste pipe. Joint between waste and hopper inlet socket of the trap shall be joined with SS 304 grade coupling with EPDM rubber gasket recommended by the manufacturer. Inlet shall be connected to a CI. P or S trap. Floor trap inlet hoppers and the traps if set in cement concrete blocks as specified in para above without extra charge. CI multi-inlet trap can be used where ever possible to be decided by the Engineer-in-Charge.

Trap & Seals

All traps shall be self cleaning design and the seal depth shall be as specified below wherever the traps are not integral with the appliances:

Appliance or ware	Material	Trap Type	Seal depth(mm)
Lavatory /wash basin	C.P. cast brass	32 mm dia Bottle	75 mm
Sink	C.P. cast brass	40 mm dia Bottle	75 mm
Kitchen floor drain of fabricated drain boxes	C.I.	75/100 mm dia 'P' or 'S'	50 mm

Urinals	C.I.	100 mm dia 'P' or 'S'	50 mm
AHU's	C.I.	75 mm dia 'P' or 'S'	50 mm

Floor Gratings

Floor and urinal traps shall be provided with 100-150mm square or round C.P./ Stainless steel grating, with rim of approved design and shape. Minimum thickness shall be 4 mm.

1.2.14 Cleanout Plugs (On Soil Pipes)

Clean out pipe for Soil, Waste or Rainwater pipes laid under floors shall be provided near pipe junctions bends, tees, "Ys" and on straight runs at such intervals as required as per site conditions. Cleanout pipe shall terminate flush with the floor levels.

Cleanout on Drainage Pipes

Cleanout pipe shall be provided on starting point of each drain and in between at locations indicated on plans or directed by the Engineer-in-Charge. Cleanout pipe shall be of size matching the full bore of the pipe but not exceeding 150 mm.

Cleanouts at ceiling level pipe shall be provided with a bend terminating at floor level above. The cap of the cleanout pipe shall have a cap flush with floor.

1.2.15 Waste pipe from appliances General

- a) Waste pipe from appliances e.g. wash basins, sinks and urinals shall be of uPVC pipes 32, 40 mm confirming to IS 4985 class 3 (6kg/cm²) and 50 mm pipe shall be of CI Hubless conforming to IS:15905.
- b) All pipes shall be fixed in gradient towards the outfalls of drains. Pipes inside a toilet room shall be in chase or as directed. Where required pipes may be run at ceiling level in suitable gradient and supported on galvanized structural clamps. Spacing for clamps for such pipes shall be as per the pipe spacing chart given in section 1.

Encasing Pipe in Cement Concrete

C.I (Cast iron) soil and waste pipes and drainage under floor in sunken slabs and in wall chases (when cut specially for the pipe) shall be encased in cement concrete 1:2:4 mix (1 cement :2 coarse sand : 4 stone aggregate 12 mm size) 75 mm in bed and all-round. When pipes are running well above the structural slab, the encased pipes shall be supported with suitable cement concrete pillars of required height at intervals of one meter.

Testing

Testing procedure specified below apply to all soil, waste and vent pipes above ground including pipes laid along basement ceiling.

Entire drainage system shall be tested for water tightness during and after completion of the installation. No portion of the system shall remain untested. Contractor must have adequate number of expandable rubber/bellow plugs, manometers, smoke testing machines, pipe and fitting work test benches and any other equipment necessary and required to conduct the tests. All testing equipment/motors etc. shall be certified for its calibration by an approved laboratory.

All materials obtained and used on site must have manufacturer's Hydraulic Test Certificate for each batch of materials used on the site.

Testing Soil, Waste and Rainwater Pipes

Apart from factory test all pipes and fittings shall be hydraulically tested for a head of 3 m preferably on a specially set up work bench. After applying pressure, strike the pipe with a wooden pallet and inspect for blow holes and cracks. Pressure may be applied for about 2 minutes. Reject and remove all defective pipes.

After installation all connections from fixtures, vertical stacks and horizontal drains including pipes along ceiling shall be tested to a hydraulic pressure not exceeding 3

m. Such tests shall be conducted for each floor separately by suitable plugs.

After the installation is fully complete, it should be tested by flushing the toilets, running at least 20% of all taps simultaneously and ensuring that the entire system is self draining, has no leakages, blockages etc. Rectify and

replace where required.

Contractor shall maintain a test register identifying date and time of each area. All tests shall be conducted in presence of Engineer-in-Charge and signed by both.

1.3 Excavation for Pipe Line

1.3.1 Excavation

The excavation for pipe works shall be open cutting unless the permission of the Engineer-in-Charge for the ground to be tunnelled is obtained in writing. Where sewers have to be constructed along narrow passages, the Engineer-in-Charge may order the excavation to be made partly in tunnel and in such cases the excavated soil shall be brought back later on for refilling the trenches or tunnel.

1.3.2 Opening out Trenches

In excavation of trenches, etc. the solid road metal ling, pavement, curbing etc. and turf is to be placed on one side and preserved for reinstatement when the trenches or other excavation shall be filled up. Before any road metal is replaced, it shall be carefully shifted. The surface of all trenches and holes shall be restored and maintained to the satisfaction of the Engineer-in-Charge and of the Owners of the roads or other property traversed and the Contractor shall not cut out or break down any live fence of trees in the line of the proposed works but shall tunnel under them, unless the Engineer-in-Charge shall order to the contrary.

The Contractor shall grub up and clear the surface over the trenches and other excavations of all trees, stumps roots and all other encumbrances affecting execution of the work and shall remove them from the site to the approval of the Engineer-in-Charge.

1.3.3 Obstruction of Roads

The Contractor shall not occupy or obstruct by his operation more than one half of the width of any road or street and sufficient space shall then be left for public and private transit, he shall remove the materials excavated and bring them back again when the trench is required to be refilled. The Contractor shall obtain the consent of the Engineer-in-Charge in writing before closing any road to vehicular traffic and the foot walks must be clear at all times.

1.3.4 Removal of Filth

All night soil, filth or any other offensive matter met with during the execution of the works, immediately after it is taken out of any trench, sewer or cess pool, shall not be deposited on to the surface of any street or where it is likely to be a nuisance or passed into any sewer or drain but shall be at once put into the carts and removed to a suitable place to be provided by the Contractor.

1.3.5 Excavation to be taken to Proper Depths

The trenches shall be excavated to such a depth that the pipes shall rest on concrete or on firm bedding as described in the several clauses relating to these so that the inverts may be at the levels given in the sections. In bad ground, the Engineer-in-Charge may order the Contractor to excavate to a greater depth than required and to fill up the excavation to the level of the sewers with concrete, broken stone, gravel or other materials. For such extra excavation and concrete, broken stone, gravel or other materials, the Contractor shall be paid extra at rates laid down for such works in the schedule, if the extra work was ordered by the Engineer-in-Charge in writing, but if the Contractor should excavate the trench to a greater depth than is required without a specific order to that effect in writing of the Engineer-in-Charge the extra depth shall have to be filled up with concrete 1:5:10 mix (1 cement: 5 fine sand: 10 stone aggregate 40mm nominal size) at the Contractor's own costs and charges to the requirements

and satisfactions of the Engineer-in-Charge.

1.3.6 Refilling

After the pipes or other work has been laid and proved to be water tight, the trench or other excavations shall be refilled. Utmost care shall be taken in doing this, so that no damage shall be caused to the sewer and other permanent work. The filling in the haunches and upto 75 cms above the crown of the sewer shall consist of the finest selected materials placed carefully in 15 cms layers and flooded and consolidated. After this has been laid, the trench and other excavation shall be refilled carefully in 15 cms layers with materials taken from the excavation, each layer being watered to assist in the consolidation unless the Engineer-in-Charge shall otherwise direct.

1.3.7 Contractor to Restore Settlement and Damages

The Contractor shall, at his own costs and charges, make good promptly during the whole period the works are in hand, any settlement that may occur in the surfaces of roads, beams, footpaths, gardens, open spaces etc. Whether public or private caused by his trenches or by his other excavations and he shall be liable for any accidents caused thereby. He shall also, at his own expenses and charges, repair and make good and damage done to buildings and other property. If in the opinion of the Engineer-in-Charge, he fails to make good such works with all practicable dispatch, the Engineer-in-Charge shall be at liberty to get the work done by the Contractor or deduct from any money that may be or become due to him or recovered from him in any other manner according to the law of the land.

1.3.8 Disposal of Surplus Soil

The Contractor shall at his own costs and charges provide places for disposal of all surplus materials not required to be used on the works. As each trench is refilled the surplus soil shall be immediately removed, the surface properly restored and roadways and sides left clear.

1.3.9 Timbering of Sewer and Trenches

The Contractor shall at all times support efficiently and effectively the sides of the sewer trenches and other excavations by suitable timbering, piling and sheeting and they shall be close, timbered in loose or sandy strata and below the surface of the sub soil water level.

All timbering, sheeting and piling with their waling and supports shall be of adequate dimensions and strength and fully braced and strutted so that no risk of collapse or subsidence of the walls of the trench shall take place. The Contractor shall be held responsible and will be accountable for the sufficiency of all timbering, branches, sheeting and piling used as also for all damage to persons and property resulting from improper quality, strength, placing, maintaining or removing of the same.

1.3.10 Shoring of Buildings

The Contractor shall shore up all buildings, walls and other structures, the stability of which is liable to be endangered by the execution of the work and shall be fully responsible for all damages to persons or property resulting from any accident.

1.3.11 Removal of Water from Sewer, Trench etc.

The Contractor shall at all times during the progress of the work keep the trenches and excavations free from water which shall be disposed off by him in a manner as will neither cause injury to the public health nor to the public or private property, nor to the work completed or in progress, nor to the surface of any roads or streets, nor cause any interference with the use of the same by the public.

1.3.12 Width and Depth of Trench

The Engineer-in-Charge shall have power by giving an order in writing to the Contractor to increase the maximum width in respect of which payment will be allowed for excavation in trenches for various classes of sewer, manholes, and other works in certain lengths to be specifically laid down by him, where on account of bad ground or other unusual conditions, he considers that such increased widths are necessary in view of the site conditions.

1.4 Water Supply System (Cold & Hot)

1.4.1 Scope of Work

Work under this section consists of furnishing all labour, materials equipment and appliances necessary and required to completely install the water supply system as required & specified hereinafter.

Without restricting to the generality of the foregoing, the water supply system shall include the following:-

- a) Municipal water connection including water meter up to U.G. water tanks.
- b) Piping from tube well to raw water tank
- c) Over Head Tank filling mains from hydro pneumatic system.
- d) Distribution system from overhead tank to toilets and other wet area in the building except upper three floors.
- e) Distribution mains from hydro pneumatic system to all fixtures and appliances for upper three floors to all buildings.
- f) Excavation and refilling of pipes trenches.
- g) Control valves, masonry chambers and other appurtenances.

- All water lines to different parts of building and making connection from source etc.
- Pipe protection and painting.
- Providing Hot water supply and return lines and insulation of hot water pipe lines.
- Control valves, masonry chambers and other appurtenances.
- Connections to all toilets kitchen equipments, tanks and appliances.
- Excavation and refilling of pipe trenches, wherever necessary.
- Trenches for taking pipe lines for these services if required.

1.4.2 General Requirements

All materials shall be new and of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Engineer-in-Charge.

Pipes and Fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner. Short or Long bends shall be used on all main pipe lines as far as possible. Use of elbows shall be restricted for short connections.

As far as possible all bends shall be formed by means of a hydraulic pipe bending machine for pipes up to 65mm dia.

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

Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.

As far as possible, all piping inside the buildings shall run either concealed or embedded. Outside the buildings the piping shall be installed at-least 60cms below finished grade. All galvanized steel piping embedded either in trenches or in concrete and masonry work shall be tightly wrapped in 1mm thick fibreglass tissue laid in bitumen. Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance

and repairs.

Water Supply System

Contractor should study the site plan and water supply system diagram for an overview of the system.

Source

- a) Water supply shall be obtained from Municipal water mains through a service connection
- b) Additional water supply shall be obtained from captive tube-wells within the site. The rising mains will be connected to the main fire static tank and then overflow into the main domestic water tank.

Water supply piping for garden hydrant and sprinkler and irrigation system will be separate and independently connected to a different pumping system.

1.4.3 G.I. Pipes & Fittings

All exposed pipes inside the building and pipes running in Shaft & terrace level shall be galvanized steel tubes conforming to IS: 1239-2004 of class specified. When class is not specified it shall be heavy class GI Pipe.

Fittings shall be malleable iron galvanized fittings, of approved make. All fittings shall have manufacturer's trade mark stamped on it. Fittings for G.I. pipes shall include Couplings, Bends, Tees, Reducers, Nipples, Unions and Bushes. Fittings shall be of IS:1879 - (part I to X) 2010.

Pipes and fittings shall be jointed with threaded fittings. Care shall be taken to remove burr from the end of the pipe after cutting by a round file. All pipes shall be fixed in accordance with layout and alignment. Care shall be taken to avoid air pockets. G.I. pipes inside toilets shall be fixed in wall chases well above the floor. No pipes shall be run inside a sunken floor as far as possible. Pipes may be run under the ceiling or floors or as directed.

1.4.4 316 L Stainless Steel Pipes & Fittings for RO water supply

Stainless steel pipes conforming to EN 10312 standard complete with press type fittings for Hot and cold water supply, RO water supply system capable to withstand temperature upto 110⁰ centigrade and pressure upto 16 bars made from 316 L grade-Material no. 1.4404 (X2CrNiMo17-12-2) of annealed and pickled stainless steel sheet, with ends deburred at 90⁰ and with length of 3 meters. Pipe qualifying to 100% eddy current, 100% hydrostatic tested and air-under water tested under 10kgs. Fittings also conforming to EN 10312 standard in 316 L stainless steel grade in accordance with DVGW regulation such as tees, coupling, elbow, male adapter, connectors etc. with Black grooved O-ring of EPDM material which can withstand temperature upto -20⁰ to 110⁰ C including suitable connection as per site requirement. Direct contact of stainless steel pipes and fittings to galvanized iron should be avoided by inserting approved type of filler material as per project manager's /consultant requirement. Flanges, clamps with hanger at spacing of 2 m centre to centre min or as required etc.

1.4.5 Clamps

Pipes in shafts and other locations shall be supported by galvanized clamps of design approved by Engineer-in-Charge. Pipe in wall chases shall be anchored by iron hooks. Pipes at ceiling level shall be supported on structural clamps fabricated from galvanized structural as described in the sub section. Pipes in typical shafts shall be supported on Slotted Angles/Channels as specified elsewhere.

Pipe hangers shall be provided at the following maximum spacing:

S. No.	Pipe Dia. (mm)	Hanger Rod Dia. (mm)	Spacing between Supports (mtr)
1	Upto 25	6	2

2	32 to 50	10	2
3	65 to 100	12	2.4
4	125 to 150	16	3.6
5	200 to 300	19	5.3

1.4.6 Unions

Contractor shall provide adequate number of unions on all pipes to enable dismantling later. Unions shall be provided near each Gunmetal Valve, Stop Cocks, or Check Valves and on straight runs as necessary at appropriate locations as required and/or directed by Engineer-in-Charge.

1.4.7 Flanges

Flanged connections shall be provided on pipes where required, all equipment connections as necessary and required or as directed by Engineer-in-Charge. Connections shall be made by the correct number and size of the bolts and made with 3 mm thick insertion rubber washer. Where hot water or steam connections are made insertion gasket shall be of suitable high temperature grade and quality approved by Engineer-in-Charge. Bolt hole dia. for flanges shall conform to match the specification for C.I. Sluice Valve to I.S. 780.

1.4.8 Trenches

The galvanized iron pipes and fittings shall be laid in trenches. The width and depth of the trenches for the different diameters of the pipes shall be as follows:

Dia. of Pipe	Width of Trench	Depth of Trench
15mm to 50mm	30 cms	60 cms
65mm to 100mm	45 cms	75 cms

At joints the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with general specifications for earth work in trenches.

When excavation is done in rock, it shall be cut deep enough to permit the pipes to be laid on a cushion of sand minimum 7.5 cm deep.

1.4.9 Painting

All pipes above ground shall be painted with one coat of Red Lead and two coats of Synthetic Enamel paint of approved shade and quality. Pipes shall be painted to standard colour code specified by Engineer-in-Charge.

All pipes in chases and below floor shall be provided with Anti-corrosive treatment.

1.4.10 Pipe protection

Where ever required all pipes below ground shall be protected against corrosion by wrapping 100mm wide and 4mm thick layer of PYPKOTE/MAKPOLYKOTE over the pipe.

1.4.11 Sand Filling

All G. I. pipes in trenches shall be protected with fine sand 150 mm all around before filling in the trenches.

1.4.12 Gunmetal Valves

Valves 65mm dia. and below shall be heavy Gunmetal Full way Valves or Globe Valves or Ball valves conforming to IS: 778-1984 of 20 Kg/cm² class. Valves shall be tested at manufacturer's works and the same stamped on it.

All Valves shall be approved by the Engineer-in-Charge before they are allowed to be used on work.

1.4.13 Sluice Valves

All valves 80mm dia. and above shall be C.I. Double Flanged Sluice Valves. Sluice valves shall be Cast Iron double flanged, with rising spindle. Each sluice valve shall be provided with wheel for valves in exposed positions and Cap Top for underground valves. Contractor shall provide suitable operating keys for Sluice Valves with Cap Tops.

Sluice valves shall be of best quality conforming to IS: 780-1984 of class specified.

- Joints for double flanged sluice valves shall be made with suitable Tail/socket pieces on the pipeline and flanges joints made with 3 mm thick insertion rubber gasket with appropriate number of bolts, nuts and washers.
- Sluice valves shall be installed at all branches.

1.4.14 Scour Valves

Scour valves shall be C.I. sluice valves as specified above. They shall be installed at the lowest level or tail end of the system or as directed by Engineer-in-Charge.

1.4.15 Air Release Valves

- Air release valves shall be single acting type air valves with Gunmetal body and bronze/gunmetal internal parts and plastic float.
- Each air release valve shall be provided with a cast iron isolating sluice valve of specification given above.

1.4.16 Insulation

For Chased Internal Pipes

Hot water pipes fixed in chase shall be thermally insulated over hot water pipes with 9mm thick nitrile or approved equivalent thermal insulation tubing, a elastomeric flexible material having hermetic blister closed cell structure of expanded synthetic rubber having a thermal conductivity not exceeding 0.040w/m²k @ 40deg C over pipes.

For Exposed Piping

Exposed hot water line laid in trenches, exposed in shafts, on terrace and along ceiling level shall be thermally insulated over hot water pipes with 9mm thick nitrile/ polyolefin or approved equivalent thermal insulation tubing, a elastomeric flexible material having hermetic blister closed cell structure of expanded synthetic rubber having a thermal conductivity not exceeding 0.040w/m²k @ 40 degC over pipes. With Aluminium Cladding/ protective coating of resin hardener paint with fibre cloth (FRP)

S.No	Pipe Size (MM)	Thickness of Nitrile Rubber Insulation (MM)
1	15 to 25	9
2	32 to 80	13
3	100 & above	19

1.4.17 Anchor Block

Suitable anchor blocks shall be provided at all bends and tees to encounter the excessive thrust developed due to water hammer.

1.4.18 cPCV Pipes

All pipes inside the buildings and where specified, outside the building shall be cPVC pipe tubes conforming to IS 15778:2007. Specific Gravity ASTM D 792 at 23⁰C should be 1.55 as specified. With Tensile Strength as per ASTM D 638 at 23⁰C should be 55N/mm².

Cutting

Pipes shall be cut either with a wheel type plastic pipe cutting or hacksaw blade and care shall be taken to make a square cut which provides optimal bonding area within a joint.

Deburring / Beveling

Burrs and fittings should be removed from the outside and inside of pipe with a pocket knife or file otherwise burrs and fittings may prevent proper contact between pipe and fitting during assembly.

Fitting Preparation

A clean dry rag/cloth should be used to wipe dirt and moisture on the fitting sockets and tubing end. The tubing should make contact with the socket wall 1/3 or 2/3 of the way into the fitting socket.

Solvent Cement Application

Only CPVC solvent cement conforming to ASTM-F493 should be used for joining pipe with fittings. CPVC schedule 40 & 80 heavy bodied CPVC solvent cement only should be used conforming to ASTM-F493.

Assembly

After applying the solvent cement on both pipe and fitting socket, pipes should be inserting into the fitting socket within 30 seconds, and rotating the pipe ¼ to ½ turn while inserting so as to ensure even distribution of solvent cement with the joint. The assembled system should be held for 10 seconds (approx) in order to allow the joint to set up.

An even bead of cement should be evident around the joint and if this bead is not continuous, remake the joint to avoid potential leaks.

Set & Cure times

Solvent cement set & cure times shall be strictly adhered to as per the below mentioned table:

Minimum Cure prior to pressure testing at 150 PSI

S. No.	Ambient Temperature during Core period	Pipe Size	
		½” to 1”	1.1/4” to 2”
1	Above 15 deg C	1 Hr	2 Hrs
2	4 – 15 deg C	2 Hrs	4 Hrs
3	Below 4 deg C	4 Hrs	8 Hrs

Once an installation is completed and cored as per above mentioned recommendations, the system should be hydrostatically pressure tested at 150 PSI (10 Bar) for minimum 24hrs. During pressure testing the system should be filled with water and if a leak is found, the joint should be cut out and replacing the same with new one by using coupler.

Transition of CPVC to Metals

When making a transition connection to metal threads, special brass/plastic transition fitting (Male & Female adopters) should be used. Plastic threaded connection should not be over torque hard tight plugs one half turn

should be adequate.

Threaded Sealants

Teflon tapes shall be used to make threaded connection leak proof.

Hangers & Supports

For horizontal runs, support should be given at 3 ft (90 cms) intervals for diameter of 1" and below and at 4 ft (1.20 mtr) intervals for larger size.

Hangers should not have throw or sharp edges which come in contact with the tubing and shall be of GI.

Support should be as per the below mentioned table:

S. No	Size of Pipe Inch	210C Ft	490C Ft	710C Ft	820 C Ft
1	½"	5.5	4.5	3.0	2.5
2	¾"	5.5	5.0	3.0	2.5
3	1"	6.0	5.5	3.5	3.0
4	1 ¼"	6.5	6.0	3.5	3.5
5	1 ½"	7.0	6.0	3.5	3.5
6	2"	7.0	6.5	4.0	3.5

All special fittings and accessories like internally or externally threaded brass adaptors, ball valves, globe valves, unions, diaphragm valves, butterfly valves, etc. shall be made of CPVC by licensee.

The CPVC solvent cement used for installing CPVC piping systems shall conform to ASTM F493. Pipes from ½" up to 2" pipes and fittings, single step medium bodied CPVC solvent cement should be used. For CPVC pipes and fittings upwards of 2", a primer shall be used followed by heavy bodied solvent cement conforming to ASTM F493. *CPVC solvent cement should not be used.*

Concealed Plumbing

All internal concealed plumbing for water supply shall be done with CPVC pipes. The pipes & fittings shall conform to CTS (Copper Tube Size) SDR-11 as per ASTM D2846. All pipes and fittings from ½" up to 2" shall come under this category. Medium body CPVC solvent cement conforming to ASTM F493 should be used for joining pipes to fittings.

Installation procedure

All parameters pertaining to the installation of CPVC plumbing system such as cutting, joining, support spacing, expansion loops, insulation, type of support, special connections, etc. shall be as per the manufacturer's specifications.

1.4.19 Valve Chambers

Contractor shall provide suitable brick masonry chambers in cement mortar 1:5 (1 cement: 5 coarse sand) on cement concrete foundations 150 mm thick 1:5:10 mix (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size) 12 mm thick cement plaster inside and outside finished with a floating coat of neat cement inside with cast iron surface box as approved and in drawings including excavation, back filling complete.

1.4.20 Water Meters

Water meters of approved make and design shall be supplied for installation at locations as per approved drawings. The water meters shall meet with the approval of the local municipal authorities. Suitable valves and chambers to house the meters shall also be provided along-with the meters.

All meters shall conform to Indian Standard IS: 779-1978 (Water meters-domestic type) and IS: 2373-1981 (water meters-bulk type). Where called for water meters shall be located in masonry chambers of appropriated size.

1.4.21 Pipe Hangers Brackets etc

Sturdy hangers, brackets and saddles of approved design shall be installed to support all pipe lengths which are not embedded over their entire run. The hangers and brackets shall be of adjustable heights and primer coated with red-oxide primer clamps. Collars and saddles to hold pipes shall be provided with suitable gaskets. The brackets and hangers shall be of Mild Steel designed to carry the weight of pipes safely and without excessive deflections.

All pipes and fittings shall be supported near every joint and half-way through every pipe length unless otherwise specified. Where called for, pipe hangers shall also be supplied with proper sound and vibration dampening devices to minimize noise and vibration transmission.

1.4.22 Testing

All pipes, fittings and valves shall be tested by hydrostatic pressure of min. 1.5 times, the working pressure and subject to minimum of 7 kg/cm² in any case and with the consent of Engineer-in-Charge.

Pressure shall be maintained for a period of at least TWELVE hours without appreciable drop in the pressure after fixing at site. (+10 %). A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and Engineer.

In addition to the sectional testing carried out during the construction, Contractor shall test the entire installation after connections to the overhead tanks or pumping system or mains. He shall rectify all leakages, and shall replace all defective materials in the system. Any damage done due to carelessness, open or burst pipes or failure of fittings, to the building, furniture and Fixtures shall be made good during the defects liability period without any extra cost.

After completion of the water supply system, Plumbing Contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently. Valves which do not effectively operate shall be replaced by new ones at no extra cost and the same shall be tested as above.

1.4.23 Connections to Water Tanks

The contractor shall provide all inlets, outlets, washouts, vents, ball cocks, overflow, control valves and all such other piping connections including level indicator to water storage tanks as called for.

Suitable float controls of an approved make, securely fixed to the tank independent of the inlet pipe and set in a position so that water inlet into the tank is cut off when filled up to the water line. The water level in the tanks shall be adjusted to 25mm below the lip of the overflow pipe. Full way gate/ball valves of approved make shall be provided as near the tank as practicable on every outlet pipe from the storage tank except the overflow pipe. The overflow pipe shall be so placed as to allow the discharge of water being readily seen. The overflow pipe shall be of size indicated. A stop valve shall also be provided on the inlet water connection to the tank. The outlet pipes shall be fixed

approximately 75mm above the bottom of the tank towards which the floor of the tank is sloping to enable the tank to be emptied for cleaning. The ball valves shall conform to Indian Standard IS:1703-1968

1.4.24 Connections to Mechanical Equipment Supplied by Other Agencies

All inlets, outlets, valves, piping and other incidental work connected with installation of all mechanical equipment supplied by other agencies shall be carried out by the Plumbing contractor in accordance with the approved drawings, requirements for proper performance of equipment, manufacturer's instructions and the

directions of the Engineer-in-Charge The equipment to be supplied by other agencies consists mainly of Kitchen, Laundry, Air-conditioning, Water Treatment and other similar equipment. The connections to the various equipment shall be effected through proper unions and isolating valves. The work of effecting connections shall be executed in consultation with and according to the requirements of equipment suppliers, under the directions of the Engineer-in-Charge. The various aspects of connection work shall be executed in a manner similar to the work of respective trades mentioned elsewhere in these specifications.

1.4.25 Disinfection

After completion of the work Contractor shall flush clean the entire system with the city's filtered water after connection has been made.

After the first flushing, commercial bleaching powder is to be added to achieve a dosage of 2 to 3 mg/l of water in the system added and flushed. This operation should be performed twice to ensure that the system is fully disinfected and usable. The Commissioning would not be considered complete without performing the Disinfection.

1.4.26 Pre Commissioning

Ensure that all pipes are free from debris and obstructions.

Check all valves and fire hydrant for effective opening and closing action. Defects should be rectified or valves replaced.

Ensure that all connections to branches have been made.

Ensure that mains have been connected to the respective pumps, underground and overhead tanks.

Water supply should be available at main Underground tank. All main line Valves should be closed.

1.4.27 Commissioning

Fill Underground tank with water. Add 1kg fresh bleaching powder after making a solution to be added near inlet.

Start Water Supply Pump and allow water to fill main Underground tank. Water will first fill the fire tank and then overflow to the Raw Water tanks.

After filling Overhead Reservoir drain the same to its one forth capacity through tank scour valve. (This is to ensure removal of all mud, debris etc. from the tank).

Fill Overhead tank to full.

Release water in the main lines by opening Valves in each circuit. Drain out water in the system through scour valves or fire hydrant in lower regions. Ensure clean water is now coming out of the system.

Open valves for individual clusters. Observe for leakages or malfunctions, check pressure & flow at end of line by opening Hydrants etc. Remove and rectify defects noticed.

Check all outlet points for proper operation by opening each valve and allowing water to flow for a few minutes. Also check for effective closure of valve.

The entire water supply system should be disinfected with bleaching powder and system flush cleaned.

Send four samples of water drawn from four extreme locations for testing for bacteriological test in sterilized bottles obtained from the concerned laboratory. (Laboratory personal may collect the samples themselves).

1.4.28 Responsibility

Responsibility for various activities in pre-commissioning and commissioning procedures will rest with the Contractor.

1.5 Tube Well

1.5.1 General Conditions

All work shall be done in a systematic manner in accordance with a programme prepared in consultation with the Engineer-in-Charge.

Expected quantity of water required is in the order of 10,000 LPH on 10-12 hours continuous pumping, but lower flow will be acceptable if the strata yield is such.

1.5.2 Water Supply & Power

Contractor shall make his own arrangement for water at site required for his work. He may obtain the water by boring a trial bore or by obtaining in water tankers at his own cost.

Contractor shall also make his own arrangements for power required for his work.

1.5.3 Site Clearance

The Contractor shall clear the site for any trees, growth, grass and rubbish to enable him to execute the work properly at his own cost.

On successful completion of the work the Contractor shall clear up the site of all his surplus material equipment and accessories and hand over the same to the Engineer-in-Charge.

1.5.4 Type of Well

- Tube well shall be bored by a reverse circulation rotary rig with 600 mm dia. (24") blind and slotted pipe. Annular space between pipe and bore shall be gravel packed.

1.5.5 Boring

Boring shall be 600-650 mm dia. to an approximate depth of 100-120 m. The depth may be increased or decreased as per actual site conditions. The depth at which the tube well boring is to be terminated shall be as agreed upon by the Engineer-in-Charge. Sub-soil water shall not be tapped.

1.5.6 Well and Housing Pipes

Pipes shall be uPVC pressure pipe with couplings.

1.5.7 Slotted Pipes

Slotted pipes shall be 250 mm dia. with slots. Slot size shall be as per soil conditions and shall be approved by the Engineer-in-Charge. No variation in rate shall be permissible due to size and dimension of slots.

1.5.8 Special Fittings

Provide all special fittings e.g. blank pipes, socket rings, bail plug, centring guides, pipe slips and top cap suitable for housing pipe.

1.5.9 Verticality

Well assembly shall be truly vertical as per latest Indian Standard and verticality certificate shall be furnished by the Contractor.

1.5.10 Gravel Packing

Space between boring and well assembly shall be packed with washed pea gravel 3 to 6 mm size.

1.5.11 Development

The well shall be developed by an air compressor of 450 cfm capacity and pressure of 10.5 kg/cm² for a period of at least twenty hours. This period may however be extended in case the development is not satisfactory.

1.5.12 Water Tests

The Contractor shall get the water tested for its quality from approved Water Testing laboratory given Annexure I. Tests shall be for drinking water quality as per IS: 10500 for Physical, Chemical & bacteriological parameters. (Tests shall be performed after development of the well and clear water is available in the discharge).

1.5.13 Sanitary Sealing

The annular space between the bore and its housing pipe shall be grouted with cement concrete 1:2:4 to a depth of 5 m below the ground level. Four 50 mm dia. gravel feeding shall be provided with caps at top. Pipes shall be G.I. to I.S. 1239, medium class.

1.5.14 Bore Log

A bore log in a standard format form shall be maintained at the site and shall give the following information.

- a) Description and depth of strata
- b) Spring level below ground.
- c) Aquifer opposite which slotted pipes have been placed.
- d) Rate of progress of drilling
- e) Full particulars of final test
- f) Four copies of strata sheets yield and water quality tests shall be handed over on completion of the well.
- g) Suggested depth for the tube well submersible pump.

1.6 Garden Hydrant System

1.6.1 Scope of Work

The scope of this section comprise of the supply, installation testing and commissioning of piping network for garden hydrant & irrigation system.

Work under this section consists of furnishing all labour, materials equipment and appliances necessary and required to completely install the garden irrigation system as required by the approved drawings, specified hereinafter and given in the approved drawing.

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

- All irrigation lines to different parts of site and making connection from source i.e. from STP etc.
- Pipe protection.
- Control valves, masonry chambers and other appurtenances.
- Connections to all hydrant point.
- Excavation and refilling of pipe trenches, wherever necessary.
- Trenches for taking pipe lines for these services if required.

1.6.2 General Requirements

All materials shall be new and of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Engineer-in-Charge.

Pipes and Fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner. Pipes shall be fixed in a manner so as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

As far as possible pipes shall be installed at-least 60cms below finished grade.

Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

1.6.3 HDPE Pipes & Fittings

All pipes used in Garden hydrant System shall be HDPE (High density Poly Ethylene pipe and conforming to I.S. 4984 of class IV (10 kg/cmsq)

Fittings shall be HDPE fittings, of approved make. Pipes and fittings shall be jointed with butt welding joint.

1.6.4 Flanges

Flanged connections shall be provided on pipes where ever required or as directed by Engineer-in-Charge. Connections shall be made by the correct number and size of the bolts and made with 3 mm thick insertion rubber washer.

1.6.5 Trenches

The HDPE pipes and fittings shall be laid in trenches. The width and depth of the trenches for the different diameters of the pipes shall be as follows:

Dia. of Pipe	Width of Trench	Depth of Trench
15mm to 50mm	30 cms	60 cms
65mm to 100mm	45 cms	75 cms

At joints the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with general specifications for earth work in trenches.

When excavation is done in rock, it shall be cut deep enough to permit the pipes to be laid on a cushion of sand minimum 7.5 cm deep.

1.6.6 Pipe Protection

Where specified in the approved drawing all pipes below ground shall be in trenches and protected with fine sand 150 mm all around before filling in the trenches.

1.7 Sewerage / Drainage System

1.7.1 Scope of Work

Work under this section shall consist of furnishing all labour, materials, equipments and appliances necessary and required to completely finish Sewerage/Drainage system as specified hereinafter or given in the approved drawing.

Without restricting to the generality of the foregoing, the sewerage system shall include:

- Internal/External sewer line.
- Excavations including refilling etc.
- Construction of Collection Chambers, Manholes and Drop Connections.
- Construction of Grease Trap etc.
- Connection to S.T.P and Disposal of treated effluent.
- Storm Water Drainage and Disposal.
- Construction of Desalting chamber & Rain water Harvesting tank
- Testing of pipe lines

1.7.2 General Requirements

All materials shall be new and of the best quality conforming to specifications and subject to the approval of the Engineer-in-Charge.

Drainage lines shall be laid to the required gradients and profiles.

All piping shall be installed at depth greater than 80cms below finished ground level.

The piping system shall be vented suitably at the starting point of all branch drains, main drains, and the highest/lowest point of drain and at intervals as shown. All venting arrangement shall be un-obstructive and concealed.

All drainage work shall be done in accordance with the local Municipal bye-laws.

Wherever the sewerage pipes run above water supply lines, same shall be completely encased in cement concrete 1:2:4 all round with the prior approval of the Engineer-in-Charge.

Location of all manholes, catch basins etc., shall be got confirmed by the Contractor from the Engineer-in-Charge before the actual execution of work at site.

All works shall be executed as directed by Engineer-in-Charge.

1.7.3 Alignment and Grade

The sewer pipes shall be laid to alignment and gradient shown on the approved drawings but subject to such modifications as shall be ordered by the Engineer-in- Charge from time to time to meet the requirements of the works. No deviations from the lines, depths of cutting or gradients of sewers shown on the plans and sections shall be permitted except by the express direction in writing of the Engineer-in- Charge.

1.7.4 Salt Glazed Stoneware Pipes

Stoneware pipes shall be of first class quality salt glazed and free from rough texture inside or outside and straight. All pipes shall have the manufacturers name marked on it and shall comply to IS: 651-1971 and shall be of approved makes.

The maximum permissible slope to the various diameters of pipes shall be as follows:

100mm pipe	-	1 in 40 to 1:50
150mm pipe	-	1 in 60 to 1:100
200mm pipe	-	1 in 80 to 1: 120 to 1: 200
250mm pipe	-	1 in 90 to 1: 120 to 1: 250

Where necessary, pipe shall be laid on a bed of plain cement concrete 1:3:6 and minimum 150 mm thick, and shall be projected by providing hunching up to half the diameter of the pipes. The width of the concrete bed for various diameters shall be as follows:

100mm dia. pipe	-	380mm wide
150mm dia. pipe	-	450mm wide
200mm dia. pipe	-	600mm wide
250mm dia. pipe	-	700mm wide

Where the pipes are laid on a soft soil, with the maximum water table level, lying at the invert level of the pipe, the pipe shall be bedded in concrete.

1.7.5 Laying of Pipes

Pipes are liable to be damaged in transit and notwithstanding tests that may have been made before dispatch each pipe shall be examined carefully on arrival at site. Each pipe shall be rung with a wooden hammer or mallet and those that do not ring true and clear shall be rejected. Sound pipes shall be carefully stacked to prevent damage. All defective pipes should be segregated, marked in a conspicuous manner and their use in the works prevented. The pipes shall be laid with sockets leading uphill and should rest on solid and even foundations for the full length of the barrel. Socket holes shall be formed in the foundation sufficiently deep to allow the pipe jointer room to work right round the pipe and as short as practicable to admit the socket and allow the joint to be made.

Where pipes are not bedded on concrete the trench bottom shall be left slightly high and carefully bottomed up as pipe laying proceeds so that the pipe barrels rest on firm ground. If excavation has been carried too low it shall be made up with cement concrete 1:5:10 mix at the Contractor's cost and charges.

If the bottom of the trench consists of rock or very hard ground that cannot be easily excavated to a smooth surface, the pipes shall be laid on cement concrete bed of 1:5:10 mix to ensure even bearing.

1.7.6 Jointing of Pipes

Tarred gaskin shall first be wrapped round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid, the pipe shall then be adjusted and fixed in its correct position and the gaskin caulked tightly home so as to fill not more than one quarter of the total length of the socket.

The remainder of the socket shall be filled with stiff mix of cement mortar (1 cement: 1 clear sharp washed sand). When the socket is filled, a fillet should be formed round the joint with a trowel forming an angle of 45 degrees with the barrel of the pipe. The mortar shall be beaten up and used after it has begun to set.

After the joint has been made any extraneous materials shall be removed from inside of the joint with a suitable scraper or "Badger". The newly made joints shall be protected until set from the sun, drying winds, rain or dust. Sacking or other materials, which can be kept damp, shall be used. The joints shall be exposed and space left all rounds the pipes for inspection by the Engineer-in-Charge. The inside of the sewer must be left absolutely clear in bore and free from cement mortar or other obstructions throughout its entire length, and shall efficiently drain and discharge.

- Gully Traps

Gully traps shall be of the same quality as described for stoneware pipes in Clause 5.

Gully traps shall be fixed in cement concrete 1:5:10 mix (1 cement: 5 coarse sand: 10 stone aggregate 40mm

nominal size) and a brick masonry chamber 30x30 cms inside in cement mortar 1:3 with 10 x 10 cms grating inside and 30x30 cms C.I. sealed cover and frame weighting not less than 7.2 kg to be constructed as per standard approved drawing. Where necessary, sealed cover shall be replaced with C.I. grating of the same size.

- **Grease Trap**

Grease Trap shall be provided on Kitchen waste lines before discharging the waste into the main sewer line. Grease Trap shall be built in brick masonry and shall be similar in construction to manholes. The grease trap shall be constructed to size as shown at the location on approved drawings. The grease trap shall be provided with drop inlet, drop outlet, galvanized wrought iron sediment pan and a baffle wall. Grease trap shall be provided with 2 nos. double seal manhole cover and frame which shall be identified with lettering 'Grease trap' as per the drawing.

- Testing of Grease Trap

All rights of the sewer and drain shall be carefully tested for water tightness by mains of water pressure maintained for not less than 30 minutes. Testing shall be carried out for manhole to manhole. All pipes shall be subject to a test pressure of 1.5 meter head of Water. The test pressure will however, not exceed 6mtr head at any point. The pipes shall be plugged preferably with standard design plugs or with rubber plugs on both sides, the upper end shall, however, be connected to a pipe for filling with water and getting the required head poured at one time.

1.7.7 Reinforced Cement Concrete Pipes

All underground storm water drainage pipes and sewer lines where specified (other than those specified cast iron) shall be centrifugally spun RCC pipes of specified class. Pipes shall be true and straight with uniform bore. Throughout cracked, warped pipes shall not be used on the work. All pipes shall be tested by the manufacturer and the Contractor shall produce, when directed a certificate to that effect from the manufacturer.

1.7.8 Laying

R.C.C. spun pipes shall be laid on cement concrete bed or cradles as specified and shown on the detailed approved drawings the cradles may be precast and sufficiently cured to prevent cracks and breakage in handling. The invert of the cradles shall be left 12mm below the invert level of the pipe properly placed on the soil to prevent any disturbance. The pipe shall than be placed on the bed concrete or cradles and set for the line and gradient by means of sight rails and bonding rods etc. cradles or concrete bed may be omitted, if directed by the Engineer-in-Charge

1.7.9 Encasing (all pipes have to be encased)

The sewer pipes shall be completely encased or surrounded with concrete where: The maximum water table level is likely to rise above the top of the barrel.

- The top (overt) of pipe is less than 200 cms under the road surface.

1.7.10 Jointing

After setting out the pipes the collars shall be centred over the joint and filled in with tarred gaskin, so that sufficient space is left on either side of the collar to receive the mortar. The space shall then be filled with cement mortar 1:2 (1 cement: 2 fine sand) and caulked by means of proper tools all joints shall be finished at an angle of 45 degree to the longitudinal axis of the pipe on both side of the collars neatly semi flexible type collar joint.

1.7.11 Curing

The joint shall be cured for at least 7 days. Refilling at joints will be permitted only on satisfactory completion of curing period.

1.7.12 Cement Concrete and Masonry Works for Manholes and Chambers etc.

Water

Water used for all the construction purposes shall be clear and free from Oil, Acid, Alkali, Organic and other harmful matters, which shall deteriorate the strength and/or durability of the structure. In general, the water suitable for drinking purposes shall be considered well enough for construction purpose.

Aggregate for Concrete

The aggregate for concrete shall be in accordance with I S: 383 and I S: 515 in general, these shall be free from all impurities that may cause corrosion of the reinforcement. Before actual use these shall be washed in water, if required as per the direction of Engineer-in-Charge. The size of the coarse aggregate shall be done as per I S: 383.

Sand

Sand for various constructional purposes shall comply in all respects with I S: 650 and I S: 2116. It shall be clean, coarse hard and strong, sharp, durable, uncoated, free from any mixture of clay, dust, vegetable matters, mica, iron impurities soft or flaky and elongated particles, alkali, organic matters, salt, loam and other impurities which may be considered by the Engineer-in-Charge as harmful for the construction.

Cement

The cement used for all the constructional purposes shall be ordinary Portland cement or rapid hardening Portland cement conforming to I S: 269.

Mild Steel Reinforcement

The mild steel for the reinforcement bars shall be in the form of round bars conforming to all requirements of I S: 432 (Grade I).

Bricks

Bricks shall have uniform colour, thoroughly burnt but not over burnt, shall have plan rectangular faces with parallel sides and sharp right angled edges. They should give ringing sound when struck. Brick shall not absorb more than 20% to 22% of water, when immersed in water for 24 hours. Bricks to be used shall be approved by the Engineer-in-Charge.

Other Materials

Other materials not fully specified in these specifications and which may be required in the work shall conform to the I S code. All such materials shall be approved by the Engineer-in-Charge before use.

1.7.13 Cement Concrete (Plain or Reinforced)

Cement concrete pipes bedding, cradles, foundations and RCC slabs for all works shall be mixed by a Mechanical Mixer where quantities of the concrete poured at one time permit. Hand mixing on properly constructed platforms may be allowed for small quantities by the Engineer-in-Charge. Rate for cement concrete shall be inclusive of all shuttering and cantering at all depth and heights.

All concrete work shall be cured for a period of at least 7 days. Such work shall be kept moist by means of gunny bags at all times. All pipe trenches and foundations shall be kept dry during the curing period.

1.7.14 Masonry Work

Masonry work for manholes, chambers, brick masonry pipe trench and such other works as required shall be constructed from 1st class bricks or 2nd class as specified in the approved drawing in cement mortar 1:5 mix (1 cement: 5 coarse sand). All joints shall be properly raked to receive plaster.

1.7.15 Cement Concrete for Pipe Support

Wherever specified or shown on the approved drawings, all pipes shall be supported in concrete bed all round or in haunches. The thickness and mix of the concrete shall be given in the approved drawing. Type of the bedding is as described as follows:

Unless otherwise directed by the Engineer-in-Charge cement concrete for bed, all round or in haunches shall be laid as follows:-

Description	Upto 3 M depth
Pipes in open ground (No sub soil water)	All round (1:4:8)
Pipes (all) in sub soil water condition	All round (1:4:8)
Pipes under the building or at road crossing or under public places	All round (1:3:6)

(1=1 cement, 3-5=coarse sand, 6-10 stone aggregate 40mm nominal size)

R.C.C. pipes or C.I. pipes ,may be supported on brick masonry or precast R.C.C or Cast insitu cradles. Cradles shall be as shown on the approved shop drawings.

Pipes in loose soil or above ground shall be supported on brick or RCC anchor blocks as shown on the approved shop drawings.

1.7.16 Manholes and Chambers

All manholes, chambers and other such works as specified shall be constructed in brick masonry in cement mortar 1:5 (1 cement: 5 coarse sand) or as specified in the approved shop drawing.

All Manholes, Chambers, etc., shall be supported on base of cement concrete of such thickness and mix or shown on the approved shop drawings.

Where not specified, Manholes will be constructed as follows:-

(All dimensions internal clear in cms)

Size of Manhole Type	90x80 Rect.	120x90 Rect.	910 dia. Circular	1220 dia. Circular	1520 dia. Circular
Maximum depth	100	245	170	230	Any depth beyond 230
Average thickness of R.C.C slab	15	15	--	--	--
Size of cover and frame (Internal dia.)	61x45.5	50 dia.	56 dia.	56 dia.	56 dia.
Weight of cover and frame	38 Kg.	116 Kg.	116 Kg.	116 Kg.	116 Kg.
Type of Cover & Frame	SFRC	SFRC	SFRC	SFRC	SFRC

All manholes shall be provided with cement concrete benching in 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20mm nominal size). The benching shall have a slope of 10cm towards the channel. The depth of the

channel shall be full diameter of the pipe. Benching shall be finished with a floating coat of neat cement.

All manholes shall be plastered with 12/15mm thick cement mortar 1:3 (1 cement: 3 coarse sand) and finished with a floating coat of neat cement inside. Manhole shall be plastered outside as above but with rough plaster.

All manholes with depths greater than 1 m shall be provided with plastic encapsulated 20mm square or 25mm round rods foot rungs set in cement concrete blocks 25 x 10 x 10cms in 1:2:4 mix 30cms vertically and staggered. Foot rests shall be coated with coal tar before embedding.

All manholes shall be provided with cast iron covers and frames and embedded in reinforced cement concrete slab or SFRC precast concrete covers as per instructions of the Engineer-in-Charge. Weight of cover, frame and thickness of slab as given above.

All Rainwater Collection Chamber shall be of the size 50x45x60cm (internal) with horizontal C.I. grating or SFRC precast Gully Grating as per instructions of Engineer- in-Charge. The grating along with frame shall be of size 500x450mm grating having total Wt. of app. 38 Kg and of approved design and quality as per instruction of Engineer-in-Charge. The remaining details of construction shall be same as stated above for the construction of the Manholes etc.

1.7.17 Making Connections

Contractor shall connect the new sewer line to the existing manhole by cutting the walls, benching and restoring them to the original condition. A new channel shall be cut in the benching of the existing manhole for the new connection. Contractor shall remove all sewage and water if encountered in making the connection without additional cost.

1.7.18 Commissioning

After successful testing of the different sewerage and drainage pipes in parts, the Contractor shall provide all facilities including necessary piping's, labours, tools and equipments etc. for carrying out testing and commissioning of the entire external sewerage and drainage system complete as per requirement in the presence of Client representative/Consultant, wherever and as may be required. Generally, the following test/inspection has to be carried out:-

- For any Leakages/seepages in the external sewerage and drainage pipes.
- For checking the functioning of the entire external sewerage and drainage system including rainwater harvesting system and to ensure that the waste water is continuously flowing towards outfall without any intermediate stagnation.
- For the functioning of the valves and accessories etc. by putting ON/OFF the controlling valves of the various diversions in the sewerage and drainage and rain water harvesting system.

1.7.19 Desalting Chamber & Rain Water Harvesting Tank

All Rainwater Collection Chamber shall be of the size 200x100x60cm (internal) complete as per approved shop drawing or as instructions of Engineer-in-Charge.

Rain water harvesting pit is constructed preferably 5 to 10m from the permanent structure. The bore will be excavated manually or drilled by reverse direct rotary method up to the water level or as per instruction of Engineer-in-Charge.

The dia. of Rain water harvesting pit shall be 4500mm. Pit shall be filled with boulders, gravel and coarse sand.

Bore shall be 450mm dia. and pipe shall be 250 mm uPVC (10 Kg/cm²) pipe. The pipe placed in the centre of the shaft touching the lowest portion of the pit. The overflow pipe from the desalting chamber is directly connected to the rain water harvesting pit so that the rain water freely enters the pit for recharging. In addition to the inlet pipe from desalting chamber an overflow pipe at the ground level so that any excess water that enters the pit is automatically drained away without damaging the pit.

1.8 Handing Over Procedure

1.8.1 Documents Submission

The Contractor before finally handing over the completed work in his scope to the owner, shall submit the documents as per the Contract and as directed by the Engineer-in-Charge. Given below the checklist for the reference of the Engineer-in- Charge.

Packages/	Sanitary Fixtures	Soil, waste & vent pipes	Water supply system	Sewerage/ drainage system	Water tanks
Final cleaning					
List of inventory					
Training Conducted on					
Operation Manual					
Maine. Manual					
As built P&I Diag/ SLD					
Defects Liability Period/ Warranty					
Commissioning report					
Test reports/ Certificates					
List of essential spares					
Address/ Contact nos. of Vendors					
Remarks					

1.9 Heat Pumps

The Packaged type Air to Water Heat Pump. shall be completely factory assembled including required Nos. of Scroll Hermetically Sealed Scroll / Reciprocating Compressor(s), evaporator, Condenser and Microprocessor Control Panel etc with R134a / 410 a/ 470 c or any other CFC free Refrigerant and COP between 3-4.

The Heat Pump shall have inbuilt hot water heat exchanger, vibration isolators, pumps, valves, expansion valve, Copper / Aluminium fins, and other accessories. The Heat Pump should be capable of producing hot water at minimum 55°C temperature at outlet (condenser circuit) temperatures at approx. 40°C ΔT. The machine should have an operating ambient temperature range of 0°C to 40°C.

Heat Pump shall have built in electric panel as per safety norms as manufacturer standard. It shall be Suitable for electric supply of 415 + 10% volts & 50 Hz. The Heat pump shall have an in-built facility to start / stop depending on variation in demand at different periods. All interconnecting wiring / cabling between heat pump and electrical panel shall be part of the equipment. The heat pump should be designed at ambient temperature at 7 degree Celsius considering de-aeration of Equipment.

SS 304 horizontal hot water storage tank of required capacity suitable for minimum 7 kg/sqcm operating pressure. Tank shall be provided with hot water flow meter at inlet & outlet, inlet/outlet, overflow/drain connections with MH cover, pressure relieve valve, pressure gauge at inlet/outlet with isolation cock & thermometer. Tank shall be provided with 24 G aluminium cladding. It shall be provided with 15 mm dia. testing spout with valve. The Heat Pumps shall be installed in N+1 condition at terrace level.

Testing , Commissioning & Operation: After satisfactory installation of all the systems, entire system shall be tested, commissioned as per procedure laid down & operated for continuous 30 days as directed by E-I-C.

1.10 Sewage Treatment Plant

1.10.1 Scope

Detailed engineering design of all plan areas, section, Civil, Structural, mechanical, electrical and piping systems according to the current and applicable BIS codes as applicable. The proposed plans of the STP shall be subject to the approval of the Architect / Consultant.

Design, manufacture, assembly, installation, testing and commissioning of the main treatment units in RCC tanks , mechanical equipment for the packaged type Sewage Treatment Plant (STP) & ETP of capacity and design parameters & specifications broadly comprising of : -

- Screen chambers with SS Screen & Grease Trap
- Grease trap for Kitchen waste
- Sewage Equalization Tank
- Tube settler
- Anoxic & MBBR Tank, Sludge Tank
- Tertiary Treatment Plant
- UF & UV Unit
- Electro Mechanical Equipment's.
- Electrical Cabling & Panel etc.
- Treated Water Tank
- UF Water Tank
- Basket Centrifuge
- Other Miscellaneous Items.
- Approval from Local Authorities
- Cutting holes, chases & like through all types of walls /floors and finishing for all services crossings, including sealing, cover plates, making good structure and finishes to an approved standard.
- Balancing, testing & commissioning of the entire STP.
- Every day's Test reports (During commissioning and for 3 month after commissioning), list of recommended spares, as-installed drawings, operation & maintenance manual for the entire STP contract.
- Training of Client's staff.

Drain channel, sump with a drainage submersible pump (1 working + 1 standby) with pipe work, valves and discharge pipe up to nearest external manhole in plant room shall be provided.

Provide PH Meter, Electronic magnetic flow meter in inlet & outlet of filtration system

1.10.2 The Work Includes

- Civil, Mechanical & Electrical works
- Piping as specified.
- Testing, commissioning and operation of plant with water and under load conditions.

Construction of all architectural, civil and structural works related to the construction of the building, its internal lighting, sludge disposal system.

Incoming power connection, electrification of pump house. Incoming sewer / rising main connection to the plant.

Connection from final effluent tank / pump to point of use for reuse or for disposal in accordance with approval of the State Board for Prevention and Control of Pollution.

1.10.3 Contractor's Experience

Contractor quoting for the work shall be an experienced specialize contractor engaged in the design, manufacture and execution of STP/ETP of similar types and must have completed at least 5 plants of similar or larger size in

the last 5 years.

Each offer must accompany a list of plants planned, constructed, executed and are in operation for at least 12 months given: -

- Owner's name, address, telephones and faxes nos.
- Architects/Consultants name, Address, Telephone & fax nos.
- Type of load (Domestic and Industrial)
- Average daily flow, BOD and other information of plant.

1.10.4 Shop Drawings

The contractor shall submit shop drawings as follows:

- On award of the work, he shall submit GA drawing, PIB diagrams, plant layout with basic dimensions, flow diagram with levels of elements.
- Fabrication and equipment layout piping, valves and all other information required for installation.
- Electrical layouts, detail of all MCC, cable sizing and system diagrams and earthing system.
- Piping layout with pipe dia. slopes, fixing arrangements.
- Three copies of the shop drawings shall be submitted for initial scrutiny. On approval of the same contractor shall submit six copies of the same incorporating corrections etc. Two sets will be stamped "GOOD FOR CONSTRUCTION" by the Consultant and returned to the contractor.

1.10.5 Other Submittals

Contractor shall furnish four sets of folders giving:

- Catalogues and technical information sheets of equipment to be installed.
- Performance curves, foundation details and fixing arrangements.

Contractors proposal for testing procedures for individual equipment and for overall testing of the plant.

Submittals shall be separate for:

- Mechanical and Piping works
- Electrical Works

All shop drawings and submittals mentioned above shall be approved by Architect and two sets duly stamped shall be returned to the contractor for execution of the works.

1.10.6 Execution of Work

All work shall be executed only in accordance with the approved shop drawings and other submittals. Contractor shall ensure that all inserts, support plates, puddle flanges and other items required to be incorporated during execution shall be placed in position as per his own requirements during execution of the works.

All special tools and tackle required for erection and assembly of the equipment covered by the contract shall be obtained by the contractor himself. All other materials such as foundation bolt nuts, etc. required for the installation of the plant and equipment shall be supplied by the contractor and are part of the contract.

1.10.7 Testing & Handing Over

The contractor shall carryout tests on different equipment as required in the presence of the Consultant or his representative in order to enable him to determine whether the plant, equipment and installation comply with the specifications, local codes and in accordance with the letter and intents of the specifications.

The installation shall be handed over to the Engineer-in-Charge only on successful completion, operational tests and acceptance of the effluent quality by the municipal / pollution control and statutory authorities.

1.10.8 Statutory Permissions

Contractor shall submit a write-up of process of the plant, drawings, design parameters flow and PIB diagrams as necessary and required for submission to the State pollution control authority.

Contractor shall furnish at his own cost, analysis of influent at source (for evaluation) as well as that of influent

at the holding tank of the STP and the effluents from the STP for submitting to State Pollution Control Board and any other statutory authority whose approval is required.

Contractor shall perform all testing and operation of the plant in presence of the Pollution Control Board if so stipulated by them.

Contractor to obtain all statutory approval as required for PCB or any other approval. Only official fee will be reimbursed to contractor by the Owner.

1.10.9 Completion Documents

On successful completion of the entire work, the contractor shall submit 4 sets of following documents to Architect. A brief write-up of process, day to day operating and maintenance instructions.

List of approved chemicals and procedure for storage and safety norms.

Completion drawing and data, catalogues, performance charts, technical data sheets and equipments installed.

Manufacturer's maintenance and operating instructions for mechanical and electrical equipment.

Laminated and framed "As Built" drawings with plans, section, process flow diagrams, pipe runs, levels and final disposal point schedule of equipment installed with all their model Nos. plate data and date of installation.

Test readings of Influent & Effluent parameters taken at final handing over time

NOC (No Objection Certificate) from State Pollution Control Board and any other statutory authority whose approval is required.

1.10.10 Performance Guarantee

Equipment supplied and installed shall be guaranteed to yield the specified effluent standards which must meet and accepted with the requirements of Pollution Control Board.

The guarantee implicitly includes replacement of the entire plant on failure to meet desired effluent parameters, replacement of individual equipment or repairs as warranted. Decision on each and every aspect on this matter shall rest with the Consultant and shall be final and binding on the contractor.

1.10.11 Defects Liability

All equipment and the entire installation shall be guaranteed against defective materials and workmanship for a period of 12 months reckoned after taking over of system by owner along with the documentation. During the defects liability period, the contractor shall replace defective parts and components free of cost. Rectification or repair may be permitted in case the defect is of minor nature.

1.10.12 Deviations from Tender Specifications

Tendered may indicate their comments only as deviations from the conditions stipulated herein. Wholesale submission of their own conditions and/or printed conditions in disregard of the conditions stipulated herein shall not be binding on this Tender.

No corrections, erasure etc. of this document shall be accepted.

1.10.13 /Sewage Characteristics

Design Parameters

Project	-	Sports building etc
Usage	-	Players, coaches, audiences etc.
Location	-	Under ground

Level	-	Ground

Design Consideration

- STP Capacity (Max). : As per DBR
- ETP Cap : As per DBR
- Area Available : As per functional requirement
- Operation : Domestic Sewage (round the clock)
- Influent
 - o pH : 7.5 to 8.5
 - o BOD 5 days @ 200C. : upto 250-350 mg/l
 - o Suspended solids (SS) : upto 250-400 mg/l
 - o Oil & grease : 50 mg/l
 - o COD : upto 450-600 mg/l
- Treated Effluent
 - o pH : 6 - 7
 - o BOD 5 days @ 200C. : less than 10 mg/l
 - o Suspended solids (SS) : less than 10 mg/l
 - o Oil & grease : NIL
 - o COD : less than 50 mg/l

1.10.14 Salient Features

The plant should be suitable for low/peak flow in line with medical waste usage.

The plant should not create any noise, with no nuisance on fly or mosquito and no foul odours.

The plant should work without the use of in-organic chemical additives

The plant should be provided with tertiary treatment in form of dual media/activated carbon filter /UV system to provide zero bacteriological standards for reuse on:

- Flushing System,
- Irrigation system

1.11 Effluent Treatment Plant (ETP)

1.11.1 Scope

Detailed engineering design of all plan areas, section, civil, structural, mechanical, electrical and piping systems according to the current and applicable BIS codes as applicable. The proposed plans of the STP shall be subject to the approval of the Architect / Consultant.

Design, manufacture, assembly, installation, testing and commissioning of the main treatment units packaged type, mechanical equipment for the Effluent Treatment Plant (ETP) of capacity and design parameters given in DBR & specifications broadly comprising of :-

- The Effluent Treatment System
- It is proposed to provide a captive customized as per site packaged Effluent treatment plant with the building compound.
- The process proposed is on basis of:
- Compact design
- Minimum space occupied
- Does not pose architectural and visual problems

- Is free from odour nuisance
- Has a treatment process which is proven and used universally

Provide PH Meter, Electronic magnetic flow meter in inlet & outlet of filtration system

1.11.2 Work Included

- Civil designing part only, Mechanical & Electrical works
- Piping as specified.
- Testing, commissioning and operation of plant with water and under load conditions.

Construction of all architectural, civil designing and structural works related to the construction of the building, its internal lighting, and sludge disposal system.

Incoming power connection, electrification of pump house. Incoming effluent / rising main connection to the plant.

1.11.3 Contractor's Experience

Contractor quoting for the work shall be an experienced specialize contractor engaged in the design, manufacture and execution of ETP of similar types and must have completed at least 5 plants of similar or larger size in the last 5 years.

Each offer must accompany a list of plants planned, constructed, executed and are in operation for at least 12 months given: -

- Owner's name, address, telephones and faxes nos.
- Architects/Consultants name, Address, Telephone & fax nos.
- Type of load (Domestic and Industrial)
- Average daily flow, BOD and other information of plant.

1.11.4 Shop Drawings

The contractor shall submit shop drawings as follows:

- On award of the work, he shall submit GA drawing, PIB diagrams, plant layout with basic dimensions, flow diagram with levels of elements.
- Fabrication and equipment layout piping, valves and all other information required for installation.
- Electrical layouts, detail of all MCC, cable sizing and system diagrams and earthing system.
- Piping layout with pipe dia. slopes, fixing arrangements.

shop drawings shall be submitted for initial of the same contractor shall submit six copies of incorporating corrections etc. Two sets will be stamped CONSTRUCTION" by the Consultant and returned to the contractor.

Three copies of the scrutiny. On approval the same "GOODFOR

1.11.5 Other Submittals

Contractor shall furnish four sets of folders giving:

- Catalogues and technical information sheets of equipment to be installed.

- Performance curves, foundation details and fixing arrangements.
- Contractor's proposal for testing procedures for individual equipment and for overall testing of the plant.

Submittals shall be separate for:

- Mechanical and Piping works
- Electrical Works

All shop drawings and submittals mentioned above shall be approved by Architect and two sets duly stamped shall be returned to the contractor for execution of the works.

1.11.6 Execution of Work

All work shall be executed only in accordance with the approved shop drawings and other submittals. Contractor shall ensure that all inserts, support plates, puddle flanges and other items required to be incorporated during execution shall be placed in position as per his own requirements during execution of the works.

All special tools and tackle required for erection and assembly of the equipment covered by the contract shall be obtained by the contractor himself. All other materials such as foundation bolt nuts, etc. required for the installation of the plant and equipment shall be supplied by the contractor and are part of the contract.

1.11.7 Testing & Handing Over

The contractor shall carryout tests on different equipment as required in the presence of the Consultant or his representative in order to enable him to determine whether the plant, equipment and installation comply with the specifications, local codes and in accordance with the letter and intents of the specifications.

The installation shall be handed over to the Engineer-in-Charge only on successful completion, operational tests and acceptance of the effluent quality by the municipal / pollution control and statutory authorities.

1.11.8 Statutory Permissions

Contractor shall submit a write-up of process of the plant, drawings, design parameters flow and PIB diagrams as necessary and required for submission to the State pollution control authority.

Contractor shall furnish at his own cost, analysis of influent at source (for evaluation) as well as that of influent at the holding tank of the STP and the effluents from the STP for submitting to State Pollution Control Board and any other statutory authority whose approval is required.

Contractor shall perform all testing and operation of the plant in presence of the Pollution Control Board if so stipulated by them.

Contractor to obtain all statutory approval as required for PCB or any other approval. Only official fee will be reimbursed to contractor by the Owner.

1.11.9 Completion Documents

On successful completion of the entire work, the contractor shall submit 4 sets of following documents to Architect.

A brief write-up of process, day to day operating and maintenance instructions. List of approved chemicals and procedure for storage and safety norms.

Completion drawing and data, catalogues, performance charts, technical data sheets and equipments installed. Manufacturer's maintenance and operating instructions for mechanical and electrical equipment.

Laminated and framed "As Built" drawings with plans, section, process flow diagrams, pipe runs, levels and final disposal point schedule of equipment installed with all their model Nos. plate data and date of installation. Test readings of Influent & Effluent parameters taken at final handing over time

NOC (No Objection Certificate) from State Pollution Control Board and any other statutory authority whose

approval is required.

1.11.10 Performance Guarantee

Equipment supplied and installed shall be guaranteed to yield the specified effluent standards which must meet and accepted with the requirements of Pollution Control Board.

The guarantee implicitly includes replacement of the entire plant on failure to meet desired effluent parameters, replacement of individual equipment or repairs as warranted. Decision on each and every aspect on this matter shall rest with the Consultant and shall be final and binding on the contractor.

1.11.11 Defects Liability

All equipment and the entire installation shall be guaranteed against defective materials and workmanship for a period of 12 months reckoned after taking over of system by Owner along with the documentation. During the defects liability period, the contractor shall replace defective parts and components free of cost. Rectification or repair may be permitted in case the defect is of minor nature.

1.11.12 Deviations from Tender Specifications

Tendered may indicate their comments only as deviations from the conditions stipulated herein. Wholesale submission of their own conditions and/or printed conditions in disregard of the conditions stipulated herein shall not be binding on this Tender.

No corrections, erasure etc. of this document shall be accepted.

1.11.13 Effluent Design Parameters

- Usage : Restaurant & Kitchen Waste
- Location : As per drawing
- Level : Belowground

1.11.14 Design Consideration

- ETP cap.(Max) : As per DBR
 - Area Available : As per functional req.
 - Operation : effluent (round the clock)
 - Influent
 - o pH : 7.5 to 8.5
 - o BOD 5 days @ 200C. : upto 450-500 mg/l
 - o Suspended solids (SS) : upto 650-750 mg/l
 - o Oil & grease : 100 mg/l
 - o COD : upto 200-300 mg/l
 - Treated Effluent
 - o pH : 6 - 7
 - o BOD 5 days @ 200C. : Less than 50 mg/l
 - o Suspended solids (SS) : less than 30 mg/l
 - o Oil & grease : NIL
 - o COD : less than 50 mg/l
-
-

1.11.15 Salient Features

The plant should be suitable for low/peak flow in line with medical waste usage.

The plant should not create any noise, with no nuisance on fly or mosquito and no foul odour.

The plant should work without the use of in-organic chemical additives

The plant should be provided with tertiary treatment in form of dual media/activated carbon filter /UV system to provide zero bacteriological standards for reuse on:

- Irrigation system

- Flushing System

1.11.16 Basis of Design

The capacity/ rating of pumps and equipment etc. shall hold good for the capacity of 400 m3/day and shall be good for meeting the treated parameters requirement as follows:

- Permissible limit as prescribed in IS: 2490 (Part-I)-1974 and environment (Protection) Rules 1986.
 - Water (Prevention and Control of Pollution) Act, 1977 & 1978.
 - Environment (Protection) Act, 1986.
 - Environment (Protection) Rules, 1986.
 - Hazardous Wastes (Management & Handling) Rules, 1989.
 - Manufacturer, Storage and Import of Hazardous Chemicals Rules, 1989.
 - Manufacturer, use import and storage and hazardous Micro- Organizers, Genetically Engineered organizations or Cell Rules, 1989.
 - Manual on sewage & sewage treatment - CPHEEO
 - The Public Liability Insurance Act, 1991.
 - All standards as laid down by Central Pollution Control Board and any other relevant statutory authority.
 - 100% recycle of waste water and removal of sludge in cake form, no water to be discharged outside the premises.

1.11.17 Scope of Supply & installation with technical specification

Mechanical Equipment's :

The various equipment's included are listed below:

S. No.	Units	Brief Specifications
1.	Oil collection tank	HDPE tank
2.	Raw effluent Transfer Pumps	Self-priming, Non Clog pump,
3.	Static Mixer	
4.	Flocculator	Suitable for tank
5.	Alum Dosing System	Metering pump with HDPE dosing tank
6.	PE Dosing System	Metering pump with HDPE dosing tank
7.	Tube Modules	55 Deg. Inclined square tube Extruded out of PVC.
8.	Sludge Transfer	Self-priming, Non

Note: *Motor rating mentioned is indicative and will be as per final model selected during detail engineering.

Electrical Items :

The electrical work covered in this contract includes:

A) 1 No. LT Panel for ETP comprising:

- Cubical type -Non compartmentalized.
- Floor / wall mounted

- Incoming power control switches SFU.
- VAF Meter, phase indicating lamps,
- Individual MCB and starters.
- 2 Nos. automatic level switch/ controller for actuating raw effluent and treated effluent pumps.
- Auto / manual selector switch.

B) Armoured cabling from our panel to motor starters and earth pits.

C) Energy Meter – 1 No.

D) Switch board shall be metal clad, totally enclosed.

Panel shall be designed for semi-auto operation of ETP. (i.e. LLC based operation for raw and filter). Pressure gauges shall be provided on delivery main for pumps, blowers and vessels.

Instrumentation :

Rotametre : Rotameter on air line.

Pressure Gauge : Pressure gauge will be provided on & Delivery main for pumps & blowers

Level Switch :Level switch for on & off pump.

1.12 Reverse Osmosis System (RO)

1.12.1 Scope of Work

Work under this contract shall consist of furnishing all labour, materials, equipment and appliances necessary and required to supply, install, commission and operate a RO plant cap. as per DBR complete with all pre and post water treatment equipment, piping and pumps.

1.12.2 RO Inlet Water quality

Design and system manufacturing /assembling is entirely based on the following feed water analysis, assumed for design purpose.

Parameter	Raw water
Colour	Absent
Total Suspended Solids	□ 2 mg/l
Turbidity	□ 2 NTU
pH	6-8
Total hardness	□ 500 mg/l
Alkalinity	□ 47 mg/l
Fluoride	□ 1 mg/l
Silica	□ 10 mg/l
Iron & Heavy Metals	□ 1 mg/l
Total Dissolved Solids	□ 1000 mg/l

1.12.3 Treated Water Qualities

Processed water (at the plant outlet) will match with Indian Standard Code : 10500.

Parameter	Raw water

pH	6-7
Total Dissolved Solids	<50 ppm
Total Suspended Solids	Nil
Turbidity	As per IS:10500
Iron as Fe	Nil
Total hardness	Less than 5 ppm

1.12.4 Schedule and Technical Details of RO System Micron Filter

Purpose

To remove the fine sand particle up to 0.05 micron and reduce silt density index to acceptable level.

Specifications

- Cartridge filter & Housing

Make : AS APPROVED

MOC of housing : PP

Length : 20"

Diameter : 6"

Quantity : 1No.

- Cartridge:

Make : AS APPROVED

Cartridge MOC : Polypropylene

Length : 20"

Diameter : 4"

Quantity : 1 No

Micron rating : 05micron

1.12.5 Dosing System

Purpose

To dose antiscalant chemical to protect the scaling formation on RO membranes.

Specifications:

Chemical Tank Volume	:	ltr/hr	100
Max. Frequency Stroke per Min.	:		100
Max. Back Pressure	:	l/h	1.08
Max. Back Pressure	:	@ Bar	12.0 Nominal
Back Pressure	:	l/h	1.38
Nominal Back Pressure	:	@ Bar	6.0
O.D. x I. D.	:	mm	6 x 4
Nominal Power	:	Watts	11
MOC	:	PP	
Capacity	:	0-6 lph	
Qty	:	1No	

1.12.6 High Pressure Pump

Purpose

To feed the reserve Osmosis Membrane at pressure more than the osmotic pressure considering flux rate, flow & recovery.

Specifications

MOC	:	STAINLESS STEEL
TYPE	:	VERTICAL MULTISTAGE
FLOW RATE	:	1000 LITERS PER HOUR.
HEAD	:	35
POWER REQUIRED	:	1.2.KW
ELECTRICAL	:	220VSINGLE, 50 HZ
CYCLE	:	2900RPM
MAKE	:	AS APPROVED

1.12.7 RO Membrane

Purpose

To remove the major part of TDS up to 98% by Reverse Osmosis Membranes arranged & designed to give adequate flow & recovery

Specification

Type	:	Spiral Wounded
Diameter of Membrane	:	8.0 inch.
Length of Membrane	:	1MT.
No of Membranes	:	4
Recovery per Membrane	:	10-15 %
Salt Rejection per Membrane	:	98-99 %
Make of Membranes	:	AS APPROVED
Systems Recovery	:	60%

1.12.8 RO Pressure Tube**Purpose**

To pack Reverse Osmosis Membranes & operate at High pressure upto 250psi

Specifications

MOC	:	SS/ FRP Composite
Diameter of Pressure vessel	:	8.5 inch
Length of pressure vessel	:	2.5meter
No Pressure Vessels	:	2
No of Membrane per Vessel	:	2
Position	:	Horizontal ,Series

1.12.9 RO Cleaning System**Purpose**

We provide a flashing system, which shall help to clean the membrane & get deposited on the membranes.

Flushing Time	:	15 Minutes.
Flushing Media	:	Treated water/Chemical
Flushing Tank Size	:	100 litre
Tank MOC	:	HDPE
Flushing Pump	:	Raw water pump will used Semi automatic with two ball valves operation.

1.12.10 Electrical Panel**Purpose**

A control is provided as a safety measure for the Pump & other electrical items.

Specification

- Complete Starters Overload relays & single phase Preventer for pump.
- Voltmeter, Ammeter, MCB's indicating lights.
- Push buttons. Rocker Switches for Dozers
- Incomers, Auto-Manual switches.

1.12.11 Instrumentation

Purpose

Flow Meter	:	To measure the online flow of water TDS Meter
	:	To measure the online TDS of water Low
pressure Switch	:	To protect RO pump from dry running.
High Pressure Switch	:	To protect RO pump from back pressure.
Pressure Gauges	:	For calculating the pressure for each unit in RO system. Rota Meter : Quantity: 2 Nos.(permeate & reject line)
Range	:	2.4cum per hour
Make	:	AS APPROVED

Digital TDS Meter

Quantity	:	1 No (Off line)
Range	:	10,000 ppm

Pressure Switch

Quantity	:	2 No (Low & high)
Range	:	0-450psi
Make	:	AS APPROVED

Pressure Gauges

Quantity	:	6 No
Range	:	0-7 Bar.
Dial Size	:	2 inches
Type	:	Bourdon
Make	:	AS APPROVED

Plumbing & Fittings

Valves, pipelines before RO module is in uPVC (16 bar tested) & CPVC after HPP, till the permeate line termination point.

NRV'S pressure relief valves, wherever needed the system will be on common MS base frame.

1.12.12 Shop Drawings & Specifications

The Contractor shall submit to the Consultant two copies of Shop Drawings for Fire Fighting works as an Advance Copy to the Engineer-in-Charge for approval before start of work. Subsequent to the approval of the shop drawings, the Contractor shall submit six copies of Shop Drawings for execution to the Engineer-in-Charge. Also the Contractor shall submit four copies of the Technical Specifications and Catalogues.

Shop drawings shall be submitted for the following conditions:

- Structural supports/hanging/laying and jointing details for all types of pipes as required.
- Fire Fighting layout plans as required and for any changes in the layout of Fire Fighting/Architectural drawings.

The Contractor can only commence the work after the approval of above documents by Consultant.

1.13 Plumbing Equipments

1.13.1 Pumps and Water Treatment Equipment

Work under this sub-head consists of furnishing all labour, materials, equipment and accessories necessary and required to completely install pumping system for various water supply services and water treatment as per approved shop drawings, specified hereinafter.

Without restricting to the generality of the foregoing, the work of pumps and water treatment equipment shall include the followings:

- Raw water pumps.
- Hydro pumps for Domestic & Flushing water.
- Soft water transfer pumps.
- Garden Hydrant Pumps.
- Hot water recirculation pumps.
- Treated water supply pumps to STP (Emergency supply)
- Sump pumps for disposal of sewage and drainage.
- Water treatment unit consisting of filter, softener and chlorination etc.
- Fire pumps.
- Motor control panels, power and control cabling and allied electrical works.
- Pipes, valves, accessories, hangers, supports, delivery and suction feeders and connection to proposed pipe work.

1.13.2 Water Supply Pumps

Raw Water / Soft Water / Garden Hydrant / Hot Water Recirculation Pump

Water supply pumps shall be suitable for clean water. Pumps shall be multistage, mono-block vertical centrifugal pumps with stainless steel body and stainless steel impeller, stainless steel shaft and coupled to a TEFC electric motor by means of a flexible coupling. Each pump should operate a curve 10m below specified head.

Pump and motor shall be mounted on a common M.S. structural base plate or as required as per site conditions.

Each pump shall be provided with a totally enclosed fan cooled induction motor.

Each pumping set shall be provided with a 150mm dia. or of suitable size gunmetal “Burden” type pressure gauge with gunmetal isolation cock and connecting piping.

Provide vibration-eliminating pads appropriate for each pump.

Provide rate of flow measuring meter with bypass arrangement with every set of pumps.

All water supply pumps shall be provided with mechanical seals. Detail of Pumps as below.

a)	Filter feed pumps	—	Cap. as per DBR
b)	Softenerfeed pumps	—	Cap. as per DBR nos. 2Nos (1W + 1SB)
c)	Soft water transfer pumps	—	Cap. as per DBR
d)	Garden Hydrant pumps	—	Cap. as per DBR
e)	Treated water transfer pumps to STP —		Cap. as per DBR (Emergency supply)
f)	Hot water recirculation pumps	—	As per functional req.

1.13.3 Hydro Pneumatic System (Domestic & Flushing Water Supply Pumps)

Domestic water supply pumps shall be packaged type skid mounted hydro pneumatic system with fixed speed system. Complete system to be mounted on a common base frame.

Pumps shall be multistage, mono-block vertical centrifugal pumps with stainless steel body and stainless steel impeller, stainless steel shaft and coupled to a TEFC electric motor by means of a flexible coupling. Each pump should operate a curve 10m below specified head.

Pressure vessel of non corrosive FRP composite construction lined with NSF and/or FDA listed material, like high density polyethylene with fully replaceable polyurethane. Air cell burst pressure of minimum of 5 times the vessel operating pressure and cycle tested for 2,50,000 cycles. No. and capacity of Pressure Vessel As per manufacturer recommendation.

Pump and motor shall be mounted on a common M.S. structural base plate or as required as per site conditions.

Each pump shall be provided with a totally enclosed fan cooled induction motor.

Each pumping set shall be provided with a 150mm dia. or of suitable size gunmetal “Burden” type pressure gauge with gunmetal isolation cock and connecting piping.

Provide vibration-eliminating pads appropriate for each pump.

Provide rate of flow measuring meter with bypass arrangement with every set of pumps.

All water supply pumps shall be provided with mechanical seals.

Pumps shall have Control Panel with programmable logic controller (PLC) for cyclic operation of pumps. Pump working sequence should change after every operation. Contractor overload relays and MCBs should confirm to IEC 898 – 1995/ specifications. Blinking indications for pumps start, trip, low level trip, and health supply should be provided in the panel along with the ammeter & voltmeter. Control panel should also consist of cooling fan.

a) Hydro Pumps (for Domestic) – As per DBR

b) Hydro Pumps (for Flushing) – As per DBR Sump Pump

Sump pumps shall be submersible type for lifting domestic sewage or muddy water/drainage. Pump with impeller of approved material shall be mounted on waterproof motor. The impeller shall be suitable for handling solids upto 46-100mm dia.

The pump shall automatically operate with high water level and stop at low water level in the sump by means of “Electronic Level Controller”, of the approved make.

The sump pumps shall be complete in all respect and shall be installed as per manufacturer’s requirement as shown in the approved shop drawing. All accessories shall be In-Built as per manufacturer’s specification.

Sump pumps are compact mono-block dry motor submersible pumps for suitable rating, with non-clog free flow open impeller, minimum solid handling capacity up to 100mm for sewer & 40 for storm water. Suitable for operation on 415 volts + 5% - 15%, 50 C/s A.C 3 phase supply, speed 960/1440R&M including oil chamber, guide wire for lifting & lowering of pump, M.S. galvanized lifting chain, duck foot bend.

The above pump sets must be supplied complete with following accessories:

- Complete piping 100mm dia. common delivery upto 1.5m as shown in the approved drawing. (The pipe should be preferably heavy duty GI)
- Necessary valve i.e. Butterfly valve on delivery/suction side and Non return valves are on delivery side.
- Necessary cable from pumps set to control panel.
- Electrical switch panel having all necessary accessories & safety devices of standard specifications. (Panels with sump pumps near each sump as per site conditions)
- Automatic built-up water level controller with necessary length of cable upto control panel.

1.13.4 Sewage Pumps (Minimum req.)

Motor rating	- 5.0KW
Discharge	- Min. 20 Cu.m/hr.
Total head	- 14 m

(Complete set as above including valves and delivery pipes and panels and with 2 nos. pumps)

1.13.5 Drainage Pumps (Minimum req.)

Motor rating	- 1.1KW
Discharge	- Min. 15 Cu.m/hr.
Total head	- 14 m

(Complete set as above including valves and delivery pipes and panels and with 3 nos. pumps)

1.13.6 Water Filter

Water filter shall be of dual filter media pressure filter downward or upward flow type suitable for a rate of filtration.

Filter shall be vertical type of required diameter. The shell shall be fabricated from M.S. plate suitable to withstand a working pressure as given below. The minimum thickness of shell will be 8mm and dished ends shall be 10mm. The filter shall have at least one pressure tight manhole cover.

Filter shall be provided with screwed or flanged connections for inlet, outlet, individual drain connections and all other connections necessary and required. Filter shall be painted inside with two or more coats of non-toxic corrosion resistant paint, one coat of red oxide primer outside with two or more coats of synthetic enamel paint of approved shade.

Filter Capacity Shall be as functional requirement.

1.13.7 Under Drain System

Filter shall be provided with an efficient under drain system comprising of collecting pipes, gunmetal/polypropylene nozzles of manufacturer's design. The entire under drain system be provided on M.S. plate or cement concrete supports.

1.13.8 Face Piping

Filter shall be provided with interconnecting face piping comprising of inlet, outlet, and backwash pipe complete with pipes, valves and accessories, as per requirement. Piping shall be G.I./M.S. piping, medium duty, as per I.S: 1239 and valves shall be cast iron double flanged sluice valves on SOUNDERS pattern with C.I. body and Neoprene rubber diaphragm (Suggested make AS APPROVED).

1.13.9 Accessories

Each filter shall be provided with following accessories:-

- 1.13.9.1 Air release valve with connecting piping.
- 1.13.9.2 150mm dia. dial burden type gunmetal pressure gauges with gunmetal isolation cock and connecting piping on inlet and outlet.
- 1.13.9.3 Sampling cocks on raw water inlet and filtered water outlet.
- 1.13.9.4 Individual drain connection with gunmetal full way valve.
- 1.13.9.5 Connection with valve for air scouring.

1.13.10 Water Softener

Softener shall be designed to give zero commercial hardness. Softener shall be with cation exchange resins.

Softener vessel shall be of mild steel plate with dished ends and self supporting arrangement. Vessel shall be suitable for a working pressure. The shell shall have a minimum thickness of 8mm and dished ends 10mm. The vessel shall be painted internally with non-toxic bitumen paint and externally with one coat of red oxide and two or more coats of synthetic paint to give an even shade.

The vessel shall have an internal collecting and distribution system of manufacturer's design.

The softener shall have a set of interconnecting face piping consisting of inlet, outlet and brine injection system with valves and accessories complete as per requirement. Piping shall be M.S. medium duty, as per

I.S: 1239 and valves shall be cast iron double flanged sluice valves on SOUNDERS pattern, with C.I. body and Neoprene rubber diaphragm (suggested AS APPROVED).

One set of hydraulic injector with control valve, brine delivery pipes with adjustable indicator.

One cylindrical salt saturator and measuring tank of M.S. rubber lined having a capacity of a minimum of two regenerations for.

One orifice board for indicating wash and rinse rate to be fitted in drain sump.

One charge of supporting gravel, sand and "cation" resin in requisite quantity. Resin shall be Indian 220 or approved equivalent make.

One water testing kit with instructions for testing water samples. Softener Capacity are as per functional requirement.

1.13.11 Piping

Pipes for suction and delivery shall be galvanized/M.S tube (heavy duty) confirming to I.S:1239 up to 150mm dia. and as per I.S:3589 for dia. 200mm and above. The M.S flanges shall confirm to I.S:6392-1971.

Gate valve and check valve above 65mm dia. shall be C.I. double flanged conforming to I.S:780 manufactured by the reputed manufacturers or C.I. double flanged butterfly valves.

Full way and check valves 65mm dia. and below shall be gunmetal tested to 20Kg/cm² pressure certified and conforming to I.S:778.

Suction strainer or foot valves shall be C.I., confirming to I.S:4038 - 1979.

1.13.12 Joints

All pipes and fittings shall be provided with flanged joints, with flanges either screwed or welded complete and jointed with 1.5mm thick gasket complete with nuts, bolts and washers etc.

1.13.13 Testing

All G.I pipes (except fire pipe) shall be tested hydrostatically for a period of 30 minutes to a pressure of 7 Kg/cm² without drop in pressure and all G.I pipes for fire shall be tested hydrostatically for a period of 30 minutes to a pressure of 10 Kg/cm² without drop in pressure.

1.13.14 Guarantee

The contractor shall submit a warranty for all equipment, materials and accessories supplied by him against manufacturing defects, malfunctioning or under capacity functioning.

The form of warranty shall be as approved by the Engineer-in-Charge.

The warranty shall be valid for a period of one year from the date of commissioning and handing over.

The warranty shall expressly include replacement of all defective or under capacity equipment, Engineer-in-Charge may allow repair of certain equipment if the same is found to meet the requirement for efficient functioning of the system.

The warranty shall include replacement of any equipment found to have capacity lesser than the rated capacity as accepted in the contract. The replacement equipment shall be approved by the Engineer-in-Charge.

1.14 Water Quality

1.14.1 Important Instruction for Quality of Water

The successful contractor will have to carry out a test of raw water from all the sources of water for the cricket stadium at their own cost from a reputed lab as approved by the Engineer-in-Charge / Consultant. On the basis of these results the contractor has to submit his shop drawings, design calculations and specifications accordingly.

Please note that it is ultimately the responsibility of the contractor to provide treated water for different use in the stadium as per International Standard as given in the attached guidelines.

1.14.2 Required Quality of Treated Water

Sl. No.	Characteristics	Acceptable as per Indian Standard of P.H.E.
1	Turbidity (Units on J.T.U scale)	2.5
2	Colour (Units on Platinum Cobalt scale)	5.0
3	Taste and Odour	Unobjectionable
4	pH	7.0 to 8.5
5	Total dissolved solids (mg/l)	500
6	Total hardness (mg/l) (as CaCO ₃)	200
7	Chlorides (as Cl) (mg/l)	200
8	Sulphates (as SO ₄)	200
9	Fluorides (as F) (mg/l)	1.0
10	Nitrates (as NO ₃) (mg/l)	45
11	Calcium (as Ca) (mg/l)	75
12	Magnesium (as Mg) (mg/l)	> 30
13	Iron (as Fe) (mg/l)	0.1
14	Manganese (as Mn) (mg/l)	0.05
15	Copper (as Cu) (mg/l)	0.05
16	Zinc (as Zn) (mg/l)	5.0
17	Phenolic compounds (as Phenol) (mg/l)	0.001

18	Anionic detergents (mg/l) (as MBAS)	0.2
19	Mineral Oil (mg/l)	0.01
20	Arsenic (as As) (mg/l)	0.05
21	Cadmium (as Cd) (mg/l)	0.01
22	Chromium (as hexavalent Cr) (mg/l)	0.05
23	Cyanides (as CN) (mg/l)	0.05

Sl. No.	Characteristics	Acceptable as per Indian Standard of P.H.E.
24	Lead (as Pb) (mg/l)	0.1
25	Selenium (as Se) (mg/l)	0.01
26	Mercury (total as Hg) (mg/l)	0.001
27	Polynuclear Aromatic Hydrocarbons (PAH)	0.2 ug/l
28	Gross Alpha activity	3p Ci/l
	Gross Beta activity Pci = pico curie	30p Ci/l
29	Bacteriological Quality of piped water supplies	
	Treated water entering the distribution system	
29.1	Faecal coliforms number/100 ml	0
29.2	Coliform organisms number/ 100 ml	0

END OF PLUMBING SECTION

HVAC TECHNICAL SPECIFICATIONS

GENERAL

CONTRACTORS RESPONSIBILITIES

The Contractor is responsible for the quality and the satisfactory operation of the installations entrusted to him, as well as for compliance with the performance stipulated in this document.

Consequently, for his own account and under his own responsibility, he must carry out all calculations and select the necessary materials and equipment.

Apart from the required performance definitions, this document and the relevant drawings also provide many indications resulting from the studies carried out by the Engineer.

The Contractor shall review these studies and check the corresponding indications.

The same applies to equipment selection, for which the information given in this document must be deemed as indicative and defines only the minimum requirements.

SCOPE DESCRIPTION

The contractor shall furnish all labor, materials, tools, supplies, equipment, transportation, supervision, technical, professional, and other services, and shall perform all operations necessary and required to satisfactorily complete all the necessary engineering, procurement services, construction work and commissioning for the systems and equipments for the project.

BASIC DESIGN CRITERIA

Refer tender Drawings and Documents.

CODES AND STANDARDS

All the systems shall be designed and installed in accordance with the requirement of International Codes and Standards and Local Authority having Jurisdiction. They shall be particularly in accordance with the following NBC 2016 / ECBC 2017 /NFPA /ASHRAE standards:

- NBC 2016
- ISHARE DESIGN DATABOOK 2017
- ECBC 2017
- RELEVANT IS STANDARDS
- ASHRAE – 62.1 (2019) Ventilation for acceptable indoor air quantity
- ASHRAE – 90.1 (2022) Energy standard for buildings except low-rise residential buildings
- ASHRAE -55 (2020) for thermal comforts
- NFPA – 90A Installation of Air Conditioning and Ventilation Systems.
- SMACNA (2005) – Sheet Metal and Air Conditioning Contractors National Association
- AHRI – Air conditioning, Heating and Refrigeration Institute
- NFPA 96 – For Kitchen related HVAC systems
- AMCA- Air Movement & Control Association- (Latest Edition)
- UL standards -For Fire Dampers - (Latest Edition)
- ISEER TESTING GUIDELINES

GENERAL CONDITIONS

1.1 The schedules, tender drawings, contract documents provided for reference design intent. It is the scope of contractor to verify, design, manufacture, supply, transport , install, test , commission, handover the complete HVAC system including all necessary services, accessories, material, equipment , Tools & tackles, labor , and any other type of service or material as required.

1.2 It is not the intent to specify completely herein all details of design and construction of system/ plant/ equipment to be supplied / erected. However, the system/ plant/ equipment supplied shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous commercial operation in a manner acceptable to the Client who will interpret the meaning of drawings and specifications and shall have the power to reject any work or material which in his judgement are not in full accordance therewith.

1.3 In case of discrepancy and / or disparity between these general and special conditions of contract and any other sections enclosed here in, the most stringent shall apply and the decisions of the Client/consultant shall be final.

1.4 Entire works which are part of this contract shall be completed in all respects and handed over in the timeline defined by the client the award of contract. However final timeline will be decided based on mutual agreement during finalization.

OTHER INSTRUCTIONS

Vendor to prepare following documents at required stages as and when asked by client/client engineer.

- ✓ Design Verification
- ✓ Design calculations
- ✓ Shop Drawings
- ✓ Technical document preparation
- ✓ Conduct witness Testing of Materials or Equipments as Specified in design documentation.
- ✓ SITC of complete system as per approvals by Client/Architect/consultants.
- ✓ Testing & commissioning of system
- ✓ As built drawings
- ✓ Handover the system
- ✓ Execution of Maintenance work for said warranty periods.

All safety precaution is the responsibility of Contractor. Vendor to follow local norms and guidelines defined by local Authority. It is also the responsibility of vendor to comply with Local Authority norms in all involved activities.

Contractor shall be responsible for getting necessary approvals on technical documentation , drawings and other documents as asked by the consultant / client timely before delivering any kind of material. The approvals has to be signed by following teams in order.

1. Consultant
2. Architect
3. Project management Agency wherever applicable
4. Client Representative

It is the sole responsibility of contractor to execute the work in satisfactory manner and with due regard to documentation.

WARRANTY PERIOD

The warranty period for all BOQ / Tender items is defined to be 36 Months from the date of Commissioning and no separate cost shall be paid towards the maintenance and rectification works as asked by client / consultant in case of any failure / breakdown of system happens. Warranty shall be applicable for complete system including Equipments , materials , Low side works , accessories , support work , ancillary work , Electrical and harness components , etc. Each and every item and its accessories will be covered in warranty scope.

1 VARIABLE REFRIGERANT FLOW SYSTEM

1.1 SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of Variable Refrigerant Volume System conforming to these specifications and in accordance with the requirements of Drawings and Schedule of quantities.

1.2 TYPE

Unit shall be air cooled, variable refrigerant flow air conditioner consisting of one outdoor unit and multiple indoor units. Each indoor unit having capability to cool independently for the requirement of the rooms.

It shall be possible to connect multiple indoor unit on one refrigerant circuit as shown in the drawings or as indicated in schedule of quantities. The indoor units on any circuit can be of different type and controlled individually. Following type of indoor units shall be connected to the system: VRF System shall be based on Variable Evaporative technology.

mounted cassette type (Single flow)

- Ceiling mounted cassette type (Double flow)
- Ceiling mounted cassette type (Multi flow)
- Ceiling mounted duct type.
- Ceiling suspended type.
- Treated fresh air type.
- Wall mounted type.
- Floor standing type.
- Concealed floor standing type.
- Air handling unit type.

Compressor installed in outdoor unit shall be equipped with capacity control mechanism, and capable of changing the rotating speed / mass flow rate of refrigerant by scroll / rotary compressor RPM to follow variations in cooling. Outdoor unit shall be suitable for mix-match connection of all type of indoor units.

The refrigerant piping between indoor units and outdoor units shall be extended up to 100m with maximum 50 m level difference without any oil traps. Oil recovery system shall be managed without disturbance to normal operation cycle of the system / compressor.

Both indoor unit and outdoor unit shall be factory assembled, tested and filled with first charge of refrigerant before delivery at site. All Outdoor Units shall have corrosion resistant, Biofouling protection coating applied to Fins, Tubes. Coating shall be Certified with ASTM B117, ASTM G85, ASTM G 87, ASTM D4798.

1.3 SELECTION CRITERIA FOR VRV UNIT

- The manufacturer to certify that the proposed unit shall be operational un-interrupted and without deration at temperature 3°C plus peak ambient dry bulb temperature of design city.
- Manufacturer to submit OEM letter for continuous operational range of the unit.
- Manufacturer to submit OEM de-rating charts for indoor and outdoor unit capacity rating at project specific design conditions and refrigerant piping lift and distance.
- ADP of unit selected should not be lower than 11.11°C (52°F) for high wall units and 10.56°C (51°F) for concealed Ductable and cassette units.

1.4 OUTDOOR UNIT

The outdoor unit shall be factory assembled, 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 tested prior to dispatch conforming to the following specifications. All outdoor units shall consist of scroll compressors, preferable with inverter drive. Outdoor units, when consisting of more than 1 module (e.g. 22 HP = 10 Hp +12 HP), each should have separate inverter driven compressor.

- a. In such case, the units shall be provided with duty cycling arrangements for multiple inverter compressors.
- b. The outdoor unit shall be modular in design to facilitate installation one after another close to each other. Preference would be given to compact units having smaller footprints.
- c. Outdoor units should be rugged of corrosion resistant design and should have strong base plate for easy mounting of unit.
- d. The outdoor unit shall comprise of sub-cooling feature to effectively use the entire coil surface through proper circuit/bridge to prevent flushing of refrigerant owing to large length of piping.
- e. The condensing unit shall be provided with state-of-the-art microprocessor-based control panel.
- f. The outdoor unit shall be provided with resin made bell mouth shaped design for fan chamber with bird wing design blades to ensure higher air discharge efficiency with low noise. The fan should be capable to respond to external static pressure of 30.0 & 60.0 Pa.
- g. DC motor shall be speed controlled to ensure a stable operation for varying ambient, by a factory fitted direct acting head pressure activated variable speed drive to give precise discharge pressure and minimum power consumption of condenser fan motor.
- h. The condenser shall be complete with provisions for refrigerant piping connections, shut off valves and any other standard accessories necessary with the equipment supplied.
- i. The noise level shall not be more than 60 dBA measured horizontally 1 metre away and 1 metre above ground for individual unit.
- j. The Condensing Unit shall be VRV inverter multi-indoor system type.
- k. All the Outdoor shall be provided with Refrigerant accumulator of appropriate size to prevent liquid refrigerant injection
- l. All Outdoor Units to be provided with inbuilt Accumulator.

The condensing unit shall be designed to facilitate fail safe operation when connected to multiple indoor units. If possible, the system should work on standard operating parameters like discharge pressures of not more than 300 PSI as the ref. Piping will be moving around within a residential house, otherwise on any misfortune of any leakage it will act like a bullet on higher pressures.

All brazing should be done by only a qualified trained person who has trained on high pressure brazing, special tools & procedures.

The outdoor unit shall be modular in design with possible future expansions.

The unit shall be provided with microprocessor control panel.

COP of the VRF Units shall be more than 3.1.

1.5 COMPRESSOR

The scroll compressor shall be an industrial quality rugged, cast iron, direct hermetic compressor with scroll plates, suction, mid-discharge & discharge service valves. The compressor shall be completely enclosed in a chamber with no leakage path and providing the capability for scroll plates to separate. The compressor shall be provided with industrial solid motor mounts internal motor protection and vibration isolation pads. Each compressor shall be independently wired and piped to its own circuit for efficient operation & ease of maintenance.

Compressor motor shall have a soft-starter device to limit starting current to not more than 08 Amps current.

The condensing unit shall be able to operate via inverter control capable of changing the speed linearly.

Condenser fan shall be direct driven propeller type arranged for vertical discharge. It shall be statically and dynamically balanced. Each fan shall have a resin made safety guard. Fan motors shall have inherent protection and shall be permanently lubricated type, resiliently mounted. The fan motor shall be equipped with inverter control so that it can be stepped down to low speed when the requirement is low.

The compressor shall be highly efficient digital scroll type inverter control. The inverter compressor shall be able to change the speed in accordance to the variation in cooling or heating load requirement:

- a. All outdoor units shall have multiple steps of capacity control to meet load fluctuation and indoor unit individual control. All parts of compressor shall be sufficiently lubricated stock. Forced lubrication may also be employed.
- b. Induction type heating shall be provided by Compressor motor coil to Oil.
- c. The inverter compressor shall preferably be efficient & reliable.

1.6 HEAT EXCHANGER

The heat exchanger shall be constructed with copper tubes mechanically bonded to slit-type aluminum fins to form a cross-fin coil.

The condenser shall have adequate face area to minimize noise and to give a high-energy efficient ratio (EER) for heat transfer. The condensing unit shall be of waffle louvre fins design for high efficiency performance. The condensing unit shall be chemically coated with hydrophobic corrosion resistant blue film.

It shall also be leak-tested, dehydrated and with refrigerant holding charged before shipment.

- a. The aluminium fins shall be covered by anti-corrosion resin coated mesh.
- b. The unit should be with sub-cooling system to optimize the path of heat exchanger and for better efficiency of condenser.
- c. The unit shall be provided with necessary number of direct driven low noise level resin made propeller type fans arranged for vertical discharge. Each fan shall have a resin made safety guard.

1.7 REFRIGERANT CIRCUIT

The refrigerant circuit shall include liquid & gas shut-off valves and a solenoid valve at the condenser end. The equipment must have inbuilt refrigerant stabilization control for proper refrigerant distribution.

All necessary safety devices should be provided to ensure the safe operation of the system.

1.8 SAFETY DEVICES

All necessary safety devices shall be provided to ensure safe operation of the system.

Following safety devices shall be part of the outdoor unit: high pressure switch, low pressure switch, fuse, crankcase heater, fusible plug, over current protection for inverter, and short recycling guard timer.

1.9 PIPING

All connections of Refrigerant piping shall be in high grade Copper of Refrigeration quality with Eddy Current Testing and material test Certificates.

All connections, tees, reducers etc. shall be standard make fittings.

Insulation of cold lines shall be carried out with nitrile rubber insulation sheets and tubes of appropriate thickness so that condensation does not occur.

For individual Piping 50 / 100 mm wide Aluminum Tape shall be used at joints of Piping with Bands for identification.

For outdoor piping, the finish shall be woven GRP Mat finished with colored Epoxy paints to withstand outside ambient conditions and UV Radiation.

1.10 OIL RECOVERY SYSTEM

Unit shall be equipped with an oil recovery system to ensure stable operation with long refrigerant piping.

System shall be designed for proper oil return to compressor along with the distribution of oil to individual compressor.

The refrigerant piping shall be extended upped 100 M with 50-M level difference without oil traps.

1.11 INDOOR UNITS

Units shall be factory assembled, wired, piped and tested.

Units shall have DX coils with copper tubes and bonded aluminum fins for highly efficient heat transfer.

Units shall have Centrifugal fans for adequate amount of Air circulation and low Noise.

Units shall have inlet filters, which are easily cleanable and replaceable.

All components of Units are easily accessible for connection, repairs and maintenance.

Units shall have very low noise.

The power supply to all units PCB/Outdoor PCB shall be in such a way that failure of any unit or PCB in communication line should not disrupt the entire system or group of units. All remaining units should remain functional in such case. The connecting system to be addressable to detect any warnings or faults in the system & should highlight the same on central controller.

All units with Factory manufactured Units Grills shall have auto swing feature for proper Air distribution.

All unit shall be controlled by electronic Expansion Valves only.

All units mounted inside the ceiling shall have fans capable of sustaining duct connections, and special filters if necessary.

Visible indoor units shall have wireless remotes. The same price shall be included in cost of unit by default.

All concealed type units to be provided with Wired remotes with interconnected piping.

All required caballing for Wired remote shall be part of Indoor unit scope & shall be provided without extra cost.

Concealed indoor units shall have sensor mounted on supply air grilles / diffusers which can be controlled with wireless remotes.

Anticorrosion treatment to avoid corrosion of coils.

All units shall have adequate insulation or lining to avoid condensation.

Electrical contractors shall only provide a socket of the required rating. Pintop with necessary caballing work and terminations up to maximum 3 m shall be in scope of HVAC contractor without extra cost.

Units shall have cleanable type filter fixed to an integrally moulded 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 or cooling and heating.

The noise level when the fan is operating at maximum speed shall not exceed NC 45.

Evaporator fan shall be statically and dynamically balanced and mounted on one shaft with permanently lubricated bearings.

All Indoor Units shall be supplied with Inbuilt / External drain pump. Necessary provisions to be considered. Drain Pump can be excluded if natural slope is available as per site conditions. If required, drain pump will be scope of contractor without any extra cost to client.

It is the responsibility of contractor to provide asked colored panels (or all visible portions of units) as asked timely by client / consultant / architect without any extra cost.

All Filters should be Minimum MERV 8 Rated.

Cooling coil and refrigeration parameters shall be designed in such a way that supply air temperature shall not be less than 14°C or 1°C above room dew point temp, whichever is more. The contractor shall guarantee inside conditions with selected supply air temperature.

1.12 CEILING MOUNTED CASSETTE TYPE UNIT (MULTI-FLOW TYPE)

The unit shall be ceiling mounted type. 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 possible to suspend from four corners.

Unit shall have a 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, and very low operating sound.

1.13 CEILING MOUNTED DUCTABLE TYPE UNIT

Unit shall be suitable for ceiling mounted type. The unit shall include pre filter, fan section & DX-coil section. The housing of unit shall be light weight powder coated galvanized steel. The unit shall have high static fan for Ductable arrangement.

1.14 HIGH WALL MOUNTED UNITS

The units shall be high wall mounted type. The unit shall include pre-filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel.

Unit shall have an attractive external casing with supply and return air grills.

1.15 FLOOR MOUNTED UNITS

The unit shall be suitable for floor mounting. The unit shall include, prefilter fan section, DX. Coil section. The housing of unit shall be light weight powder coated galvanized / anodized

aluminum panels. Unit shall have an attractive external casing with supply & return air grilles.

1.16 CENTRAL REMOTE CONTROLLER (OPTION IF SPECIFIED IN BOQ)

A multi-functional microprocessor based centralized controller (central remote controller) shall be supplied as an optional accessory.

The controller shall be able to control up to minimum 250 nos. of indoor units with zoning option and / or in case of larger installation should provide bigger controller with the following functions.

- Temperature setting for each zone, or group, or indoor unit.
- On/Off as a zone or individual unit.
- Indication of operating condition.
- **Controller should be capable to control, schedule, Group all systems as per requirement in building.**
- Select ON of all operation modes for each zone.
- The controller shall have wide screen liquid crystal display and shall be wired by a non-polar 2 / 3 wire transmission cable to 1000m away from the indoor unit. Vendor to include signal booster cost if required in BOQ cost.
- The controller shall be integrated to BAS system thru software for monitoring & controlling of all above parameters including start/ stop of each indoor / outdoor unit. All necessary interface cards / units should be supplied as a part of the system to integrate to the BAS Software.

OR

The manufacturer needs to provide BAS gateway / interface device for software integration to BAS for monitoring and controlling of all above parameters including start / stop of each indoor / outdoor unit. CRC controller shall not be required in this case.

- The controller shall be selected by Contractor in such a way that all the selected Indoor/Outdoor units and groups are controlled at single location or as asked timely by client/consultant or architect. Necessary quantities, Numbers or modules has to be selected by contractor as per requirement. If required , the contractor shall provide additional CRCs without extra cost to client.
- The CRC should be provided with tenant billing feature along with necessary software integration. The CRC has to be BMS compatible with communications in BACnet/MODbus protocol. Necessary cost to be considered by HVAC contractor as part of the scope including software & hardware features.

1.17 UNIFIED ON/OFF CONTROLLER (OPTION IF SPECIFIED IN BOQ)

Unified ON / OFF controller shall be supplied as an optional accessory.

The controller shall be able to control minimum 2 groups (each group containing maximum 16 indoor units) or 128 nos. of indoor units with the following functions.

- On / Off as a zone or individual unit.
- Indication of operation condition of each group.
- Select one of 4 operation modes.

The controller shall be wired by a non-polar 2 wire transmission cable to distance of 1 km away from indoor unit.

The controller shall be integrated to BAS system thru software for monitoring & controlling of all above parameters including start/ stop of each indoor / outdoor unit. All necessary interface cards / units should be supplied as a part of the system to integrate to the BAS Software.

1.18 CONDENSATE:

25mm dia uPVC pipes, 40mm dia uPVC headers & fittings shall be used for condensate, from Evaporator Unit to drain point. The joints shall be properly sealed so that there is no water leakage. U-trap shall be provided at the end. Additional insulation drain tray shall be provided below the Evaporator Unit, if required.

Mounting

All indoor units shall be mounted with Brackets, Hangers etc. With proper size anchor Fasteners.

1.19. ELECTRICAL INSTALLATION

For Variable Refrigerant flow systems, power will be provided near outdoor unit location. HVAC Contractor to provide suitable distribution panel along with 3-phase power to outdoor units and single-phase power to all indoor units fed by these outdoor units. Power / control cabling and earthing along with supports shall be included.

1.20. GENERAL

Vendor to include below points for VRF system in their offer.

- a. VRF shall be with 100% inverter provision.
- b. Outdoor units shall function as per the varying evaporative & ambient temperature/pressure.
- c. Indoor & Outdoor units shall be complete with is starter control panel, contactors, switchgears, control cabling. Power shall be provided at one point at each outdoor unit.
- d. All control cabling of the VRF system, between indoor & outdoor units shall be in the VRF vendor scope.
- e. IP rating of outdoor units shall be minimum IP-24
- f. Outdoor units shall be provided with Base frame & Vibration Isolation Pads

- g. Outdoor units with isolation/globe valves, angle valve for refrigerant charging (provision of temperature & pressure gauges)
- h. Charge of Green refrigerant (Zero ODP) & compressor oil to be included.
- i. The outdoor unit shall be provided with isolation valve for maintenance & pump down of the refrigerant. Base/installation Frame for installation of the outdoor units (unit shall be installed one above other as there is space constraint) to be include in the scope.
- j. If one room has more than one indoor units then units shall be provided with Timer/ sequencer /controller for the scheduling of equipment (For standby option)
- k. All copper piping will be hard type for the size 1 inch & above. Piping shall be as per IS.10773.1995 & latest revision.
- l. Copper piping with all fitting, (T fitting, cross-T fitting, elbow, reducers, sockets, nipple, adaptor, bush, coupling, ferrules, union, caps, flanges, gaskets, nut bolt, screw, brazing, soldering, welding, flux etc.)
- m. Complete refrigerant piping to be leak tested as per industry standard with pressure test with nitrogen gas & hold the pressure for the 24Hr. The piping shall also be vacuum tested & it should hold pressure for a minimum of 24 Hr.
- n. Suitable piping traps to be provided to prevent the liquid flood back, oil accumulation etc.
- o. Refrigerant piping between indoor & outdoor units shall be insulated with nitrile rubber insulation
- p. Refrigerant Piping will be laid on & covered with 2 mm thick GSS cable tray.
- q. Each indoor unit shall be provided with expansion valve, filters, drier, and isolation valves. Each indoor unit/equipment shall be suitable for ADP up to 50 Deg F
- r. Controller for indoor unit shall be Digital display type with display of Fan speed, room temperature, room RH, set point, on /off status, heating cooling mode. Indoor Unit shall be multi speed controller. Capacity given is on medium speed
- s. Number of expansion valve can be more than one as per the indoor unit selection, same to be included in the scope/cost.
- t. Wired / wireless remote control with each indoor unit.
- u. Indoor units shall be selected considering Noise level shall not be more than 49dB(A)
- v. Indoor units (like high wall split) shall be provided with installation frame. Ceiling hang Indoor units shall be installed with spring isolator for the vibration control.
- w. Each equipment will be drain point with drain piping with cleanable U trap. Cassette units shall be provided with pumps with NRV for drain water.
- x. Piping connection details (orientation) will be as per the HVAC layout, schedule to be produced mentioning room no, room name & capacity & orientation of piping connection.
- y. Complete supporting of the system is in the vendor scope.
- z. Centralized system controller for the VRF shall be capable to cater/control the numbers of units mentioned in the BOQ. If more than one centralized controller is required than need to include in the same item/prices.

HORIZONTAL /VERTICAL FLOOR MOUNTED AIR HANDLING UNITS

SCOPE

The Scope of this section comprises the supply, erection, testing and commissioning of air handling units conforming to these Specifications and in accordance with requirements.

TYPE

The air handling units shall be double skin modular, draw through type comprising of various sections such as mixing chamber (wherever R .AIR and F.AIR are ducted.), pre filter section, chilled water coil section, fan section supply air plenum as per details given in Drawings and

design requirement.

CAPACITY

The air handling capacities, maximum motor HP, static pressure shall be as shown on Drawings and as per design requirement'.

CASING

Double skinned panels shall be 40+/-2 mm thick Double Skin Panels with thermal break profile, shall be made of 0.8mm Pre-coated GSS on outside and 0.8mm Galvanized sheet inside with 275 GSM galvanized coating for corrosion resistance and with CFC – FREE P.U. insulation of 42 (+/- 5%) kg/Cu M injected in between with an internal gasket between the skins to interrupt the thermal bridge of the panel. Outer sheet of panels shall be made of galvanized pre-coated sheet of 0.8 mm thickness to ensure mechanical strength as per class D1 of EN 1886, air leakage as per class L1 of EN 1886, thermal bridging of minimum TB3 class and thermal transmittance of minimum T3 class as per EN 1886.

Manufacturer shall submit test certificate of conformity for Class D1, Class L1, Class TB3 & Class T3 issued by internationally recognized Independent Laboratory should be submitted along with type test report.

The entire framework shall be mounted on an aluminium alloy or 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 openable 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.

Mixing Box

AHU's requiring mixing boxes as specified in drawings shall be complete with fresh and return air dampers.

Damper

Dampers shall be opposed to the type of blade. Blades shall be made of double-skinned aero-foil aluminium sections with integral gasket and assembled within a rigid extruded aluminium alloy frame. All linkages and supporting spindles shall be made of aluminium 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.

Motor and Drive

Fan motors shall be energy efficient (IE-3) and shall be 415±10% volts, 50 cycles, three phase, totally enclosed fan-cooled class F, with IP-55 protection. Motors shall be especially designed for quiet operation. Drive to fan shall be provided through direct-drive arrangement.

Fan

Fans shall be direct driven plug fan with aerofoil design blades for Floor Mounted AHU/TFA units and Ceiling Suspended unit with Forward Curved Direct Driven Fan with three phase motor so as to give maximum efficiency for given duty condition. All direct driven Plug 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 despatch. 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 galvanised steel in case of forward curved, MS epoxy coated in case of backward curved DIDW fans and MS epoxy coated/composite material for direct driven 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. 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 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.

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/Heating Coils

- **Chilled Water Cooling/Heat Coil**

Chilled water coils shall have 12.5mm (1/2") to 15mm (5/8") dia. tubes minimum 0.41 mm thick with aluminium fins firmly bonded to copper tubes assembled in a 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 each coil shall not exceed 150 meters per minute. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory tested at 21 Kg./Sq.cm air pressure under water. Tube shall be hydraulically/mechanically expanded for minimum thermal contact resistance with fins. Fins spacing shall be 11 to 13 fins per inch (4 to 5 fins per centimeter).

DX Cooling/Heating coil

Dx cooling coil section with aluminium finned plain copper tubes (tubes thickness not less than 0.3mm & dia. 9.52mm) cooling coil. Tubes minimum 0.5 mm thick with aluminium fins firmly bonded to copper tubes assembled in a 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 each coil shall not exceed 150 meters per minute. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory tested at 21 Kg./Sq.cm air pressure under water. Tube shall be hydraulically/mechanically expanded for minimum thermal contact resistance with fins.

SPECIAL NOTE : CONTRACTOR TO CHECK TENDER DETAILS FOR CONNECTIONS OF VRF ODU WITH TFA OR AHU UNIT. COIL RD TO BE STUDIED. CONTRACTOR TO CONSIDER THE NECESSARY COST OF EXPANSION KITS OR ADDITIONAL CAPACITIES AS REQUIRED FOR CONNECTION OF VRF SYSTEM WITH ASKED AIR HANDLING UNIT OR TREATED FRESH AIR HANDLING UNIT WITH MENTIONED COIL RD. IT WILL BE DSITC SCOPE OF CONTRACTOR FOR MENTIONED SYSTEM. NO EXTRA COST SHALL BE PAID TOWARDS ANY SUCH MODIFICATIONS.

Filters

Shall be done as per specification given under Electronic Air Filter System.

Filter Assembly

Shall be done as per specification given under Electronic Air Filter System.

AHUs shall be certified as per following standards

- For Mechanical performance as per EN 1886 : 2007
- Mechanical Strength of Casing_D1
- Casing Air Leakage_L1
- Filter Bypass Leakage_F9
- Thermal Transmission_T3
- Thermal Bridging_TB3

For Rating & Performance for Units, Components and Sections as per EN 13053 : 2006 +A1: 2011

Acoustic insulation of Casing as per ISO 11546-2

The real unit shall be tested at the certified laboratory for following parameter.

- Air flow: Static pressure data, power consumption.
- Octave bands for conducted sound power emissions as per EN ISO 3741, 3744 & 3746
- Heat recovery as per EN 308
- Cooling Duty as per EN 1216
- Heating Duty as per EN 1216
- Air Side and Water side pressure drop
- Filter performance as per EN 779 Aerodynamic testing of damper and valves as per EN 1751
- Fluid flow as per EN ISO 5167-1
- Fan performance as per ISO 5801

Note:

1. Above tested parameter and selected parameter should be strictly within the close tolerances set by the above mentioned standards.
2. All the technical selections should be from a selection software version that is enlisted on the third party (such as Eurovent/ AHRI) certifying body website. If a manufacturer submits separate selection sheets for different components, it means that the components are not included in the certification process. The complete AHU selection shall contain all components which should carry Eurovent/ AHRI logo on each page with the software version.

Isolators

Vibration isolators shall be provided with all air handling units. The fan and motor framework shall be isolated from the AHU framework by means of spring type vibration isolators. The AHU shall be mounted on 8/9 nos. 200x200x200 P.C.C. blocks suitable for weight of the AHU. The framework of the AHU and the P.C.C. blocks shall be isolated by means of neoprene mats of size 150mmx150mm in two layers with 20g G.S.S. sheet sandwiched in between.

Accessories

Each air handling unit shall be complete with the accessories including

- Insulated isolation valves, Y-strainer, header drain valves, unions and insulated condensate drain piping upto sump or floor drain in air handling unit room/ nearest point, as described in section schedule document.
- Manual air vents at high points in the cooling coil and drain plug in the bottom of the coil. – to be included in the cost of the AHU.
- Thermometers in thermometer wells and pressure gauges in test points in chilled water supply and return lines. – to be included in the cost of the AHU. Air and Water side control as specified under section "Control and Instruments"

Painting

Powder coated paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop-painted surfaces.

Noise Control

Air Handling Units shall be selected for the lowest operating noise level of the equipment. Fan performance rating, power consumption, and sound power data with operating points clearly indicated shall be submitted with the tenders and verified at the time of testing and commissioning of the installation. The sound level of the AHU shall be less than 60 dBA at one meter distance at room condition.

Connections

Piping installation requirements are specified in other section. The Drawings indicate the general arrangement of piping, valves, fittings, and specialities. The following are specific connection requirements:

- Arrange piping installations adjacent to units to allow unit servicing and maintenance.
- Connect piping to air-handling units with flanges enabling easy removal of the coil.
- Connect condensate drain pans using 50 mm (2-0 inch) minimum, insulated G.I. pipe and extend to nearest floor drain. Construct deep trap (depth as per detail) at connection to drain pan and install cleanouts at changes in direction.
- Duct installations and connections are specified in other sections. make final duct connections with flexible connections.
- Electrical Connections: The following requirements apply:
- Electrical power wiring is specified in section Electrical.
- Temperature control wiring and interlock wiring is specified in Section "Electrical Control systems."
- Grounding: Connect unit components to ground in accordance with the Indian Electrical Code.

Adjusting, Cleaning, And Protecting

- Adjust water coil flow, with control valves to full coil flow, to indicate l/s (gpm).
- Adjust damper linkages for proper damper operation.
- Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, and coils entering air face.

Commissioning

- Final Checks Before Start-Up: Perform the following operations and checks before start-up:
- Remove shipping, blocking and bracing.
- Verify unit is secure on mounting and supporting devices, connections for piping, ductwork and electrical are complete. Verify proper overload protection is installed in motors, starters, and disconnects.
- Perform cleaning and adjusting specified in this Section.
- Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operations. Reconnect fan drive system and align belts.
- Lubricate bearings, pulleys, belts, and other moving parts with factory recommended lubricants.
- Set outside-air / supply air dampers to minimum outside-air setting.
- Comb coil fins for parallel orientation.
- Install temporary throw away filters for initial run and finally install clean filters.
- Verify manual and automatic volume control, and fire dampers in connected ductwork system are in the full-open position.
- Disable automatic temperature control operators.
- Starting procedures for central-station air-handling units:
- Energize motor, verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicate RPM.
- Replace fan and motor pulleys as required to achieve design conditions.
- Measure and record motor electrical values for voltage and amperage.
- Shut unit down and reconnect automatic temperature control operators.

Testing

Cooling capacity of various Air handling units shall 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 a calibrated rotating vane 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 and input current, whereas noise level at various locations within the conditioned spaces shall be measured by a sound pressure level meter.

CEILING SUSPENDED AIR HANDLING UNITS

SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of ceiling mounted air handling units, conforming to these specifications and in accordance with requirements of drawings and as per design requirement.

TYPE

The air-handling units shall be double skin ceiling suspended, draw through type comprising of various sections such as pre-filter section, chilled water coil section, fan section, as per details given in drawings and as per design requirement.

CAPACITY

The air moving and coil capacities shall be As per DPR/Detailed Design and as per design requirement.

UNIT CONSTRUCTION

The unit shall be ceiling suspended type. The housing/casing of the air handling unit shall be double skin construction. The framework shall be of extruded aluminium hollow sections. All the frame shall be assembled using pressure die cast aluminium joints to make a sturdy, strong & self-supporting frame work for various sections.

40mm thick double skin panels shall be made of 0.8 mm pre-plasticized GSS sheet on outside and 0.8 mm galvanized sheet inside with PUF insulation injected in between. These panels shall be screwed on to the framework with soft rubber gasket on aluminium frame to make the joints air tight. Insulation material shall be of 40 Kg./m³ density (minimum). Detachable steel insulated drain pan with necessary slope to facilitate fast removal of condensate shall be provided. Necessary outlet from the drain pan shall be provided. The unit shall be suitably insulated from inside to avoid condensation on outer surface. Necessary provision for ceiling suspension shall be provided. The drain pan shall be insulated with 12mm thick closed cell Nitrile rubber or as per manufacturer's specifications.

Manufacturer shall submit test certificate of conformity for Class D1, Class L1, Class TB3 & Class T3 issued by internationally recognized Independent Laboratory should be submitted along with type test report.

FAN AND MOTOR

Plug Fans:-Fans shall be backward curved plug fan with aerofoil design blades so as to give maximum efficiency for given duty condition. The fan shall be AMCA certified and the entire Fan + Motor assembly shall be balanced before dispatch. Multiple fans/ single fan shall be used in AHU to suit available AHU Room at site & as per approved shop drawing. The supply air fan shall be as per requirements. The fan impeller shall be supported to housing with angle iron frame & pillow block heavy duty ball bearing. The fan housing with TEFC Sq. Cage motor shall be mounted on a common adjustable base frame on vibration isolators/ rubber turret mounts vibration isolators. The fan motor shall be installed inside the housing of air handling unit to keep low noise level. The fan & motor assembly shall be of aluminium extruded section only.

COIL

The chilled water coil shall be of seamless copper tubes not less than 0.4 mm thick and 12mm OD. Coil face areas shall be such as to ensure rated capacity from each unit and such that air velocity across each coil shall not exceed 150 meters per minute. The coil shall be pitched in the unit casing for proper drainage. The fins shall be spaced by collars forming integral part of the fins. The tubes shall be staggered in the direction of airflow. The fins shall be uniformly bonded to the tubes by mechanical expansion of the tube for minimum thermal contact resistance with fins. Coil size shall be selected for a max. Face velocity of 500 FPM.

Fin spacing shall be 11 to 12 FPI & shall be 0.17 to 0.2 mm thick. The coils shall be tested against leaks at a hydraulic pressure of 21 kg/sq.cm. This pressure shall be maintained for period of at least 2 hours.

No drop should be observed indicating any leaks. The water headers shall be completed with water in/out connections, vent plug on top and drain at bottom and designed to provide water velocity between 2 to 6 FPS. The coils exceeding 6 rows depth should be in two equal parts.

FILTER

Shall be done as per specification given under Electronic Air Filter System.

ACCESSORIES

Each air-handling unit shall be provided with manual air vent at highest point in the cooling coil. In addition; following accessories may be required at air handling units.

- a. Stem type thermometer at inlet and outlet of each coil with tubing and gauge cocks and as per applicable specifications.
- b. Pressure gauge with globe valves at inlet and outlet of each coil with tubing and as per applicable specifications.
- c. Butterfly valves at inlet and outlet of each coil.
- d. Y Strainer at inlet of each coil.
- e. Union and condensate drain piping from the unit up to the drain trap as described in section piping.
- f. PIB Control Valve located in chilled water lines connected to the coil. This valve shall be operated through the cooling/heating thermostat and shall control the flow of chilled/hot water and as per applicable specifications.
- g. Cooling /heating thermostat as per section
- h. Automatic Controls and Instruments' shall be located in return air stream.
- i. Double Flexible connection of fire retardant Hessian between the fan outlet and duct.
- j. Vibration isolators of minimum 90% efficiency.
- k. Motor & drive package
- l. Air purge valve on top of coil header and drain valve at bottom.

DESIGN DATA FOR AIR HANDLING UNITS

- i. Fan outlet velocity shall not exceed 550 MPM.
- ii. The air velocity across coil shall not exceed 150 MPM.
- iii. The air velocity across air pre filter shall not exceed 150 MPM.

Motor rating is tentative only and shall be suitable for the duty but not less than the specified HP. Motors shall be selected considering at least 20% margin over the break power.

The AHU fan shall be selected for a total static pressure as indicated under Technical Schedule for Equipment'.

INSTALLATION

Unit shall be installed above the false ceiling in a manner so as to permit the removal of all the parts of AHU for any maintenance work without dismantling other equipment such as plenum, pipes, ducts etc. Air handling unit installation shall be carried out as per manufacturer's recommendation. Rubber in shear type suspension hangers shall be provided for vibration isolation.

PERFORMANCE DATA

Air handling unit shall be selected for the lowest operating noise level. 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.

TESTING

Cooling/heating capacity of various air-handling unit models shall be computed from the measurements of airflow and dry and wet bulb temperatures of air entering and leaving the coil.

DATA/ INFORMATION:-

The contractor shall complete the Data Sheet & submit as a part of his technical submittal at appropriate stage.

HORIZONTAL FLOOR MOUNTED AIR HANDING UNITS – DATA SHEET

1.	GENERAL	
1.1	Manufacturer	
1.2	Type of Unit	
1.3	Over All Dimensions (L x W x H) (mm)	
1.4	Weight (Including Water in circulation) Kg.	
1.5	Approximate Noise Level (DBA)	
1.6	Fan Discharge Position	
2.0	FAN SECTION	
2.1	Air Quantity (CFM)	
2.2	Total Static Pressure (mm of WG)	
2.3	Fan Speed (RPM)	
2.4	Fan Diameter (INCH) and no. Of fans	
2.5	Balancing (Static and / or dynamic)	
2.6	BHP	
2.7	Motor HP, RPM, Make & Type	
3.0	COOLING COIL	
3.1	Coil Fin Material (Aluminum or copper)	
3.2	Tube Diameter (INCH) and material	
3.3	Water through coil (USGPM) and no. of circuits	
3.4	Fin Size (INCH)	
3.5	No of Fins / INCH	
3.6	Water velocity through Coil (FPS)	
3.7	Water Coil Pressure Drop (ft of WG)	
3.8	Outside Coil Surface (SQFT)	
3.9	Face Area (SQFT) of Coil	
3.10	Rows Deep	
3.11	Water Temperature IN & OUT (DEG F)	
3.12	Air In and Out DB& WB Temp (DEG F)	

VERTICAL FLOOR MOUNTED

AIR HANDING UNITS – DATA SHEET

1	GENERAL	
1.1	Manufacturer	
1.2	Type of Unit	
1.3	Over All Dimensions (L x W x H) (mm)	
1.4	Weight (Including Water in circulation) Kg.	
1.5	Approximate Noise Level (DBA)	
1.6	Fan Discharge Position	
2.0	FAN SECTION	
2.1	Air Quantity (CFM)	

2.2	Total Static Pressure (mm of WG)	
2.3	Fan Speed (RPM)	
2.4	Fan Diameter (INCH) and no. Of fans	
2.5	Balancing (Static and / or dynamic)	
2.6	BHP	
2.7	Motor HP, RPM, Make & Type	
3.0	COOLING COIL	
3.1	Coil Fin Material (Aluminum or copper)	
3.2	Tube Diameter (INCH) and material	
3.3	Water through coil (USGPM) and no. of circuits	
3.4	Fin Size (INCH)	
3.5	No of Fins / INCH	
3.6	Water velocity through Coil (FPS)	
3.7	Water Coil Pressure Drop (ft of WG)	
3.8	Outside Coil Surface (SQFT)	
3.9	Face Area (SQFT) of Coil	
3.10	Rows Deep	
3.11	Water Temperature IN & OUT (DEG F)	
3.12	Air In and Out DB& WB Temp (DEG F)	

CEILING SUSPENDED AIR HANDING UNITS

DATA SHEET B

	GENERAL	
1.1	Manufacturer	
1.2	Type of Unit	
1.3	Over All Dimensions (L x W x H) (mm)	
1.4	Weight (Including Water in circulation) Kg.	
1.5	Approximate Noise Level (DBA)	
1.6	Fan Discharge Position	
2.0	FAN SECTION	
2.1	Air Quantity (CFM)	
2.2	Total Static Pressure (mm of WG)	
2.3	Fan Speed (RPM)	
2.4	Fan Diameter (INCH) and no. Of fans	
2.5	Balancing (Static and / or dynamic)	
2.6	BHP	
2.7	Motor HP, RPM, Make & Type	
3.0	COOLING COIL	
3.1	Coil Fin Material (Aluminum or copper)	

3.2	Tube Diameter (INCH) and material	
3.3	Water through coil (USGPM) and no. of circuits	
3.4	Fin Size (INCH)	
3.5	No of Fins / INCH	
3.6	Water velocity through Coil (FPS)	
3.7	Water Coil Pressure Drop (ft of WG)	
3.8	Outside Coil Surface (SQFT)	
3.9	Face Area (SQFT) of Coil	
3.10	Rows Deep	
3.11	Water Temperature IN & OUT (DEG F)	
3.12	Air In and Out DB& WB Temp (DEG F)	

VARIABLE FREQUENCY DRIVES FOR HVAC SYSTEMS

GENERAL REQUIREMENTS –

Specifically HVAC Drives from MAKES mentioned in make list.

- a. 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.
- b. The frequency converter shall not be a general purpose product, but a dedicated HVAC engineered product.
- c. The VFD and its options shall be factory mounted and tested as a single unit under full load before dispatch.
- d. The VFD shall be tested to UL 508C. The appropriate UL label shall be applied.
- e. The VFD shall be CE marked and conform to the European Union Electro Magnetic Compatibility directive.
- f. The VFD shall be UL listed for a short circuit current rating of 100 kA and labeled with this rating.

TECHNICAL REQUIREMENTS

- 2.1 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.
- 2.2 The VFD shall include an input full-wave bridge rectifier and maintain a fundamental (displacement) power factor near unity regardless of speed or load.
- 2.3 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.
- 2.4 VFDs with saturating (non-linear) DC link reactors shall require an additional 3% 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.

- 2.5 All VFDs 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 61800-3 : 2004, Category C1 with 50m motor cable (unrestricted distribution). The suppliers of VFDs shall include additional EMC filters if required to meet compliance to this requirement.
- 2.6 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.
- 2.7 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.
- 2.8 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.
- 2.9 The VFD must be able to produce full torque at low speed to operate direct driven fans.
- 2.10 Output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD.
- 2.11 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 de-couple the motor from the load to perform the test.
- 2.12 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.
- 2.13 VFD shall minimize the audible motor noise through the use 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.
- 2.14 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.
- 2.15 Overload protection in VFD shall automatically compensate for changes in motor speed.
- 2.16 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.
- 2.17 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.
- 2.18 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.

- 2.19 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.
- 2.20 If the temperature of the VFD's heat sink rises to 80C, 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.
- 2.21 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.
- 2.22 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.
- 2.23 Protect from output switching: The VFD shall be fully protected from switching a contactor/ isolator at the output without causing tripping e.g.: for switching on/off the isolators of the AHU/ ventilation fans/ pumps near the motor with VFD in ON mode.
- 2.24 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.
- 2.25 When used with a pumping system, the VFD shall be able to detect no-flow 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.

INTERFACE FEATURES

- 1. 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 password protect them from undesired operation.
- 2. There shall be an "Info" key on the keypad. The Info key shall include "on-line" context sensitive assistance for programming and troubleshooting.
- 3. The VFD shall be programmable to provide a digital output signal to indicate whether the VFD is in Manual or Auto mode. This is to alert the Building Automation System whether the VFD is being controlled locally or by the Building Automation System.
- 4. 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.
- 5. All VFDs shall have the same customer interface. The keypad and display shall be identical and interchangeable for all sizes of VFDs.
- 6. 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.
- 7. Display shall be programmable to communicate in multiple languages including English, Chinese, Korean, Japanese, Thai and Indonesian.
- 8. A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.
- 9. A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD. The

VFD shall also have individual Fan, Pump, and Compressor menus specifically designed to facilitate start-up of these applications.

10. A three-feedback PID controller to control the speed of the VFD shall be standard.
11. 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.
12. The VFD shall be able to apply individual scaling to each feedback signal.
13. 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.
14. The VFD's PID controller shall be able to actively adjust its setpoint 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.
15. The VFD shall have three additional PID controllers which can be used to control damper and valve positioners in the system and to provide setpoint reset.
16. Floating point control interface shall be provided to increase/decrease speed in response to contact closures.
17. 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.
18. 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 no-flow 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 "wake-up" 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.
19. 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.
20. VFD shall be programmable to display feedback signals in appropriate units, such as inches of water column (in-wg), 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, CO2 concentration in ppm, pressure in bar, differential pressure in PSI etc.
21. 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.
22. Standard Control and Monitoring Inputs and Outputs
 - a. Four dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
 - b. Two terminals shall be programmable to act as either as digital outputs or additional digital inputs.
 - c. Two programmable relay outputs, Form C 240 V AC, 2 A, shall be provided for remote indication of VFD status.
 - d. Each relay shall have an adjustable on delay/ off delay time.

- e. Two programmable analog inputs shall be provided that can be either direct-orreverse acting.
- f. Each shall be independently selectable to be used with either an analog voltage or current signal.
- g. 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.
- h. A programmable low-pass filter for either or both of the analog inputs must be included to compensate for noise.
- i. The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting.
- j. 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.
- k. It shall be possible to read the status of all analog and digital inputs of the VFD through serial bus communications.
- l. It shall be possible to command all digital and analog output through the serial communication bus.

Optional Control and Monitoring Inputs and Outputs

- a. It shall be possible to add optional modules to the VFD in the field to expand its analog and digital inputs and outputs.
- b. These modules shall use rigid connectors to plug into the VFD's control card.
- c. The VFD shall automatically recognize the option module after it is powered up. There shall be no need to manually configure the module.
- d. Modules may include such items as:
 - e. Additional digital outputs, including relay outputs
 - f. Additional digital inputs
 - g. Additional analog outputs
 - h. Additional analog inputs, including Ni or Pt temperature sensor inputs
- i. It shall be possible through serial bus communications to control the status of all optional analog and digital outputs of the VFD.
- 1. 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.
- 2. A real-time clock shall be an integral part of the VFD.
 - a. It shall be possible to use this to display the current date and time on the VFD's display.
 - b. 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 setpoints and output relays. Is shall be possible to program unique events that occur only during normal work days, others that occur only on non-work 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.
 - c. All VFD faults shall be time stamped to aid troubleshooting.
 - d. It shall be possible to program maintenance reminders based on date and time, VFD running hours, or VFD operating hours.

- e. The real-time clock shall be able to time and date stamp all faults recorded in the VFD fault log.
- f. The VFD shall be able to store load profile data to assist in analyzing the system demand and energy consumption over time.
- i. The VFD shall include a sequential logic controller to provide advanced control interface capabilities. This shall include:
 - ii. Comparators for comparing VFD analog values to programmed trigger values.
 - iii. Logic operators to combine up to three logic expressions using Boolean algebra
 - iv. Delay timers
 - v. A 20-step programmable structure

The VFD shall include a Cascade Controller which allows the VFD to operate in closed loop set point (PID) control mode for one motor at a controlled speed and control the operation of 3 additional constant speed motor starters.

SERIAL COMMUNICATIONS

1. The VFD shall include a standard EIA-485 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:
 - a. Metasys N2
 - b. Modbus RTU
2. VFD shall have standard USB port for direct connection of Personal Computer (PC) to the VFD. The manufacturer shall provide at 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.
3. The VFD shall have provisions for an optional 24 V DC back-up 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.

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.

1. Four independent setups shall be provided.
2. Four preset speeds per setup shall be provided for a total of 16.
3. 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, over-voltage, 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 a 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. Semi-automatic setting of lockout ranges shall simplify the set-up.

SERVICE CONDITIONS

- 7.1 Ambient temperature at full speed, full load operation with continuous drive rated output current:
- a. -10 to 45°C for ratings upto 90 kW without derating
 - b. -10 to 40°C for ratings 110 kW and higher without derating
 - c. Relative Humidity : 0 to 95%, non-condensing.
 - d. Elevation : Up to 3,300 feet without derating.
 - e. AC line voltage variation : + 10% of nominal with full output.
 - f. VFD Enclosure protection : IP 55, integral, with no additional cabinets.
 - g. Side Clearances : No side clearance shall be required for cooling.
 - h. All power and control wiring shall be done from the bottom.
 - i. All VFDs shall be plenum rated.

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.

ELECTRONIC AIR FILTRATION SYSTEM

General

It is the intent of the specification to incorporate highly efficient electronic air filtration system with low pressure drops into the building AHU system.

All AHU's shall be fitted with a true electronic air cleaner system (complete with washable pre-filter, charging section and collector section) to be installed before the cooling coils. Other forms of air filtration systems such as charged media filters, dielectric media filters, or ionizers (which do not have second stage collector plates) shall not be acceptable. The electronic air cleaner (EAC) shall be capable of removing particulates as small as 0.01 microns including microscopic haze particles, smoke, dust, mould spores and bacteria.

Approvals / Code Requirements

The EAC shall be Underwriter Laboratories (UL) Listed for safety. The EAC shall also be EMC (Electromagnetic compatibility) certified. Full documentation must be submitted to confirm compliance to the above requirements. Ozone level of EACs provided must be within the acceptable limit of 0.05ppm. Tenderers must also provide a test report to confirm conformance.

Safety Provisions

Each EAC cell shall have their automatic interlock switch which disconnects power and discharges the cell when the access door is opened. In addition, the EAC shall be capable of interlocking when disconnecting the power to

each individual EAC unit, or when the AHU fan is not running.

A high voltage test button shall be provided for each individual high tension power supply unit to indicate the presence of high voltage on the electronic cells. An overall test button for a group of power supply units to provide a general indication of high tension voltage is not approved.

Performance / Reliability Requirements

The average capacity of the EAC shall be at least 1000cfm for the single cell unit and 2000cfm for the double cells unit.

The EAC filtration to be certified as MERV13 or above as per ASHRAE 52.2 from a reputed laboratory.

The solid state power supply shall provide dual voltage to the ionizer and collector section. The voltage to the ionizer shall be at least 8000V DC to create an intense electrostatic field to allow maximum transfer of electrical charge from the ionizing wires to air particles. The voltage to the collector shall be at least 4000V DC.

The entire Filtration system shall be washable and reusable without need for replacements. Electrostatic media filters that collect particles on disposable media pads shall not be acceptable.

The average initial pressure differential drop across the entire filtration system shall not exceed 75 pa at 2000cfm and 2.5 m/s airflow. The ionizing wires and collector plates shall be integrated within one pack. It shall be washable for repeated use. A washable aluminium mesh prefilter shall be provided at the inlet to trap all larger sized particles. Pre Media-Filter should not acceptable nor needed in filtration system of AHU.

Filter cells shall be universal to allow for a single inventory of filters as spare parts.

The EAC shall be completed with Hot- dipped Galvanized cabinet to protect against rust, heavy duty commercial used electronic cells, solid state power supply, protective screen and prefilter. A washable aluminum mesh prefilter shall be provided at the inlet to trap all larger sized particles.

The EAC shall have the capability for the optional addition of activated carbon (Charcoal) filter. The activated carbon filter shall be able to reside into the EAC cabinet as and when necessary; no modification for the initial installation shall be allowed. Material of the carbon filter should be 3/8" carbon impregnated foam with not less than 30PPI. Frame of the carbon filter to be Tin Plated and Air entering side to be marked on the same. The additional pressure drop on adding the carbon filter shouldn't be more than 10Pa.

Diagnostics / Interfacing to Building Management System

The EAC shall have the capability of interface with the building management system through a Solid State Performance Indicator (SSPI). Any system which uses separate DP switch for pressure across EAC's will not be accepted. The following status shall be allowed for remote monitoring by the building management system as common fault:

1. Any malfunction of the system that shall cause an alarm activation (CHECK)
2. Excessive dirt accumulation in the collector cells that could result in the reduction of the EAC performance (WASH)

The EAC shall have local LEDs at each individual unit to indicate the above status and it shall be able to provide in addition a signal to link-up with the building management system for monitoring.

Submission of Compliance Documentation

Tenderers must submit a Clause-by-Clause Compliance Summary and provide full documentation/technical literature/data sheets/reports to confirm compliance for each clause. Please also submit a project reference list.

2.1 SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of centrifugal, in-line and propeller type fans and roof mounted units conforming to these Specifications and in accordance with the requirement of Drawings and Schedule of Quantities.

2.2 TYPE

Centrifugal, in-line propeller fans and roof mounted units shall be of the type as indicated on Drawings and identified in Schedule of Quantities.

2.3 CAPACITY

The air-moving capacity of fans shall be as shown on Drawings and in Schedule of Quantities.

2.4 CENTRIFUGAL FAN

Centrifugal fan shall be DWDI / SWSI Class 1 construction arrangement 3 (i.e. bearings on both the sides) for DWDI fans complete with access door, squirrel-cage induction motor, V-belt drive, belt guard and vibration isolators, direction of discharge / rotation, and motor position shall be as per the Approved-for-Construction shop drawings.

- a. Housing shall be constructed of 14-gauge sheet steel 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 should be provided throughout split joints to make it airtight.

18-gauge galvanized wire mesh inlet guards of 5 cm sieves shall be provided on both inlets. Housing shall be provided with standard cleanout door with handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.
- b. Fan Wheel shall be backward-curved non-over loading type. Fan wheel and housing shall be statically and dynamically balanced. For fans up to 450 mm dia, fan outlet velocity shall not exceed 550 meter/minute and maximum fan speed shall not exceed 1450 rpm. For fans above 450 mm dia, the outlet velocity shall be within 700 meter/minute and maximum fan speed shall not exceed 1000 RPM. High static pressure fan speed shall be as per manufacturer.
- c. Shaft shall be constructed of steel, turned, ground and polished.
- d. Bearings: shall be of the sleeve / ball-bearing type mounted directly on the fan housing. Bearings shall be designed especially for quiet operation and shall be of the self-aligning, oil / grease pack pillow block type.
- e. Motor: Fan motor shall be energy efficient and suitable for 415±10% volts, 50 cycles, 3 phase AC power supply, squirrel-cage, totally enclosed, fan-cooled motor, provided with class F insulation, and of approved make. Motor name plate horsepower shall exceed brake horsepower by a minimum of 10%. Motor shall be designed especially for quiet operation and motor speed shall not exceed 1440 rpm. The fan and motor combination selected for the particular required performance shall be of the most efficient (smallest horse power), so that sound level is lowest.

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HP	POWER FACTOR			EFFICIENCY		
	FL	3/4L	1/2L	FL	3/4L	1/2L
0.50	0.71	0.62	0.50	73.00	73.00	68.00

0.75	0.74	0.64	0.50	78.00	78.00	70.00
1.00	0.76	0.67	0.55	82.50	82.50	77.00
1.50	0.77	0.70	0.57	83.80	83.80	80.00
2.00	0.77	0.70	0.57	85.00	85.00	81.00
3.00	0.82	0.74	0.60	86.40	86.40	84.00
5.00	0.82	0.78	0.63	88.30	88.30	86.00
7.50	0.85	0.80	0.71	89.50	88.50	88.00
10.00	0.86	0.83	0.76	90.30	90.30	89.00
12.50	0.84	0.82	0.73	90.50	90.50	88.00
15.00	0.85	0.83	0.76	91.50	91.50	89.50
20.00	0.85	0.83	0.76	92.20	92.20	91.00
25.00	0.85	0.82	0.76	92.40	92.40	91.00
30.00	0.85	0.80	0.72	92.80	92.80	92.00
40.00	0.86	0.85	0.80	93.20	93.20	91.00
50.00	0.87	0.85	0.77	93.60	93.60	91.60
60.00	0.88	0.86	0.78	93.90	93.90	91.90
75.00	0.87	0.85	0.78	94.20	94.20	92.80

- f. Drive to fan shall be provided through belt with adjustable motor sheave and a standard belt guard. Belts shall be of the oil-resistant type.
- g. Vibration Isolation: MS base shall be provided for both fan and motor, built as an integral part, and shall be mounted on a concrete foundation through resistoflex vibration isolators. The concrete foundation shall be at least 15 cm above the finished floor level, or as shown in approved-for-construction shop drawings.
- a. Centrifugal fans for smoke extract application shall have external belt drive and motor. Fan & casing shall be internally rated for 300°C for 2 hours.

2.5 AXIAL FLOW FAN

2.5.1 Axial Flow Fan (Standard)

Fan shall be complete with motor, motor mount, belt driven (or direct driven) and vibration isolation type, suspension arrangement as per approved for construction shop drawings.

- a. Casing: shall be constructed of heavy gage sheet steel. Fan casing, motor mount and straightening vane shall be of welded steel construction. Motor mounting plate shall be minimum 15 mm thick and machined to receive motor flange.

An inspection door with handle and neoprene gasket shall be provided. Casing shall have flanged connection on both ends for ducted applications. 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.

- b. Rotor: hub and blades shall be cast aluminium alloy or cast steel construction. Blades shall be die-formed aerofoil shaped for maximum efficiency and shall vary in twist and width from hub to tip to effect equal air distribution along the blade length. Rotor shall be statically and dynamically balanced. Extended grease leads for external lubrication shall be provided. The fan pitch control may be manually readjusted at site upon installation, for obtaining actual air flow values, as specified and quoted. Taper lock bushing shall be used to mount the propeller to the motor shaft. The impeller and fan casing shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency.

c. Motor: shall be energy efficient squirrel-cage, totally-enclosed, fan cooled, standard frame, constant speed, continuous duty, single winding, suitable for $415 \pm 10\%$ volts, 50 cycles, 3 phase AC power supply, provided with class 'F' insulation. Motor shall be specially designed for quiet operation. The speed of the fans shall not exceed 1000 RPM for fans with impeller diameter above 450 mm, and 1440 RPM for fans with impeller diameter 450 mm and less. For lowest sound level, fan shall be selected for maximum efficiency or minimum horsepower. Motor conduit box shall be mounted on exterior of fan casing, and lead wires from the motor to the conduit box shall be protected from the air stream by enclosing in a flexible metal conduit.

HP	POWER FACTOR			EFFICIENCY		
	FL	3/4L	1/2L	FL	3/4L	1/2L
0.50	0.71	0.62	0.50	73.00	73.00	68.00
0.75	0.74	0.64	0.50	78.00	78.00	70.00
1.00	0.76	0.67	0.55	82.50	82.50	77.00
1.50	0.77	0.70	0.57	83.80	83.80	80.00
2.00	0.77	0.70	0.57	85.00	85.00	81.00
3.00	0.82	0.74	0.60	86.40	86.40	84.00
5.00	0.82	0.78	0.63	88.30	88.30	86.00
7.50	0.85	0.80	0.71	89.50	88.50	88.00
10.00	0.86	0.83	0.76	90.30	90.30	89.00
12.50	0.84	0.82	0.73	90.50	90.50	88.00
15.00	0.85	0.83	0.76	91.50	91.50	89.50
20.00	0.85	0.83	0.76	92.20	92.20	91.00
25.00	0.85	0.82	0.76	92.40	92.40	91.00
30.00	0.85	0.80	0.72	92.80	92.80	92.00
40.00	0.86	0.85	0.80	93.20	93.20	91.00
50.00	0.87	0.85	0.77	93.60	93.60	91.60
60.00	0.88	0.86	0.78	93.90	93.90	91.90
75.00	0.87	0.85	0.78	94.20	94.20	92.80

- d. Drive: to fan shall be provided through belt drive with adjustable motor sheave and standard sheet steel belt guard with vented front for heat dissipation. Belts shall be of oil-resistant type.
- e. Vibration Isolation: The assembly of fan and motor shall be suspended from the slab by vibration isolation suspension of heavy duty spring isolators type.
- f. Accessories: The following accessories shall be provided with all fans :
- i. Outlet cone for static pressure regain.

- ii. Inlet cone.

Fan silencers may be provided where specifically called for in Schedule of Quantities. Fans shall be factory assembled and shipped with all accessories factory-mounted.

Axial Flow Fan shall be AMCA certified for Air and Sound performance in accordance to AMCA 210 and AMCA 300. Fan shall be suitable for both indoor and outdoor application with all accessories. Base fan performance shall be at standard conditions (density 1.2 Kg/Cu.mt.)

2.5.2 Axial Flow Fan (UL Listed/ CE Certified)

Fan shall be suitable for mounting in duct or wall / floor / slab as required. Fan shall be complete with motor, motor mount, belt driven (or direct driven) and vibration isolation type, suspension arrangement as per approved for construction shop drawings.

- a. Casing: shall be constructed of heavy gage sheet steel. Fan casing, motor mount and straightening vane shall be of welded steel construction. Bolt construction is not acceptable. Motor mounting plate shall be of structural steel with minimum 15 mm thick and suitable to handle the weight of the motor and propeller, machined to receive motor flange.

An inspection door with handle and neoprene gasket shall be provided. Casing shall have flanged connection on both ends for ducted applications. Fan casing are with internal punched inlet and outlet flanges to prevent air leakage, for size upto 1600 mm dia and shall be constructed of rolled steel with a continuous seam welded confirming to UL standards. 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 as prescribed in UL-705.

- b. Rotor : hub and blades shall be cast aluminum alloy or cast steel construction. Blades shall be die-formed aerofoil shaped for maximum efficiency and shall vary in twist and width from hub to tip to effect equal air distribution along the blade length. Rotor shall be statically and dynamically balanced. Extended grease leads for external lubrication shall be provided. The fan pitch control may be manually readjusted at site upon installation, for obtaining actual air flow values, as specified and quoted. Taper lock bushing shall be used to mount the propeller to the motor shaft. The impeller and fan casing shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency.
- c. Motor: shall be energy efficient squirrel-cage, totally-enclosed, fan cooled, standard frame, constant speed, continuous duty, single winding, suitable for 415±10% volts, 50 cycles, 3 phase AC power supply, provided with class 'F' insulation. Motor shall be specially designed for quiet operation. The speed of the fans shall not exceed 1000 RPM for fans with impeller diameter above 450 mm, and 1440 RPM for fans with impeller diameter 450 mm and less. For lowest sound level, fan shall be selected for maximum efficiency or minimum horsepower. Motor shall pass elevated temperature test and other tests as per UL standards and shall be UL listed. Motor conduit box shall be mounted on exterior of fan casing, and lead wires from the motor to the conduit box shall be protected from the air stream by enclosing in a flexible liquid tight PVC conduit confirming to UL standards.

HP	POWER FACTOR			EFFICIENCY		
	FL	3/4L	1/2L	FL	3/4L	1/2L

0.50	0.71	0.62	0.50	73.00	73.00	68.00
0.75	0.74	0.64	0.50	78.00	78.00	70.00
1.00	0.76	0.67	0.55	82.50	82.50	77.00
1.50	0.77	0.70	0.57	83.80	83.80	80.00
2.00	0.77	0.70	0.57	85.00	85.00	81.00
3.00	0.82	0.74	0.60	86.40	86.40	84.00
5.00	0.82	0.78	0.63	88.30	88.30	86.00
7.50	0.85	0.80	0.71	89.50	88.50	88.00
10.00	0.86	0.83	0.76	90.30	90.30	89.00
12.50	0.84	0.82	0.73	90.50	90.50	88.00
15.00	0.85	0.83	0.76	91.50	91.50	89.50
20.00	0.85	0.83	0.76	92.20	92.20	91.00
25.00	0.85	0.82	0.76	92.40	92.40	91.00
30.00	0.85	0.80	0.72	92.80	92.80	92.00
40.00	0.86	0.85	0.80	93.20	93.20	91.00
HP	POWER FACTOR			EFFICIENCY		
	FL	3/4L	1/2L	FL	3/4L	1/2L
50.00	0.87	0.85	0.77	93.60	93.60	91.60
60.00	0.88	0.86	0.78	93.90	93.90	91.90
75.00	0.87	0.85	0.78	94.20	94.20	92.80

- d. Drive : Fan shall be provided through direct / belt drive with adjustable motor sheave and standard sheet steel belt guard with vented front for heat dissipation. Belts shall be of oil-resistant type.
- e. Vibration Isolation : The assembly of fan and motor shall be suspended from the slab by vibration isolation suspension of heavy duty spring isolators type.
- f. Accessories : The following accessories shall be provided with all fans :
- Outlet cone for static pressure regain.
 - Inlet cone.

Fan silencers may be provided where specifically called for in Schedule of Quantities. Fans shall be factory assembled and shipped with all accessories factory-mounted confirming to UL standards.

Complete fan assembly (fan, impeller, fan casing, motor base frame along with motor) shall be ensure mechanical, electrical, water safety as per UL standards.

Axial Flow Fan shall be AMCA certified for Air and Sound performance in accordance to AMCA 210 & AMCA 300 and shall be UL listed in accordance with UL 705 for both indoor and outdoor application with all accessories. Base fan performance shall be at standard conditions (density 1.2 Kg/Cu.mt.)

2.6 PROPELLER FAN

Propeller fan shall be direct-driven, three or four blade type, mounted on a steel mounting plate with orifice ring.

- a. Mounting Plate shall be of steel construction, square with streamlined venturi inlet (reversed for supply applications) coated with baked enamel paint. Mounting plate shall be of standard size, constructed of 12 to 16 gauge sheet steel depending upon the fan size. Orifice ring shall be correctly formed by spinning or stamping to provide easy passage of air without turbulence and to direct the air stream.
- b. Fan Blades shall be constructed of aluminium or steel. Fan hub shall be of heavy welded steel construction with blades bolted to the hub. Fan blades and hub assembly shall be statically and dynamically balanced at the manufacturer's works.
- c. Shaft shall be of steel, accurately ground and shall be of ample size for the load transmitted and shall not pass through first critical speed thru the full range of specified fan speeds.
- d. Motor shall be standard (easily replaceable) permanent split capacitor or shaded pole for small sizes, totally enclosed with prelubricated sleeve or ball bearings, designed for quiet operation with a maximum speed of 1000 rpm for fans 60 cm dia or larger and 1440 rpm for fans 45 cm dia and smaller. Motors for larger fans shall be suitable for $415 \pm 6\%$ volts, 50 cycles 3 phase power supply, and for smaller fans shall be suitable for $220 \pm 6\%$ volts, 50 cycles single phase power supply. Motors shall be suitable for either horizontal or vertical service as indicated on Drawings and in Schedule of Quantities.
- e. Accessories : The following accessories shall be provided with propeller fans :
 - i. Wire guard on inlet side and bird-screen at the outlet.
 - ii. Fixed or gravity louvers built into a steel frame at the outlet.
 - iii. Regulator for controlling fan speed for single phase fan motor.
 - iv. Single phase preventers for 3 phase fans.

2.7 PERFORMANCE DATA

All fans shall be selected for the lowest operating noise level. Capacity ratings, power consumption, with operating points clearly indicated, shall be submitted and verified at the time of testing and commissioning of the installation.

2.8 TESTING

Capacity of all fans shall be measured by an anemometer. Measured air flow capacities shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

2.9 COMMISSIONING & HANDOVER:

CONTRACTOR SHALL PROVIDE ALL THE DOCUMENTS ASKED BY CONSULTANT/CLINT/ARCHTECT

3.0 REFRIGERANT PIPING

- a. All refrigerant pipes and fittings shall be hard drawn copper tubes and wrought copper / brass fittings suitable for connection with silver solder / phos-copper.
- b. All joints in copper piping shall be sweat joints using low temperature brazing and / or silver solder. Before jointing any copper pipe or fittings, its interiors shall be thoroughly cleaned by passing a clean cloth via

wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while constructing the joints. Subsequently, it shall be thoroughly blown out using carbon dioxide / nitrogen.

- c. Refrigerant lines shall be sized to limit pressure drop between the evaporator and condensing unit to less than 0.2 kg per sq.cm.
- d. Sight glass with moisture indicator and removable type combination dryer cum filter with MS housing and brass wire mesh / punched brass sheet shall be installed in liquid line of the refrigeration system incorporating a three valve by pass. After ninety days of operation, liquid line drier cartridges shall be replaced.
- e. Heat exchanger shall be MS heavy duty pipe in pipe type and without any joint in the inner pipe.
- f. Horizontal suction line shall be pitched towards the compressor and no reducers shall be provided for proper oil return.
- g. After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using Freon mixed with nitrogen / carbondioxide at a pressure of 20 kg per sq. cm (high side) and 10 kg per sq. cm (low side). Pressure shall be maintained in the system for a minimum of 12 hours. The system shall then be evacuated to a minimum vacuum of 70 cm of mercury and held for 24 hours. Vacuum shall be checked with a vacuum gage.
- h. All refrigeration piping shall be installed strictly as per the instructions and recommendations of air conditioning equipment manufacturer.

3.1 STEEL WIRE ROPE HANGERS & SUPPORTS:

Wire Hangers shall be used to suspend all static HVAC & Mechanical services.

Wire Hangers should consist of a pre-formed wire rope sling with a range of end fixings to fit various substrates and service fixings, these include a ferruled loop, permanently fixed threaded M6 (or M8, M10) stud, permanently fixed nipple end with toggle, at one end or hook or eyelet, cladding hook, barrel, wedge anchor, eyebolt anchor or any other end fixture type or size as per manufacturers recommendation and design. The end fixings and the wire must be of the same manufacturer with several options available. The system should be secured and tensioned with a Hanger self-locking grip (double channel lock) at the other end. Once the grip is locked for safety purpose unlocking should only be done by using a separate setting key and should not be an integral part of the self-locking grip. Only wire and/or supports supplied and/or approved, shall be used with the system.

- a. Wire Hangers should have been independently tested by Lloyds Register. APAVE, TUV, UL NEBS, CSA, Chiltern International fire, ADCAS, Intertek, ECA, and SMACNA, approved by ULC and CSA and comply with the requirements of DW/144 and BSRIA – wire Rope Suspension systems. Wire rope should be manufactured to BSEN 12385: 2002
- b. The contractor shall select the correct specification of wire hanger to use for supporting each service from Table 1 below. Each size is designated with a maximum safe working load limit (which incorporates a 5:1 safety factor).

The correct specification of wire hanger required is determined using the following formula.

Weight per meter of object suspended (kg) X distance between suspension points (m) = weight loading per Hanger suspension point (kg).

Where the installed wire rope is not vertical then the working load limit shall be reduced in accordance with the recommendations give in the manufacturer's handbook.

The contractor shall select the correct length of wire rope required to support the service. Lengths from 1-10m lengths. Specials can be made, check with manufacturer. No in-line joints should be made in the rope.

Table. 1

Wire (Gripple) Hanger Safe Working Loads		
Hange rsize	minimum breaking load of Wire Rope (kg/lbs)	working load limit (kg/lbs)
No. 1	80kg/176 lbs	0-10 kg / 0-22 lbs
No. 2	260kg/572 lbs	10-45 kg / 23-100 lbs
No. 3	580kg/1276 lbs	45-90 kg / 101-200 lbs
No. 4	1500kg/3300 lbs	90-225 kg / 210-495 lbs
No. 5	2160kg/4752 lbs	225-325 kg / 496-715 lbs
No. 6	2500kg/5500 lbs	325-500 kg / 715-1100 lbs

The standard range of Hanger Kits should contain galvanized high tensile steel wire rope or stainless-steel wire rope as per the application, the minimum specification is as above and should be manufactured to BS 302 (1987), BSEN12385. **Comply with manufacturer's load ratings and recommended installation procedures.**

- 3.1.1 Mechanical Supports – Gripple Hanger Supports are suitable for: Water Pipes, Drainage Pipes, Gas Pipes, Refrigeration Pipes, Condensation Water Pipes.
- 3.1.2 Piping Supports: Rigid supports may be used in conjunction with Gripple hangers to assist with alignment of services as per the Schedule. These can be at 30m intervals or so depending on the run of the service. Rigid support must also be used in conjunction with Gripple hangers with pipe work at each change of direction or connection or as per approved drawings. For insulated pipe, provide protective sleeve to protect the entire circumference of the pipe insulation. Stainless Steel Supports should be available for food, chemical and High Corrosion areas near coastlines.
- 3.1.3 Any other Gripple solution can be used based on manufacturer's recommendation on site conditions after prior approval. Support piping in accordance with Schedule I, II & III specified below:
- 3.1.4 For further technical information, refer to manufacturers catalogue and installation guide. **Comply with manufacturer's load ratings and recommended installation procedures. All supporting system to be provided by same manufacturer.**

4. AIR DISTRIBUTION

(FOR DUCTS FABRICATED IN FACTORY AS PER "SMACNA" STANDARDS)

4.1 SCOPE

The scope of this section comprises supply fabrication, installation and testing of all sheet metal / aluminum ducts, supply, installation, testing and balancing of all grilles, registers and diffusers. All to be in accordance with these specifications and the general arrangement shown on the Drawings.

4.2 DUCT MATERIALS

4.2.1 Raw Materials

Galvanized steel sheets with Class - VII Galvanizing – light coating of zinc (Zinc coating shall be Lead free), nominal 120gm/sq.m surface area and Lock Forming Quality prime material along with mill test certificates. In addition, if deemed necessary, samples of raw material, selected at random by owner's site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

4.2.2 Gauges, Bracing By Size Of Ducts

All ducts shall be factory fabricated from galvanized steel / aluminum of the following thickness, as indicated below :

4.2.2.1 For Ducts with External SP upto 250 Pa

To be used for Hotels & Commercial Projects	Rectangular Ducts G. S.	External Pressure 250 Pa		
	Maximum Duct Size	Duct Section Length 1.2 m (4 ft)		
		Gauge	Joint Type	Bracing Spacing
	1–500 mm	26	C&S Connector	Nil
	501 – 750 mm	26	TDF Flange	Nil
	751 – 900 mm	24	TDF Flange	Nil
	901 – 1200 mm	24	TDF Flange	Nil
	1201 – 1500 mm	22	TDF Flange	Nil
	1501 – 1800 mm	20	TDF Flange	JTR or ZEE BAR
	1801 – 2100 mm	20	TDF Flange	JTR or ZEE BAR
	2101 – above	18	TDF Flange	JTR or ZEE BAR

OR

4.2.2.2 For Ducts with External SP upto 500 Pa

For Hospital & Clean room jobs, where AHU SP is specified as 75 mm and above.	Rectangular Ducts G. S.	External Pressure 500 Pa		
		Duct Section Length 1.2 m (4 ft)		
	Maximum Duct Size	Gauge	Joint Type	Bracing Spacing
	1–400 mm	26	C&S Connector	Nil
	401-700 mm	24	TDF Flange	Nil
<u>Not Suitable for</u>	701-900 mm	24	TDF Flange	Nil
	901-1000 mm	22	TDF Flange	Nil

OTs	1001-1200 mm	22	TDF Flange	JTR or ZEE BAR
	1201-2100 mm	20	TDF Flange	JTR or ZEE BAR
	2101-above	18	TDF Flange	JTR or ZEE BAR

*Distance of reinforcement/bracing from each joint. Bracing material to be same as of material used for joining of duct sections.

FOR ALUMINUM DUCTS MATERIAL SHALL BE ONE COMMERCIAL GAUGE HIGHER WITH 22 G AS MINIMUM

4.2.3 For Round Ducts

Duct diameter mm	Upto 50 mm Wg static pressure (+ve)		51 – 250 mm Wg static pressure (+ve)		Upto 50 mm Wg static pressure (-ve)	
	Spiral seam gauge	Longitudinal seam gauge	Spiral seam gauge	Longitudinal seam gauge	Spiral seam gauge	Longitudinal seam gauge
Upto 650	26	24	24	22	24	22
651-900	24	22	22	20	22	20
901 – 1250	22	20	20	20	20	18
1251 – 1500	20	18	18	18	18	16
1501 – 2100	18	16	18	16	16	14

4.3 FABRICATION STANDARDS & EQUIPMENT

All duct construction and installation shall be in accordance with SMACNA standards. In addition ducts shall be factory fabricated utilizing the following machines to provide the requisite quality of ducts.

1. Coil (Sheet metal in Roll Form) lines to facilitate location of longitudinal seams at corners/folded edges only, for required duct rigidity and leakage free characteristics. No longitudinal seams permitted along any face side of the duct.
2. All ducts, transformation pieces and fittings to be made on CNC profile cutter for requisite accuracy of dimensions, location and dimensions of notches at the folding lines.
3. All edges to be machine treated using lock formers, flangers and rollers for turning up edges.
4. Kitchen exhaust ducting shall be with 16 G MS welded construction. Suitable access doors shall be provided at every 3m. Provision shall be made for firefighting agency to install duct mounted sprinklers at every 3m. Generally exhaust ducts shall have slope towards kitchen hood. Spot Welded M.S Stuck-up pins shall be provided facilitating insulation of the Duct .

Laundry and dish washer extract duct shall be air and water tight construction manufactured from Aluminium sheets in accordance to BS 1470

4.4 DUCT CONSTRUCTION

4.4.1 All ducts shall be fabricated and installed in workmanlike manner, conforming to relevant SMACNA codes.

- a) Ducts so identified on the Drawings shall be acoustically lined and insulated from outside as described in the section "Insulation" and as indicated in schedule of Quantities. Duct dimensions shown on drawings, are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in Schedule of quantities. The fabricated duct dimensions should be as per approved drawings and care should be taken to ensure that all connecting sections are dimensionally matched to avoid any gaps.
- b) Ducts shall be straight and smooth on the inside with longitudinal seams shall be airtight and at corners only which shall be either Pittsburgh or snap button as per SMACNA practice, to ensure air tightness.
- c) All ducts up to 75cms width within conditioned spaces shall have C&S connector. The internal ends of slip joints shall be in the direction of airflow. Care should be taken to ensure that Cleats are mounted on the longer side of the duct and Cleats on the shorter side. Ducts and accessories within ceiling spaces, visible from air-conditioned areas shall be provided with two coats of mat black finish paint.
- d) Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Air-turns (vanes) shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.
- e) Ducts shall be fabricated as per details shown on Drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees, or angles, of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing.
- f) All sheet metal connection, partitions and plenums, required to confine the flow of air to and through the filters and fans, shall be constructed of 18 gauge GSS / 16gauge aluminum, thoroughly stiffened with 25mm x 25mm x 3mm galvanized steel angle braces and fitted with all necessary inspection doors as required, to give access to all parts of the apparatus. Access doors shall be not less than 45cm x 45cm in size.
- g) Plenums shall be shop/factory fabricated panel type and assembled at site. Fixing of galvanized angle flanges on duct pieces shall be with rivets heads inside i.e. towards GS sheet and riveting shall be done from outside.
- h) Self-adhesive Neoprene rubber / UV resistant PVC foam lining 5mm nominal thickness instead of felt, shall be used between duct flanges and between duct supports in all ducting installation.
- i) All fire rated duct, smoke exhaust ducts shall be quoted with flame bar BWII or equivalent to achieve the required fire rating also all the related accessories gaskets shall be suitable for the required fire rating.

4.5 INSTALLATION PRACTICE

All ducts shall be installed generally as per tender drawings, and in strict accordance with approved shop drawings to be prepared by the Contractor:

- a) The Contractor shall provide and neatly erect all sheet metal work as may be required to carry out the intent of these Specifications and Drawings. The work shall meet with the approval of Owner's site representative in all its parts and details
- b) All necessary allowances and provisions shall be made by the Contractor for ducts, pipes, or other obstructions in the building, whether the same are shown on the drawings. Where necessary to avoid beams or other structural work, copper or other pipes, and ducts, the ducts shall be rerouted, divided or resized to one side (the required area being maintained) all as per the site requirements.
- c) If a duct cannot be run as shown on the drawings, the contractor shall install the duct between the required points by any path available in accordance with other services and as per approval of owner's site representative.
- d) All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with hangers formed of galvanized steel wire ropes (as per clause 20.12) and galvanized steel angle/channel or a pair of brackets, connected by galvanized steel wire hangers under ducts, rigid supports may be provided at certain interval if need be. The spacing between supports should be not greater than 2.4 meter. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates or Toggle end wire fixing left in slab at the time of slab casting.

Galvanized steel cleat with a hole for passing the wire rope hanger shall be welded to the plates. Trapeze hanger formed of galvanized steel wire rope using Gripple shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash/anchor fastener driven into the concrete slab by electrically operated gun. Wire rope supports shall hang through the cleats or wire rope threaded studs can be screwed into the anchor fasteners.

- b) Alternatively, if mentioned in the SOQ, all ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with trapeze hangers formed of galvanized steel rods and galvanized steel angle/channel or a pair of brackets, connected by galvanized steel rod under ducts. The spacing between supports should be not greater than 2.0 meter. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the hanger rods shall be welded to the plates. Trapeze hanger formed of galvanized steel rods shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash/anchor fastener driven into the concrete slab by electrically operated gun. Hanger rods shall then hang through the cleats or fully threaded galvanized rods can be screwed into the anchor fasteners.

- c) Ducting over furred ceiling shall be supported from the slab above, or from beams after obtaining approval of Owner's site representative. In no case shall any duct be supported from false ceiling hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other contractor's work in the building.
- d) Where ducts pass through brick or masonry openings, it shall be provided with 25mm thick TF quality expanded polystyrene around the duct and totally covered with fire barrier mortar for complete sealing.
- e) All ducts shall be totally free from vibration under all conditions of operation. Whenever ductwork is connected to fans, air handling units or blower coil units that may cause vibration in the ducts, ducts shall be provided with a flexible connection, located at the unit discharge. Flexible connections shall be constructed of fire retarding flexible heavy canvas sleeve at least 10cm long securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting ductwork rigidly held by independent supports on both sides of the flexible connection. The flexible connection shall be suitable for pressure at the point of installation.
- f) Duct shall not rest on false ceiling and shall be in level from bottom. Taper pieces shall taper from top.

4.6 DAMPERS

- a. Dampers: All duct dampers shall be opposed blade louver dampers of robust 16 G GSS construction and tight fitting. The design, method of handling and control shall be suitable for the location and service required.
- b. Dampers shall be provided with suitable links levers and quadrants as required for their proper operation. Control or setting device shall be made robust, easily operable and accessible through suitable access door in the duct. Every damper shall have an indicating device clearly showing the damper position at all times.
- c. Dampers shall be placed in ducts at every branch supply or return air duct connection, whether or not indicated on the Drawings, for the proper volume control and balancing of the air distribution system.
- d. Pressure relief dampers: Pressure relief dampers shall be constructed with 18G Aluminum construction with parallel blade construction. Leafs shall be 100% air tight upon closure. Leafs shall be loaded with spring pressure of stiffness (k value) corresponding to set point pressure.
- e. Non return damper (Back draft damper) : Non return damper shall be constructed out of 16G GSS. Blades shall ensure 100% air leak proof performance on closure. Design shall ensure that no rattling noise is produced at design duty.
- f. Constant Air Flow Regulator :

Constant Air Flow Regulators (CAR) shall be used to obtain constant air volume at a given pressure range.

The Constant Air Flow Regulators (CAR) shall be of the circular type for high pressures and to be inserted into ductwork and suitable for vertical as well as horizontal mounting and it should be

placed at a minimum distance of 3x the duct diameter from air supply grilles and minimum distance of 1x the duct diameter from air exhaust grilles

Constant Air Flow Regulators (CAR) body, valve and piston shall be made out of flame retardant PVC, fire classification M1. They shall contain a self regulating PVC valve, piston, rubber strip for air tightness inside the duct and stainless steel calibrated spring and shall have preset air volume.

Constant volume regulator shall be made of PVC. The range covers an air flow range from 15 up to 1200 m³/h within a pressure range from 50 up to 600 Pa.

4.7 FIRE & SMOKE DAMPERS (UL Listed Only)

- a. All supply and return air ducts at AHU room crossings and at all floor crossings or as indicated in the drawings shall be provided with Motor operated Fire & smoke damper of at least 90 minutes rating. These shall be of multi-leaf type and provided with Spring Return electrical actuator having its own thermal trip for ambient air temperature outside the duct and air temperature inside the duct. Actuator shall have Form fit type of mounting, metal enclosure and guaranteed long life span. The dampers shall meet the requirements of NFPA90A, 92A and 92B. Dampers shall have a fire rating of 1.5 Hrs. in accordance with latest edition of UL555 and shall be classified as Leakage Class 2 smoke damper in accordance with latest version of UL555S. Each fire/smoke damper shall be AMCA licensed and bear the AMCA seal for air Performance. Pressure drop shall not exceed 7.5Pa when tested at 300m/min face velocity on 600x600mm size damper. Actuator shall be UL listed.
- b. Each damper shall be supplied with factory mounted sleeve of galvanized steel of thickness as per SMACNA and of minimum 500mm long or as specified in schedule of quantities depending up on the wall thickness. The damper shall be fitted in to sleeve either using welding or self-tapping screws. All welded joints shall be finished using heat resistance steel paint. UL listed and approved Silicon sealant shall be applied at all corners as well as at joints between damper frame and sleeve. Damper Frame shall be a roll formed structural hat channel, reinforced at corners, formed from a single piece of 1.6mm galvanized steel. Damper blades shall be airfoil shaped (equivalent to 2.3mm thickness strength) roll formed using 0.8mm thick single piece of galvanized sheet. Bearings shall be of stainless steel fitted in an extruded hole in the damper frame. Blade edge seals shall be silicone rubber and galvanized steel mechanically locked into the blade edge (adhesive type seals are not acceptable). Side Jam seals of stainless steel and Top and bottom seals of galvanized steel shall be provided. All galvanized steel used shall be with minimum 180 gm / sqm Zinc coating. Bigger size Dampers shall be supplied in Multiple modules of sizes not exceeding in dimensions of certified module, jack shafted together. Multiple actuators shall be provided for large dampers with higher torque requirements as prescribed in UL.
- c. The electric actuator shall be energized either upon receiving a signal from smoke detector installed in AHU room supply air duct /return air duct. Electric Actuator of suitable Torque and as approved by UL shall be factory mounted and tested. The actuator shall be suitable for 24V AC supply. In addition, actuator shall have elevated temperature rating of 250 deg.F. Electric Actuator shall have been energized hold open tested for a period of at least one year with no spring return failure. Each fire/smoke damper shall be equipped with a heat actuated release device which shall allow controlled closure of damper rather than instantaneous to prevent accident.(Electrical fusible link).The EFL shall allow the damper to reopen automatically after a test, smoke detection or power

failure condition. The damper shall be equipped with a device to indicate OPEN and CLOSE position of Damper blades through a link mounted on the damper blade.

- d. Each damper shall be provided with its own control panel, mounted on the wall and suitable for 240 VAC supply. This control panel shall be suitable for spring return actuator and shall have at least the following features:
- Potential free contacts for AHU fan ON/ Off and remote alarm indication.
 - Accept signal from external smoke / fire detection system for tripping the electrical actuator.
 - Test and reset facility.
 - Indicating lights / contacts to indicate the following status:
 - Power Supply On
 - Alarm
 - Damper open and close position.
- e. Actuators shall be mounted on the sleeve by the damper supplier in his shop and shall furnish test certificate for satisfactory operation of each Motor Operated Damper in conjunction with its control panel. Control panel shall be wall mounted type.
- f. It shall be HVAC Contractor's responsibility to co-ordinate with the Fire Alarm System Contractor for correctly hooking up the Motor Operated Damper to Fire Detection / Fire Management System. All necessary materials for hooking up shall be supplied and installed by HVAC Contractor under close co-ordination with the fire protection system contractor.
- g. HVAC Contractor shall demonstrate the testing of all Dampers and its control panel after necessary hook up with the fire protection / fire management system is carried out by energizing all the smoke detectors with the help of smoke.
- h. HVAC Contractor shall provide Fire retardant cables wherever required for satisfactory operation and control of the Damper.
- j. HVAC Contractor shall strictly follow the instructions of the Damper Supplier or avail his services at site before carrying out testing and installation at site.
- k. Fire/smoke damper shall be provided with factory fitted sleeves; however, access doors shall be provided in the ducts within AHU room in accordance with the manufacturer's recommendations.
- l. The Contractor shall also furnish to the Owner, the necessary additional spare actuators and temperature sensor (a minimum of 5% of the total number installed) at the time of commissioning of the installation.

4.8 FIRE DAMPERS

All Fresh Air Ducts Entering into the AHU room shall be with Motorized Fire & Smoke damper of at least 90 minutes rating. These shall be of multi-leaf type and Provided with Spring Return electrical actuator having its own thermal trip for ambient Air temperature outside the duct and air temperature inside the duct. Dampers shall Be UL labelled for use in dynamic systems. The damper shall have a dynamic closure Airflow rating equal to or greater than the airflow at the damper's installed location and a dynamic closure pressure rating of 101.6 mm H2O. Damper actuators shall be factory Mounted and qualified for use with the damper in accordance with UL555S. Actuator shall Have Form fit type of mounting, metal enclosure and guaranteed long life Span. The

Dampers shall meet the requirements of NFPA90A, 92A and 92B. Dampers Shall have a Fire rating of 1.5 Hrs. in accordance with latest edition of UL555 and shall be Classified as Leakage Class 1 smoke damper in accordance with latest version of UL555S. Each Fire/smoke damper shall be AMCA licensed and bear the AMCA seal for air Performance.

The Damper Manufacturer's submittal data shall certify all air performance pressure drop data is licensed in accordance with the AMCA Certified Ratings Program. Damper air performance data shall be developed in accordance with the latest edition of AMCA Standard 500-D.

Damper frames shall be galvanized steel formed into a structural hat channel shape with reinforced corners. Bearings shall be sintered bronze sleeve type rotating in extruded holes in the damper frame. Jamb seals shall be stainless steel compression type.

Each damper shall be provided with its own control panel, mounted on the wall and suitable for 240 VAC supply. This control panel shall be suitable for spring return actuator and shall have at least the following features:

- Potential free contacts for AHU fan ON/ Off and remote alarm indication.
- Accept signal from external smoke / fire detection system for tripping the electrical actuator.
- Test and reset facility.
- Indicating lights / contacts to indicate the following status:
 - Power Supply On
 - Alarm
 - Damper open and close position.

It shall be HVAC Contractor's responsibility to co-ordinate with the Fire Alarm System Contractor for correctly hooking up the Motor Operated Damper to Fire Detection / Fire Management System. All necessary materials including power cabling between control panels to fire dampers actuator for hooking up shall be supplied and installed by HVAC Contractor under close co-ordination with the fire protection system contractor.

4.9 SUPPLY AND RETURN AIR REGISTERS

Supply & return air registers shall be of either steel or aluminium sections as specified in schedule of quantities. Steel construction registers shall have primer Coat finish whereas extruded aluminium registers shall be either Anodised or Powder Coated as specified in Schedule of Quantities. These registers shall have individually adjustable louvers both horizontal and vertical. Supply air registers shall be provided with key operated opposed blade extruded aluminium volume control damper anodised in matt black shade.

The registers shall be suitable for fixing arrangement having concealed screws as approved by Architect. Linear continuous supply cum return air register shall be extruded aluminium construction with fixed horizontal bars at 15 Deg. inclination & flange on both sides only (none on top & bottom). The thickness of the fixed bar louvers shall be minimum 5.5 mm in front and 3.8 mm in rear with rounded edges. Flanges on the two sides shall be 20 mm/30 mm wide as approved by Architect.

The grilles shall be suitable for concealed fixing. Volume control dampers of extruded aluminium

anodised in black color shall be provided in supply air duct collars. For fan coil units horizontal fixed bar grilles as described above shall be provided with flanges on four sides, and the core shall be & suitable for clip fixing, permitting its removal without disturbing the flanges.

- a. All registers shall be selected in consultation with the Architect. Different spaces shall require horizontal or vertical face bars, and different width of margin frames. These shall be procured only after obtaining written approval from Architect for each type of register.
- b. All registers shall have a soft continuous rubber/foam gasket between the periphery of the register and the surface on which it has to be mounted. The effective area of the registers for air flow shall not be less than 66 percent of gross face area.
- c. Registers specified with individually adjustable bars shall have adjustable pattern as each grille bar shall be pivotable to provide pattern with 0 to +45 degree horizontal arc and upto 30 degree deflection downwards. Bars shall hold deflection settings under all conditions of velocity and pressure.
- d. Bar longer than 45 cm shall be reinforced by set-back vertical members of approved thickness.
- e. All volume control dampers shall be anodised aluminium in mat black shade.

4.10 SUPPLY AND RETURN AIR DIFFUSERS

Supply and return air diffusers shall be as shown on the Drawings and indicated in Schedule of Quantities. Mild steel diffusers/dampers shall be factory coated with rust-resistant primer. Aluminium diffusers shall be powder coated & made from extruded aluminium section as specified in schedule of quantities.

- a. Rectangular Diffusers shall be steel / extruded aluminium construction, square & rectangular diffusers with flush fixed pattern for different spaces as per schedule of quantities. These shall be selected in consultation with the Architect. These shall be procured only after obtaining written approval from Architect for each type of diffuser.
- b. Supply air diffusers shall be equipped with fixed air distribution grids, removable key-operated volume control dampers, and anti-smudge rings as re-required in specific applications and as per requirements of schedule of quantities. All extruded aluminium diffusers shall be provided with removable central core and concealed key operation for volume control damper.
- c. Linear Diffuser shall be extruded aluminium construction with removable core, one or two way blow type. Supply air diffusers shall be provided with volume control/ balancing dampers within the supply air collar. Diffusers for different spaces shall be selected in consultation with the Architect, and provided as per requirements of schedule of quantities. All diffusers shall have volume control dampers of extruded aluminium construction anodized in mat black shade.
- d. Slot Diffuser shall be extruded aluminium construction multislot type with air pattern controller provided in each slot. Supply air diffusers shall be provided with Hit & Miss volume control dampers in each slot of the supply air diffusers. Diffusers for different spaces shall be selected in consultation with the Architect and provided as per requirement of Schedule of Quantities.
- e. Data centers shall be provided with floor grilles. Grilles shall be of nominal size of 600mm x 600mm and shall be fitted in floor tile of false floor. Grille shall be with dampers for flow control. Grill shall be heavy duty 16G Aluminium and shall take care of human traffic load. Damper shall be operable in situ without requirement of removal of grille.

4.11 STEEL WIRE ROPE HANGERS & SUPPORTS:

Wire Hangers shall be used to suspend all static HVAC Air Distribution services.

Wire Hangers should consist of a pre-formed wire rope sling with a range of end fixings to fit various substrates and service fixings, these include a ferruled loop, permanently fixed threaded M6 (or M8, M10) stud, permanently fixed nipple end with toggle, at one end or hook or eyelet, cladding hook, barrel, wedge anchor, eyebolt anchor or any other end fixture type or size as per manufacturers recommendation and design. The end fixings and the wire must be of the same manufacturer with several options available. The system should be secured and tensioned with a Hanger self-locking grip (double channel lock) at the other end. Once the grip is locked for safety purpose unlocking should only be done by using a separate setting key and should not be an integral part of the self-locking grip. Only wire and/or supports supplied and/or approved, shall be used with the system.

- Wire Hangers should have been independently tested by Lloyds Register, APAVE, TUV, UL NEBS, CSA, Chiltern International fire, ADCAS, Intertek, ECA, and SMACNA, approved by ULC and CSA and comply with the requirements of DW/144 and BSRIA – wire Rope Suspension systems. Wire rope should be manufactured to BSEN 12385: 2002
- The contractor shall select the correct specification of wire hanger to use for supporting each particular service from Table 1 below. Each size is designated with a maximum safe working load limit (which incorporates a 5:1 safety factor).

The correct specification of wire hanger required is determined using the following formula.

Weight per meter of object suspended (kg) X distance between suspension points (m) = weight loading per Hanger suspension point (kg).

Where the installed wire rope is not vertical then the working load limit shall be reduced in accordance with the recommendations give in the manufacturer's handbook.

The contractor shall select the correct length of wire rope required to support the service. Lengths from 1-10m lengths. Specials can be made, check with manufacturer. No in-line joints should be made in the rope.

Table. 1

Wire Hanger Safe Working Loads		
Hanger size	minimum breaking load of Wire Rope (Kg / lbs)	working load limit (kg/lbs)
No. 1	80kg/176 lbs	0-10 kg / 0-22 lbs
No. 2	260kg/572 lbs	10-45 kg / 23-100 lbs
No. 3	580kg/1276 lbs	45-90 kg / 101-200 lbs
No. 4	1500kg/3300 lbs	90-225 kg / 210-495 lbs
No. 5	2160kg/4752 lbs	225-325 kg / 496-715 lbs
No. 6	2500kg/5500 lbs	325-500 kg / 715-1100 lbs

The standard range of Hanger Kits should contain galvanized high tensile steel wire rope or stainless-steel wire rope as per the application, the minimum specification is as above and should be manufactured to BS 302 (1987), BSEN12385. **Comply with manufacturer's load ratings and recommended installation procedures.**

A HVAC Supports

Gripple Hanger Supports are suitable for: Rectangular duct, Spiral Duct, Oval Duct, Fabric Duct, Diffusers, plenum boxes

B Ducting Supports:

- a. All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with hangers formed of galvanized steel wire ropes and galvanized steel angle/channel or a pair of brackets, connected by galvanized steel wire hangers under ducts, rigid supports may be provided at certain interval if need be. The spacing between supports should be not greater than 2.4 meter. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates or Toggle end wire fixing left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the wire rope hanger shall be welded to the plates. Trapeze hanger formed of galvanized steel wire rope using Gripple shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash/anchor fastener driven into the concrete slab by electrically operated gun. Wire rope supports shall hang through the cleats or wire rope threaded studs can be screwed into the anchor fasteners. In case of PEB structure Loop and Catenary system can be used based on the site conditions as per approved suspension system drawings.
- b. All horizontal ducts shall be adequately secured and supported. In an approved manner, with trapeze Hangers formed of galvanized steel wire rope in a cradle support method (refer to typical drawings) under ducts at no greater than 3000mm centre, for 300mm-above appropriate size angle along with neoprene pad in between the duct & MS angle should be used with prior approval. All vertical duct work shall be supported by structural members on each floor slab. Duct support shall be through dash / anchor fastener driven into the concrete slab by electrically operated gun. Hanger wires shall then hang around the ducting. Rigid supports shall be used in conjunction with wire rope hangers to assist with alignment of services where recommended for by the manufacturer. Rigid support must also be used in conjunction with wire rope hangers with duct work at each change of direction or connection or as per approved drawings. Support ducting in accordance with Schedule I specified below. Any other Gripple solution can be used based on manufacturer's recommendation on site conditions after prior approval. In cases of Spiral ducting the wire can be wrapped directly around the ducting without the need for a spiral ducting clamp for sizes above 1100 a cradle support should be provided, refer to manufacturer's recommendations.
- c. Ducting over furred ceiling shall be supported from the slab above or from beams after obtaining approval of Construction manager/consultant. In no case shall any duct be supported from false ceiling Hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other Contractor's work in the building. All supports of pipe shall be taken from structural slab/wall by means of fastener.
- d. Stainless Steel Supports should be provided for food, chemical and High Corrosion areas near coastlines.

For further technical information refer to manufacturers catalogue and installation guide. **Comply with manufacturer's load ratings and recommended installation procedures.**

Schedule I: Duct Hanger Schedule

Maximum Duct Size (mm)	Gauge	Wire Hanger size	Maximum Duct Size (mm)	Gauge	Wire Hanger size
1 - 500	26	No. 1 or 2	1-400 mm	26	No. 2
501 - 750	26	No. 1 or 2	401-700 mm	24	No. 2 or 3
751 - 900	26	No. 2	701-900 mm	24	No. 2 or 3
901 - 1200	24	No. 2 or 3	901-1000 mm	22	No. 3 or 4
1201 - 1500	22	No. 3	1001-1200 mm	22	No. 3 or 4
1501 - 1800	22	No. 3 or 4	1201-2100 mm	22	No. 3 or 4
1801-2100	20	No. 3 or 4	2101 - 3000mm	18	No. 4
2101-3000	18	No. 4	3001 - above (Trapeze type support Arrangement)	18	No. 3 or 4
3001 - above (Trapeze type support Arrangement)	18	No. 3 or 4			

Notes: All supports are considered at 2400 mm interval in above table and may vary as per the design but should not be greater than 2400mm.

All units shall be adequately secured and supported in an approved manner using wire hanger suspension Y fit solution as per manufacturers' recommendation with prior approval.

Rigid Supports to be used in conjunction with wire supports:

Rigid supports if required in conjunction with wire hangers shall be of steel, adjustable for height and Zinc chromate primer coated and finish coated black. Where supports and clamps are of dissimilar materials, a gasket shall be provided in between. If the MS angle at the bottom if required as per design should be as per following table:

Longer size of Duct (mm)	Type of Joints
Up to 750	25x25x3 mm L angle with M8 nuts & bolts
751-1000	25x25x3 mm L angle with M8 nuts & bolts
1001-1500	40x40x5 mm L angle with M8 nuts & bolts
1501-2250	50x50x5 mm L angle with M10 nuts & bolts
2251 & above	50x50x6 mm L angle with M10 nuts & bolts

All the supporting system should be supplied from the same manufacturer.

5.14 DOCUMENTATION & MEASUREMENTS FOR DUCTING

All ducts fabricated and installed should be accompanied and supported by proper documentation viz:

- a) Bill of material/Packing list for every duct section supplied.

Measurement sheet covering each fabricated duct piece showing dimensions and external surface area along with summary of external surface area of duct gauge-wise.

Each and every duct piece to have a tag 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 and verification.

Unless otherwise specified, measurements for ducting for the project shall be on the basis of centerline measurements described herewith:

Ductwork shall be measured on the basis of external surface area of ducts. Duct measurements shall be taken before application of the insulation. The external surface area shall be calculated by measuring the perimeter comprising overall width and depth, including the corner joints, in the center of each duct section, multiplying with the overall length from flange face to flange face of each duct section and adding up areas of all duct sections. Plenums shall also be measured in a similar manner.

For tapered rectangular ducts, the average width and depth shall be considered for perimeter, whereas for tapered circular ducts, the diameter of the section midway between large and small diameter shall be adopted, the length of tapered duct section shall be the centerline distance between the flanges of the duct section.

For special pieces like bends, tees, reducers, branches and collars, mode of measurement shall be identical to that described above using the length along the centerline.

The quoted unit rate for external surface of ducts shall include all wastage allowances, flanges and gaskets for joints, nuts and bolts, hangers and angles with double nuts for supports, rubber strip 5mm thick between duct and support, vibration isolator suspension where specified or required, inspection chamber/access panel, splitter damper with quadrant and lever for position indication, turning vanes, straightening vanes, and all other accessories required to complete the duct installation as per the specifications. These accessories shall NOT be separately measured nor paid for.

- b. Special Items for Air Distribution shall be measured by the cross-section area perpendicular to air flow, as identified herewith :

- i. Grilles and registers - width multiplied by height, excluding flanges. Volume control dampers shall form part of the unit rate for registers and shall not be separately accounted.
- ii. Diffusers - cross section area for air flow at discharge area, excluding flanges. Volume control dampers shall form part of unit rate for supply air diffusers and shall not be separately accounted.

- iii. Linear diffusers - shall be measured by cross-sectional areas and shall exclude flanges for mounting of linear diffusers. The supply air plenum for linear diffusers shall be measured with ducting as described earlier.
- iv. Fire dampers - shall be measured by their cross sectional area perpendicular to the direction of air flow. Quoted rates shall include the necessary collars and flanges for mounting, inspection pieces with access door, electrical actuators and panel. No special allowance shall be payable for extension of cross section outside the air stream.
- v. Flexible connection - shall be measured by their cross sectional area perpendicular to the direction of air flow. Quoted rates shall include the necessary mounting arrangement, flanges, nuts and bolts and treated-for-fire requisite length of canvas cloth.
- vi. Kitchen Hoods - shall be measured by their cross sectional area at the capture point of fumes, parallel to the surface of kitchen equipment. Quoted rates shall include the grease filters, provision for hood light, suspension arrangement for the hood, profile to direct the air to ventilation ducts and provision for removable drip tray.

5.16 FLEXIBLE DUCT

Insulated flexible duct should be UL 181 CLASS I AIR DUCT LISTED AND LABELLED WITH NFPA 90A & 90B AND SEAL OF AIR DIFFUSION COUNCIL with double lamination of tough polyester which encapsulates steel helix wire forms the air tight inner core, double layer core wrapped in a multiple thickness of fiberglass wool with R Value 4.2, Green guard certification of fiberglass wool must. Reinforced and sheathed in a rugged and durable tridirectionally reinforced matlized polyester jacket.

Flexible duct connections should be made as per UL181 listing procedure with proper flexible right forming brace connection allowing right connections for flexible duct into energy efficient . and Strapping the flexible duct connections with flexible duct strap ties.

5.17 TESTING AND BALANCING

After the installation of the entire air distribution system is completed in all respects, all ducts shall be tested for air leaks by visual inspection.

The entire air distribution system shall be balanced using an anemometer. Measured air quantities at fan discharge and at various outlets shall be identical to or less/excess than 5 percent of those specified and quoted. Branch duct adjustments shall be permanently marked after air balancing is completed so that these can be restored to their correct position if disturbed at any time. Complete air balance report shall be submitted for scrutiny and approval, and four copies of the approved balance report shall be provided with completion documents.

6. INSULATION

6.1 SCOPE

The scope of this section comprises the supply and application of insulation conforming to these specifications. The insulation material shall be Closed Cell Elastomeric Nitrile Rubber / Polyethylene Foam / EPDM

6.2 MATERIAL

Thermal insulation material for Duct & Pipe insulation shall be with factory laminated black fiber glass cloth closed cell Elastomeric UV resistant. Thermal conductivity as per **BS 874 part 2 – 86 (DIN 52613 52612) / DIN EN 12667 / EN ISO8497** of the insulation material shall not exceed 0.038 W/m²K or 0.212 BTU / (Hr-ft²-°F/inch) at an average temperature of 30°C. Density of the nitrile rubber shall be 40-60 Kg/m³, for EPDM shall be 40-60 Kg/m³ & for polyethylene material it shall be 25-30 Kg/m³. The product shall have temperature range of -40 °C to 105°C. The insulation material shall be fire rated for Class 0 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 vapour permeability shall be not less than 0.024 per inch (2.48 x 10⁻¹³ Kg/m.s.Pa i.e. μ≥7000: Water vapour diffusion resistance) as per **DIN 53122 part 2, DIN 52615 / EN 12086 & EN13469**.

In addition to above properties the insulation material for ducts shall be anti-microbial. Microbiological growth on insulation surface shall be in accordance with ASTM G-21 and bacterial resistance to ASTM2180.

The Material shall comply to ISO 5659 / BS 6853 / ABD 0031 for smoke density and toxicity values. The thermal conductivity of insulation material shall not be effected by aging as per **DIN 52616 standard**.

Insulation shall be with self-Adhesive for ducting and piping and available in roles / sheets

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 density and thickness.** 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 non-flammable and with low VOC content (maximum 850 gm/l as per IGBC guide lines) strictly as per manufacturer's recommendations.

Ducting insulation thickness shall be as per table below.

Ducting position	Thk. for non-coastal places	Thk. for coastal places
SA duct in RA path	13 mm	19 mm
Ducted return air system	SA duct: 19 mm RA duct: 13 mm	SA duct: 25 mm RA duct: 19 mm
Both SA & RA exposed	Both 25 mm	Both 25 mm

6.3 DUCT INSULATION

External thermal insulation shall be provided as follows :

The thickness of insulation material shall be as shown on drawings or identified in the schedule of quantity. Following procedure shall be adhered to:

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 insulation to size with sufficient allowance in dimension. Cutting of insulation sheets shall be done with adjustable blade to make 90° cut in thickness of sheet. Hackshaw or blades are not acceptable tools for cutting the insulation.

Material shall be fitted under compression and no stretching of material shall be permitted. All longitudinal and transverse joints shall be sealed by providing 50 mm wide Fibre glass cloth laminated tape as per manufacturer recommendations. The insulation installers shall be certified by manufacture.

Where ducts/pipes penetrates walls / floor it shall be insulated with intumescent properties insulation material for fire protection. The treatment shall be minimum 500 mm extended on both sides.

6.4 DUCT ACOUSTIC LINING

Open Cell Nitrile Rubber

Duct acoustic lining material shall be Nitrile Rubber open cell foam. Thermal conductivity of the insulation material shall not exceed $0.047 \text{ W/m}^2\text{K}$ at an average temperature of 20°C . Density of the nitrile rubber shall be $140 - 180 \text{ Kg/m}^3$. The material should withstand maximum surface temperature of $+85^\circ\text{C}$ and minimum surface temperature of -20°C . The material should conform to Class 1 rating for surface spread of Flame in accordance to BS 476 Part 7 & HBF, HF 1 & HF 2 in accordance to UL 94, 1996.

Insulation should have antimicrobial product protection, and should pass Fungi Resistance as per ASTM G 21 and Bacterial Resistance as per ASTM E 2180. 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 15 mm thick specified for the individual application and with noise absorption properties as per IS: 8225 / ISO 354 / ASTM423C. The insulation should be installed as per manufacturer's recommendation.

Alternative: Resin Bonded Fibre glass

Insulation material for Duct Acoustic Lining shall be resin bonded fibre glass. The thermal conductivity of the fibre glass shall not exceed $0.034 \text{ K Cal/(hr-sq.m-deg C/meter)}$ or $0.23 \text{ BTU/(hr.sq.ft.-deg F/inch)}$ at 32 deg C (90 deg F) mean temperature and density shall be not less than 48 kg/m^3 . Thickness of the material shall be as specified for individual application as per schedule of quantity.

Ducts so identified and marked on drawings and included in Schedule of Quantities shall be provided with acoustic lining of thermal insulation material for a distance of minimum 5 meters as follows:

The inside surface for the ducts shall be covered with adhesive, and provided with 22 gauge GI Channels $25 \times 25 \text{ mm}$ screwed back to back and fixed on the inside of duct, spaced not more than 60 cm center to form a frame work of $60 \times 60 \text{ cms}$ square. Cut panels $60 \times 60 \text{ cms}$ of resin bonded fiber glass 25 mm thick shall be fitted in the squares.

These insulation panels shall be fixed to the sheet metal with cold setting adhesive compound. The inner most surface shall be covered with fiberglass tissue and 28 gage perforated aluminium sheet having atleast 15 percent perforations. The aluminium sheet shall be screwed to GI channels using cup washer and neatly finished to give true inside surface.

Acoustic lining in Plenums especially for Air diffusion connected to slot diffusers shall have 12mm thick rigid board of fiberglass/mineral wool having density of 48 Kg/m^3 .

6.5 ACOUSTIC LINING OF MECHANICAL ROOMS / CEILING:

Open Cell Nitrile Rubber

Two walls and ceiling of air conditioning plant room and air handling unit / fan rooms may be provided with acoustic lining. Material shall be processed from Nitrile rubber open cell foam.

The material should be fibre free. The density of the same shall be 140-180 Kg/m³. The material should have thermal conductivity not exceeding 0.05 W/Mk. The maximum surface temperature of material shall withstand is 105°C. and minimum temp shall be -20°C. Thickness shall be as specified. The material should confirm to class 1 rating for surface spread of flame as per BS 476 Part 7 & HBF, HF1 & FH 2 in accordance with UL 94, 1996. Thickness, if not specified, shall be considered as 20mm.

Surface shall be cleaned and two coats of adhesive recommended by the manufacturer should be applied on the walls. The foam sheets should be cut to required size and a layer of adhesive should also be applied to it. When it is tack dry it is stuck to the walls / ceiling.

All longitudinal and transfer joint shall be covered with 22 gauge 50 mm wide GI strip with screws..

Acoustic lining of walls shall be terminated approximately 15 cm above the finished floor to prevent damage to insulation due to accidental water-logging in plant/AHU / fan rooms.

6.6 OVERDECK INSULATION FOR ROOF

Over deck insulation shall be done with either of the following options.

- i. 100 mm thick expanded polystyrene of density 45-48 kg/cm³ & thermal conductivity of 0.24 Btu in / ft² hr°F (at 24°C as per ASTM C – 518).
- ii. 75 mm thick extruded polystyrene of density 45-48 kg/cm³ & thermal conductivity of 0.21 Btu in / ft² hr°F (at 24°C as per ASTM C – 518).
- iii. 65 mm thick Polyurethane foam (boards or sprayed) of density higher than 40 kg/cm³ & thermal conductivity of 0.17 Btu in / ft² hr°F (at 24°C as per ASTM C – 518).

Minimum compressive strength for above insulations as per ASTM D-2842 shall be 570 kPa & water absorption as per ASTM D-2842 shall not be more than 1%.

Method of Application

- (a) Clean RCC slab and make it free from dust and other laitance matter.
- (b) Lay cement screed of average thickness of 40 mm to prepare a minimum slope of 1:100 on roof slab.
- (c) Lay 100 mm thick expanded polystyrene boards or 75 mm thick extruded polystyrene board or 65 mm thick polyurethane boards over prepared surface of cement screed fixing with adhesive. Adhesive shall be strictly as per recommendations from manufacturer.

OR

Lay 65 mm thick Polyurethane foam (sprayed) over prepared surface.

- (d) Lay 80 gsm geotextile fabric over insulation layer as mentioned above.
- (e) Lay average 20 mm thick waterproof cement plaster 1:4 mix on geotextile fabric to maintain a minimum slope of 1:100 and rounding off the junction of roof and parapet walls for a height of 300 mm and conducting necessary leakage / dampness tests, etc.
- (f) Lay cement mortar for top finishing layer while maintaining minimum slope of 1:100.
- (g) Lay top finishing layer as precast paver blocks/tiles.

(Note : If contractor is awarded work of waterproofing + overdeck insulation, follow all steps from (a) to (g). if contractor is awarded work of only overdeck insulation follow step (c) and (d). Rest will be done by Civil Contractor).

6.7 MEASUREMENT OF INSULATION

Unless otherwise specified measurement for duct and pipe insulation for the project shall be on the basis of center line measurements described herewith

- a. Pipe Insulation shall be measured in units of length along the center line of the installed pipe, strictly on the same basis as the piping measurements described earlier. The linear measurements shall be taken before the application of the insulation. It may be noted that for piping measurement, all valves, orifice plates and strainers are not separately measurable by their number and size. It is to be clearly understood that for the insulation measurements, all these accessories including cladding, valves, orifice plates and strainers shall be considered strictly by linear measurements along the center line of pipes and no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.
- b. Duct Insulation and Acoustic Lining shall be measured on the basis of surface area along the center line of insulation thickness. Thus the surface area of externally thermally insulated or acoustically lined be based on the perimeter comprising center line (of thickness of insulation) width and depth of the cross section of insulated or lined duct, multiplied by the center-line length including tapered pieces, bends, tees, branches, etc. as measured for bare ducting.

7.0 DX-CONDENSING UNITS

- 1.1 Each condensing unit shall be complete unit with hermetically sealed Rotary DC Inverter /Inverter scroll compressor air-cooled condenser, condenser fans with motors, internal piping, switches, and internal wiring and shall be enclosed in a weatherproof outdoor type housing.
- 1.2 The compressor shall be hermetic, with enclosed gas cooled motor. The compressors shall be suitable for /R-407c/R-410a.
- 1.3 The condenser coil shall be air cooled type with aluminium fins and copper tubes and necessary refrigerant connections. The copper tubes shall not be less than 1/2" O.D.
- 1.4 The condenser air fans shall be propeller type direct driven, each complete with motor. The air quantity and area of the condenser shall be adequate for working in the specified outdoor conditions.
- 1.5 The casing shall be fabricated from galvanized steel, zinc phosphate and finished with baked enamel paint. The casing shall make the whole unit fully weather proof, suitable for outdoor installation.
- 1.6 The unit shall include a remote control assembly with thermostat and speed switches.
- 1.7 The necessary charge of refrigerant gas and lubricated oil shall be provided to run the system.
- 1.8 Inverter PCB should be refrigerant cooled.

- 1.9 Unit should be operable at higher ambient condition up to 52 deg C.
- 1.10 Controller should be with touch type display. It should have smart function such as error Indication, ON/OFF timer with temp set point from 19 deg C to 30 deg C
- 1.11 Unit should support operating refrigerant piping length upto 25 rmt.

In duct Air Purifier Irradiation Specifications

Description:

UV Bio Wall, Induct Air Purifier or equivalent.

- i. An individual Array that will provide a barrier wall of germicidal UV energy that will treat 100% of the air that passes through it.
- ii. An Array will consist of 5 outwardly projecting UV lamps to be used in an air duct supporting a longitudinal (parallel) airflow.
- iii. The overall diameter of the Array will not exceed 4.25 inches (18.4cm)
- iv. The lamp assemblies will be positioned that a cylindrical Array of UV assemblies is obtained.
- v. An aluminum convex deflector element mounted to the support, so that the airflow is directed over the UV lamp assemblies.
- vi. The cone diameter shall not exceed 3.5 inches (8.75cm)
- vii. The wire sets connecting the Array to the ballast box that are inside the duct shall be constructed of 18Awg, UL 1716 Teflon wire.
- viii. The aluminum ballast box shall consist of one ballast for each lamp, (see 4.1.1) a resettable hour accumulating counter that will show the accumulated hours for each lamp, an LED "Lamp On" indicator for each lamp, an audible buzzer to indicate a "Lamp Out" condition. A dry contact will be included to remotely monitor a lamp out condition and a second dry contact to be able to remotely turn on and turn off the Array.

ELECTRICAL ELEMENTS

The ballasts shall be preheat start, solid state electronic type, 120 VAC to 277VAC multivoltage, 50-60Hz.

Electrical power requirements :

24 inch Array: 265 watts

30 inch Array: 400 watts

40 inch Array: 525 watts.

50 inch Array: 700 watts

60 inch Array: 822 watts.

INSTALLATION

The one piece anodized aluminium Array will contain a plurality (5) of reflectors, having a generally parabolic inner surface and a UV lamp mounted to each reflector so that the generally parabolic reflector inner surface reflects all the UV radiation emitted by the UV lamps in a radial direction.

The Array can be positioned either in the return side of the duct, or in the supply side of the duct.

The inside of the duct where the Array will be installed, must be lined with aluminum to reflect the UV intensity back into the duct. The aluminum must have a minimum coefficient of reflection of 85%.

UV LAMP

- a) The Array will be available with UV lamp lengths of 24 inches, 30 inches, 40 inches, 50 inches, or 60 inches.
- b) The high intensity UVC lamps will be of the low-pressure 19mm. (3.0 Torr) mercury laden argon-neon type with an internal Alumina coating to reduce solarization .
- c) The UVC lamps are pure fused quartz, type 219 shell, properly doped with Titanium Oxide in order to filter out 99.99% of the 185 nm wavelength.

PERFORMANCE & OTHER REQUIREMENT

The specific linear UV output power for each individual lamp shall not be less than 300 milliwatt/cm.

In order to validate the performance of the proposed arrangement, the manufacturer / vendor shall submit a manufacturer approved computer simulation, showing the minium dose. Average dose and maximum dose towards the end of two years. The passes summary should include influenza virus, Mycobacterium tuberculosis, Sars Cov-2 with the minium, average inactivation rates and average log for each pass.

WARRANTY

The UV Air Purifier shall carry 17,000 hours of lamp warranty and 12 years of warranty on ballast box (electronic).

Certification

The purifier as a complete assembly including the ballast- electronics electrical UV lamps must Be CSA or UL Certified. Only lamps having UL listing/ CSA Certification will disqualify. The Complete assembly must be tested for Air purification by some reputed independent body.

Local Setup

The supplier should have a local setup established to assist in the installation & other technical Issues.

Reference list:

The supplied make must have at least one such installation in any building in the region.

Cooling Coil Mounted UVC Irradiation Specifications

GENERAL

- 1.1 Equipment to be CSA/UL/or ETL certified.
- 1.2 Each AHU, will be packaged with a plan for the installation of the lamp assemblies as supplied by the manufacturer's calculation chart, indicating the orientation (upstream, downstream, or both sides of the coil) of the installation.

• PRODUCT

- 2.1 Coil Clean Object Sterilizer or equivalent.
- 2.2 To effectively irradiate the HVAC coil surface and maximize the UV irradiation onto the coil, each UVC lamp will be mounted to a parabolic reflector made of aluminum, reflecting at least 90% of the UVC (254 nm) energy, optimizing the output UVC of the lamp.
- 2.3 The aluminum parabolic reflector will be built from an aluminum extrusion aerodynamically shaped to be capable of withstanding air velocities up to 1000 ft/min. without wobble, vibration or whistle noise.
- 2.4 The ballast will be mounted in an adequate aluminum enclosure that will enable it to be mounted on a rigid surface outside of the AHU, protecting the power source from moisture and humidity.

ELECTRICAL

- 3.1 The power source will be an electronic type, preheat start with a power factor greater than 0.95 and an energy conversion of at least 75%.
- 3.2 The power source shall be available in 120 V, 230V AC 50-60 Hz. and be able to operate reliably in indoor environments ranging from $\pm 15^{\circ}\text{C}$ to 70°C temperature, with relative humidity up to 100%.

INSTALLATION

- 4.1 Each UVC source will be clamp-mounted for easy installation, positioning and maintenance onto standard $\frac{3}{4}$ -inch (1.87 cm) electrical conduit or aluminum tubing, supplied by the vendor or field supplied and installed as a permanent support structure. The support structure will be adequately fixed with non-corrosive hardware so that

the UVC source does not vibrate or loosen.

4.3 The UVC source may be installed either upstream, downstream, or on both sides of the coil depending on the recommendation of the manufacturer.

4.4 In order to guarantee the adequate performance for a given coil, the vendor shall specify in detail, a manufacturer approved layout of the number of UVC sources required and their respective position (distance from the coil, alignment on the coil as well as on which side of the coil the UV source is to be installed).

4.5 Safety interlock switches are to be installed on all access doors where UV intensity may be present. Manufacturer to provide CAUTION LABELS to be installed on these access doors.

UV LAMP

5.1. The High Intensity UVC lamp will be of the low-pressure (3.0 Torr) mercury laden argon-neon type internally coated to reduce solarisation.

5.2. The UVC lamp is a pure fused quartz type 219 shell, properly doped with Titanium Oxide in order to filter out 99.99% of the 185 nm. wavelength to avoid the production of ozone.

5.3. The UVC source net output will be at least 300 milliWatt/cm of arc length in the 245 nm to 266 nm. band while operating at nominal temperature in an air stream moving at 400 fpm.

5.4. The UVC lamp design will be based on a Single Ended, 4-pin type connection, hot cathode, T-6 diameter (19 mm).

PERFORMANCE & OTHER REQUIREMENT

6.1. Adequate performance is defined as the irradiation intensity distribution required so that the most UV resistant microorganism *Aspergillus Niger* spores requiring a lethal UV dose of 996 milliJoule/cm² of 99% elimination will not survive more than 60 minutes anywhere on the treated surface of the coil even at lamp end of life output i.e. after 17,000 hours of operation. In order to validate the performance of the proposed arrangement, the vendor shall submit a manufacturer approved computer simulation showing the resulting *Aspergillus Niger* spores as the control microorganism kill (time map) of the treated surface of the coil after 17,000 hours of operation.

WARRANTY

7.1. The power source will carry a 10-year corrosion and performance warranty.

7.2. The high intensity UVC lamp will be guaranteed for 17,000 hours.

Thermal VAV Diffusers

LINEAR:

Thermally-powered VAV diffusers shall be a complete VAV terminal and thermostat self-contained in a linear diffuser. They should be thermally powered with room thermostat/actuator. External wiring or Pneumatics shall not be allowed.

The room thermostat/actuator shall open damper blade(s) on a rise in room temperature and modulate airflow to control the space within 1½°F/0.9°C of temperature setting. The temperature setting shall be adjustable between 70°F/21°C and 78°F/26°C. The initial set point shall be factory set at 74°F/23°C.

The diffuser and blades shall be constructed of extruded aluminum with all visible portions powder coated. The diffuser shall be complete with a plenum constructed of 24-gauge galvanized steel.

The diffuser shall have an induction chamber and supply air venturi at one end for inducing room air

past the room sensing thermostat/actuator. The venturi shall be at least 4 in. / 100 mm wide for effective induction. The VAV diffusers shall have positive induction of secondary room air over the room thermostat at all flows from fully closed to fully open.

Ratings for flow and sound shall be verified by an independent testing laboratory certified for ARI 890 and ADC testing.

Power compression spring cartridges shall be attached directly to the thermostat/actuators to contain the forces produced without distorting other parts of the diffuser and assure accuracy of control.

Cooling air supply to the VAV diffuser shall be constant temperature (may be reset to another constant temperature). Supply air shall be limited to no lower than 50°F/10°C.

All VAV diffusers shall warrant that the diffuser shall be free from defects in materials and workmanship for a period of ten years from date of commissioning.

ROUND:

Thermally powered VAV diffusers shall be a complete VAV terminal and thermostat self-contained in a round 24in / 600mm diameter diffuser. They shall be thermally powered with one room thermostat/actuator. External wiring or pneumatics shall not be allowed.

The VAV diffusers shall have a thumbwheel and temperature scale to adjust the cooling set point. The adjustment shall be right above the hinge down panel and shall require no tools to adjust. The set point shall be adjustable between 70°F/21°C and 78°F/26°C. The initial set point shall be factory set at 74°F/23°C.

The VAV diffusers shall open on a rise in room temperature. The mechanism shall not extend above the inlet of the diffuser.

All VAV diffusers shall have a dial and scale to adjust minimum flow between 5 cfm/2.4 L/s and 50% of maximum flow without tools. Minimum flow shall be factory set at 10%. A fixed maximum flow stop shall be factory set for the fully open air flow of the specified inlet size.

All VAV diffusers shall have a lever which will open the damper for balancing without tools. The balancing lever shall be accessible from the outside of the diffuser without folding down the appearance panel or removing any part of the diffuser.

All VAV diffusers shall warrant that the diffuser shall be free from defects in materials and workmanship for a period of ten years from date of commissioning.

SQUARE:

Thermally powered variable air volume modules, each module shall be a complete VAV terminal and thermostat self-contained in a nominal 2' x 2' diffuser. External wiring or pneumatics shall not be allowed.

The modules shall vary the supply air volume to provide VAV cooling. They shall be thermally Powered using one room temperature sensing thermostat. The room temperature settings shall be Adjustable in the field by adjusting the room thermostat.

The room temperature sensing thermostat shall sense room temperature and vary the supply air.

The room sensing thermostat shall have a micrometer type temperature set point adjustment with an indicator that moves along a 70°F/21°C to 78°F/26°C temperature scale. Initial set point shall be factory set at 74°F/23°C.

Each unit shall have four perimeter dampers to provide 66 linear inches of variable discharge area at the perimeter of the diffuser for maximum Coanda effect and to avoid dumping. Each module shall be factory tested.

The manufacturer shall warrant that the module shall be free from defects in materials and workmanship for a period of ten years from date of shipment.

Each module shall have a hinged appearance panel that can be unlatched and folded down to hang allowing hands to be free for adjusting temperature set points. Instructions for the module shall be on the inside of the appearance panel.

DIGITAL WALL ADJUSTER: (suitable for Master Therma-Fusers)

The VAV diffuser shall be equipped for adjustment of room temperature control level by a remote adjust unit. This shall include resistance heater(s) attached to the room thermostat(s). The heater(s) shall be wired to a NEMA 1 terminal box mounted on the exterior of the VAV diffuser housing. The thermostat(s) in the VAV diffuser shall be factory set at 74°F/23°C.

The remote adjust unit shall also be supplied by same supplier and shall be capable of adjusting the control level of one master and up to four secondary diffusers. The remote adjust unit shall be suitable for mounting directly onto the wall or onto a standard 2"x4" electrical box (by others). Two push buttons on the unit shall allow adjustment of the room temperature control level set point between 68°F/20°C and 76°F/24°C. Display shall be digital with warmer/cooler indicators and optional numeric set point readout.

The digital wall adjuster unit shall be supplied with 24 VAC $\pm$ 2 VAC power. Wiring between the master diffuser and the digital wall unit shall be supplied by same supplier. All other wiring including power wiring to the 24 Volt transformer, the 24 Volt transformer, wiring from the transformer to the master diffuser, wiring from the master diffuser to the building management system (BMS) if required, and wiring between the master diffuser and any secondary diffuser(s) shall be furnished and installed as part of the electrical specifications.

ECOLOGY UNIT FOR KITCHEN EXHAUST

The scope includes Design , Supply , Fabricate , Install , Test & Commission the complete product as per site requirement.

Description

Unit Shall Be Double Skin Type Self Contained Factory Assembled Capable Of Significantly Reducing Smoke, Grease & Odor From The Exhaust Air Stream. Unit Shall Have UL 762 Certified Mixed Flow Fan Suitable for Kitchen Exhaust Application & Electrostatic Precipitator Having Efficiency Not Less Than 90% For 1 Micron Particle Size At Operating Condition (Airflow).

Housing

Unit Housing Shall Be 23 Mm +/- 2 Mm Thick Puf Insulated Double Skin Panel With 0.6 Mm Thick Precoated Gi Sheet Outer Skin & 0.6 Mm Thick Plain Inner Gi Sheet With Casing Constructed Of Extruded Aluminum Profile.

Base

Unit Base Shall Be Bolted Construction Made Of Heavy Gauge Gi & Complete Unit Supported On Base.

Fan Specifications

Fan Type-Fan Shall Be Mixed Flow Inline Fan Suitable For Kitchen Exhaust Application, Low Noise Level & Energy Efficient. Motor Must Be Outside Airpath.

Certification

Fan Must Be AMCA Certified For Air & Sound Performance.

Fan Must Be UL 762 Certified. (UL 762 Is Concerned With Fans Designed For Removal Of Smoke & Grease Laden Vapors With Air Stream Temperature Up To 400 Degrees Fahrenheit.)

Fan Housing

Fan Housing Shall Be Constructed Of Welded Heavy Gauge Steel To Assure No Air Leakage. Housing Shall Have Inlet And Outlet Collars For Slip Fit Duct Connections. Housing, Bearing & Motor Supports Shall Be Constructed Of Structural Steel Members. Welded Steel Vanes Shall Straighten The Flow Of Air From The Fan Discharge.

Fan Coating

Fan Housing Must Be Coated with Permatector Coating.

Fan Wheel

The Fan Wheel Shall Be Of The Mixed Flow Type. Wheel Shall Have Wheel Cone, Spherical Back Plate And Single Thickness Cambered Blades. Wheel Shall Be Statically & Dynamically Balanced To Grade G6.3 Per Ansi S2.19.

Fan Noise Level

Fan Shall Be Low Noise Level. Inlet & Outlet Sound Power Levels Shall Be Provided for Each of The Octave Bands At The Point Of Operation.

Electrostatic Precipitator Specifications

Efficiency-Electrostatic Precipitator Shall Be Rated At 90% To 95% Ashrae Standard 52.2.

Certification

Electrostatic Precipitator Must Be CE Certified.

Performance Data Submitted Must Be for Complete Esp Unit with Prefilter, Ionizer, Collector Section. Only Cell Performance Data Without Prefilter Is Not Acceptable.

Construction Made of Minimum Of 1.5mm Galvanized Sheet, With Reinforced Structure And High Bake Epoxy Powder Coated To Protect Against Rust And Corrosion.

Fully Welded, Making It Waterproof And Oil Leak-Proof.

Built-In Large Capacity Oil Drain-Pan And Drain Outlet From Side Only, Bottom Drain Not Allowed.

All Doors Shall Be Gasketed To Prevent Air And Water Leakage

Prefilter

Washable Type Aluminium Mesh

Electrostatic Precipitator Specifications

Ionizer & Collector Ionizer And Collector Should Be Independent. One-Piece Construction Is Not Acceptable, To Save Replacement Cost And For Easier Cleaning

Ionizer:

Each Ionizer Shall Have Airflow Capacity To 1912 Cfm.

High Voltage Support Insulators Shall Be Of Aluminum Oxide Ceramic For Increased System Reliability, Isolation Efficiency And Reduces Maintenance And Replacement Costs. Teflon Material Is Not Acceptable.

Insulator Creepage Distance Shall Be Not Less Than 95mm, For Prevention Of Discharge And Flashover, Enhancement Of Filtration Efficiency, Maintenance Of Equipment Safety, Adaptation To Heavy Smoke And Reduction In Maintenance Needs

Constructed With An Aluminum Airfoil Frame Which Shields The Ceramic Insulators From Air Stream.
It should have Tungsten Wires Which Resist Coating And Corrosion. Spiked Design Is Not Acceptable.
9 Sets Of 0.31mm Diameter Heavy Duty Tungsten Wires In Each Ionizer.
Contact With High Voltage should be Made Through Stainless Steel Coil Springs Requiring No Mechanical Connection.
Ionizers Plates Shall Be Made Of A5052 Aluminum Alloy For High Strength And Corrosion Resistance.

Collector:

Each Collector Shall Have Airflow Capacity To 1912 Cfm.
Over 13 Sqm Surface Area In A Single Module.
Over 7.3 Sqm Effective Collection Area In A Single Module.
Minimum Effective Collection Area Of 2.9 Sqm Per 1000cmh.
Each Collector Shall Have A 10’’ Minimum Depth In Air Flow Direction To Maximize The Efficiency And Retention Time Of Contaminated Air, As Well As High Dirt And Oil Holding Capacity.
Insulators Are Shielded From The Airstream By Inverted End Plates.
Collector Plates Shall Be Made Of A5052 Aluminum Alloy For High Strength And Corrosion Resistance.

Post Filter:

Washable Type Aluminum Mesh.

Power Packs (High Voltage Power Supply):

The Power Pack Shall Have Dry Contacts To Link To Bms, To Send Signals Of Working Status, Wash Requirement, And Fault Alert To Bms.
The Power Pack Shall Have Error Code Display Functions, To Help User Find The Fault Easily.
The Power Pack Shall Display The Output Voltage And Current.
The Power Packs Shall Have Four Led Lights On Itself To Indicate The Power Input, Working Status, Fault, And Cleaning Alert.
The Power Packs Shall Have Advanced Self-Protections, Including But Not Limited To Short-Circuit Protection, Arcing Protection, Overload Protection, No Load Protection, Overcurrent Protection, Overtemperature Protection.
Dual High Voltage Output Of (-)12 To 13.5kv For The Ionizer And (-)6.0 To 6.7kv To Collector.

Electrical Control:

Interlocks Shall Be Provided To Cut Off The High Voltage Output When Electrical Door Or Filter Access Door Opened.
High Voltages Electrical Residual On Collector Shall Be Atomically Released When Electrical Door Or Filter Access Door Opened.

MANUFACTURER'S AUTHORIZATION (MAF)

It is the sole responsibility of the contractor to provide MAF Letter Format (On OEM Letter head with seal)

Date: _____

To,

<<< NAME OF CLIENT/ORGANIZATION>>>

Subject: Manufacturer's Authorization Certificate to Contractor

Tender Ref.: << PLEASE SPECIFY SPECIFIC TENDER REF.NO.>>

Dear Sirs,

This is with reference to the above-mentioned Tender.

We hereby authorize <<NAME AND ADDRESS OF CONTRACTOR/SUB CONTRACTOR>> to offer our range of product in their tender bids. Being authorized <<NAME AND ADDRESS OF CONTRACTOR/SUB-CONTRACTOR>> may make techno-commercial and commercial proposal for this tender.

Upon being awarded the work << NAME AND ADDRESS OF CONTRACTOR/SUB-CONTRACTOR >> are authorized to install and commission our range of products falling under <<SECTION/PRODUCT CATEGORY>> of this tender.

We as Original Equipment Manufacturers will provide all the techno-commercial and service support necessary to << NAME AND ADDRESS OF CONTRACTOR/SUB-CONTRACTOR >> for this project during the commissioning phase of the equipment's and until hand-over.

We also confirm that the items would be serviceable during the warranty period of 36 months free of cost and for at least 7 years thereafter with the following rate schedule as attached.

Thanking and assuring best of our services at all times.

Yours faithfully

(Seal & Signature)

Attachments :

1. Warranty letter with equipment schedule
2. Rate schedule for comprehensive AMC contract from 4th Year onwards

3. Liability and Battery limits
4. Service Team contact details

Note : The MAF Letter to be submitted with proposed 3 years warranty in above format before concluding the contract. The MAF Letter has to be submitted for All major Equipments.

The Equipment schedule shall be as per approved As built drawings.

TECHINICAL SPECIFICATION OF ELECTRICAL & LV WORKS

1.0 ELECTRICAL GENERAL PROVISIONS

1.1 GENERAL

1.1.1 Work Description

The scope of works for all electrical works and ELV system comprises of design, engineering, supply, delivery, installation, testing and commissioning, handover, training, maintenance and warranty all as described or reasonably implied in the Contract. The EPC Contractor is obliged to provide fully functioning works and systems in conformance with the requirements of the Contract and approved design and development documents prepared by the EPC contractor.

In the event certain items are not fully described or indicated in the Contract, but deemed essential by the EPC contractor for the performance of the works and systems then the provision of such items shall form part of the EPC Contractors scope of works at no additional cost to the Owner.

The drawings and documents from consultant shall be used as guidance for the EPC contractor in producing his detail design and shop drawings for carrying out works at site.

The EPC Contractor shall be responsible to co-ordinate the equipment and services and shall produce properly coordinated shop drawings to demonstrate the installation comply with the performance requirement with shop drawings, calculations and details. The Consultant shall monitor the process of shop drawings and document preparation.

Shop drawings shall take into account actual measurement and setting out dimensions/levels obtained and determined by the EPC Contractor on site, actual equipment / material used, actual routing of services, co-ordination with all installation, and site conditions/constraints.

Scope of Work:

The Electrical HT, LT and ELV shall generally include the following:

Common Services:

Liaison with Client to obtain and coordinate provision of incoming electricity supply.

Design, Supply, installation, testing and commissioning of complete 11KV HT power distribution system, 2 nos. 11KV incoming electrical supply feeder from State Electricity Board grid station to SEB meter room located at proposed location as per drawing, 11KV cabling from SEB meter room to Main HT Panel board, main HT panel board and further to distribution 11/0.433KV CSS, 11/0.433KV Oil type outdoor transformers, Main LT distribution system and associate accessories and arrange SEB acceptance upon completed

Complete central earthing systems for connection with component electrical systems.

Internal Services:

Complete LT distribution system including main LT switchboard, automatic IGBC, Hybrid power factor system devices, sub-boards and distribution boards, utility services panel boards, UPS and associated distribution main and sub-main cabling and associated accessories.

Complete lighting and power installation including all final circuiting work and associated accessories and lighting automation system.

Normal and emergency lighting supply and installation and associated accessories.

Complete earthing system.

Complete lightning protection system and associated accessories.

Complete telephone cabling system and associated accessories.

Complete wiring work to external & landscape & facade and public area architectural/special lighting as per lighting design and associated accessories.

Complete internal cable system and outlets for Telephone and MATV system and associate works.

Complete Security systems

Miscellaneous works like providing and fixing of rubber mats, fire buckets, first aid box, fire extinguishers, gas flooding etc.

All associated interfacing power supply work to other mechanical installations.

Addressable Fire Alarm & Voice evacuation System

Voltage drop, transformer losses, power factor and other parameter shall be as per ASHRAE 90 and GRIHA requirement.

Lighting density shall be furnished through energy simulation carried out for GRIHA rating 3 star.

IP CCTV and Access control system, Audio Visual system, IT Data & Voice Networking system including Passive, Active, Wi-Fi and EPBAX system

All associated interfacing works with other M&E installations.

Additional Hume pipes for future block services etc.

Other works as shown on the Drawings and described elsewhere in the Contract documents.

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

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

Also the EPC Contractor shall furnish combined guarantee minimum for 1 year from the date of successful commissioning from the manufacturer. In case there is any defect, the free replacement of any part or in whole will be made immediately at no extra cost to Owner.

Fee, Permits & Tests:

The EPC contractor shall obtain all sanctions and permits required for the above said works from all there levant authorities. On completion of the work ,the EPC Contractor shall obtain N.O.C from concerned authorities including, Chief Electrical Inspector. The original of the same shall be delivered to the Owner through Consultant.

The Owner shall have full power regarding the Equipment's/materials get tested by authorized/recognized independent agency at the EPC contractor's expense in order to prove their soundness and adequacy. The EPC contractor will rectify the defects/suggestions pointed out by independent agency through Owner at EPC contractor's expense.

The installation shall comply in all respects with the requirements of Indian Electricity Act 1910, Indian Electricity Rules (IER) 1956 and other related Laws and Regulations (for F.F. etc.) as amended up to date, there under and special requirements, if any, of the State Electricity Boards etc. The EPC contractor shall be liable to furnish the list of authorized licensed persons/ employed/deputed to carry out the works/ perform the assigned duties to fulfill the requirement of Rule 5 of IER 1956 as amended up to date.

Codes & Standards:

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

The design engineering, manufacturing and the installation shall be in accordance with established codes, sound engineering, practices and specifications. Further, the same shall conform to the statutory regulations applicable in the country. EPC Contractor shall obtain all approvals from statutory authorities, e.g. electrical inspector, SEB or any other agency as applicable before commissioning of electrical system & above system including ELV system etc. if required.

Some of the relevant Indian and British Standards are listed below.

Indian Electricity Act.

Indian Electricity Rules.

Factory Act.

UPPCL Supply codes.

CPWD Specifications etc.

Any other standard may be followed provided it is equivalent or more stringent than the standards specified above.

In case of any deviation/conflict with the codes & standards, the following order of precedence shall govern

Recommended Design guide lines of consultant

International standards& requirements.

Local codes of practice

Approved design development documents

Design:

The EPC Contractor shall be fully responsible for the complete design of all works for the Contract, including all temporary works.

It is the responsibility of the EPC Contractor to ensure that his design does not compromise the design intents of the consultant's approved design development documents, all authority's compliances and approvals.

The design and workmanship shall be in accordance with the best engineering practices, to ensure satisfactory performance and service life. The equipment offered by the EPC contractor shall be complete in all respects.

Any materials or accessories, which may not have been specifically mentioned, but which are usual and necessary for the completion of the system and satisfactory & trouble free operation and maintenance of the equipment shall be provided without any extra cost to the Owner. This shall also include spares for commissioning of the equipment.

This specification defines the basic guidelines to develop a suitable electrical system as necessary for the Complex. All data required in this regard shall be taken in to consideration to develop a detailed engineering for the system. Site conditions as applicable are mentioned elsewhere.

EPC contractor shall be responsible for:

Detailed co-ordination with other services, shop drawings for various electrical layouts such as equipment layouts, cabling layouts, earthing layouts, including equipment installation and cable termination details etc. prior to start of work.

Preparation of bill of materials for all works.

Protection co-ordination drawings/tables for complete power system.

Shop inspection and testing procedures.

Field-testing and commissioning procedures.

Preparation of as built drawings.

EPC contractor shall also be responsible for:

Any other work/activity which is not listed above however is necessary for completeness of electrical system.

Date of Commencement and Completion Period:

The EPC contractor shall be allowed admittance to the site on the date of commencement as described in the General Conditions and he shall thereupon and forthwith begin the works and shall regularly proceed with and complete the same on or before the date of completion subject, never the less to the provisions for the extension of time. The time being the essence of the contract, the EPC Contractor will adhere to the time, progress chart and project schedule and will give proportional output/progress in proportional time.

Schedule and Manner of Operations:

Time being the essence of this Contract, the EPC Contractor will be expected to furnish all labor and materials in

sufficient quantities and at appropriate times, expedite and schedule the work as required and so manage the operation that the work will be completed within the time stated in the Contract.

Coordination of Work

Contract documents establish scope, materials and quality but are not detailed installation instruction.

Coordinate work with related trades and furnish, in writing, any information necessary to permit the work of related trades to be installed satisfactorily and with the least possible conflict or delay.

The drawings show the general arrangement of equipment and appurtenances. Follow these drawings as closely as the actual construction and the work of other divisions will permit. Provide off-sets, fittings, and accessories which may be required but not shown on the drawings. Investigate the site, and review drawings of other divisions to determine conditions affecting the work, and provide such work and accessories as may be required to accommodate such conditions.

The locations of thermostats, switches, panels and other equipment indicated on the drawings are approximately correct. Exercise particular caution with reference to the location of panels, thermostats, switches, etc., and have the precise and definite locations accepted by the Engineer before proceeding with the installation.

The drawings show only the general run of services and approximate location of equipment, outlets, panels, etc. Any significant changes in location of equipment, outlets, panels, etc., necessary in order to meet field conditions shall be brought to the determine attention of the Consultant for review before such alterations are made. Modifications shall be made at no additional cost to the Contract. Carefully check space requirements with other division works to ensure that equipment can be installed in the space allotted.

Wherever work interconnects with work amongst different installation, coordinate with other trades to insure that they have the information necessary so that the EPC Contractor may properly install the necessary connections and equipment. Identify items requiring access in order that the Ceiling Trade will know where to install access doors and panels.

Furnish and set sleeves for passage of risers through structural masonry and concrete walls and floors and elsewhere as required for the proper protection of each riser passing through building surfaces.

Provide fire stopping around all pipes, conduits, ducts, sleeves, etc., which pass through fire compartments.

Provide required supports and hangers for equipment suitably so as not to exceed allowable loading of structures.

Wherever the work is of sufficient complexity, prepare additional detail drawings to scale to coordinate the work with the work of other trades. Detailed work shall be clearly identified on the drawings as to the area to which it applies. Submit these drawings to the Engineer for review. At completion include a set of these drawings with each set of record drawings.

Coordinate with the local utility companies/authorities for their requirements for service connections and provide all necessary provisions, grounding, materials, equipment, labor, testing, and appurtenances.

Before commencing works, examine adjoining works on which this work is in any way affected and report conditions which prevent performance of the works. Become thoroughly familiar with actual existing conditions to which connections must be made or which must be changed or altered.

The EPC Contractor is responsible to any modifications required due to service not properly coordinated.

Electrical Power Supply Interfaces

The EPC Contractor shall provide power supply points/isolators at certain designated locations within the development for all mechanical and electrical installations as indicated on the drawings. It is the responsibility of the Contractor to coordinate and make connections to these power supply points/isolators and to provide all the necessary 'down-stream' power supply distribution board/network to the mechanical system's control panels, equipment, sensors, field devices, etc.

Inter facing with All Services and Systems

General

The EPC Contractor shall provide all necessary provisions for interfacing amongst installation, services, and

equipment. All necessary sensors, current/voltage transformers, voltage-free contacts, relays, auxiliary contacts, terminals, transducers etc. for interfacing works shall be provided by the EPC Contractor.

All control/monitoring wiring from sensors, equipment, and components for the interfacing shall be terminated at a separate interfacing compartment located at the respective equipment/system's switchboard or control panel. The interfacing compartment shall be completed with all necessary connectors, terminals, and with proper identifications to allow interfacing works to be easily carried out. The compartment shall clearly indicate "Extra Low Voltage Cable Only. No Power Cable Connection". Where there is no equipment/system switchboard or control panel involved, the EPC Contractor shall provide separate interfacing panels with provisions same as the interfacing compartment as described above. The locations of the switchboard/control panels and the interfacing panels shall be properly coordinated.

For every control panel and each module of the switch board, at least Ten (5) spare Terminals shall be provided for future interfacing works.

Wiring and cables for interfacing with the fire alarm system and other fire protection and life safety systems shall be fire rated to comply with Civil Defense's requirements.

All the interface provisions shall be DC operated and rated not more than 50mA.

The EPC Contractor shall provide and make all power cable connections from mechanical equipment, local control panels, and distribution boards to the electrical isolators or power points (including cable termination) provided. Location of power supply isolators and power points shall be properly coordinated.

In addition to the interfacing requirements shown on the Drawings, interfacing provisions as described below shall also be provided and included in the Contract.

Electrical Installation

The Electrical Installation shall provide the following:

Circuit breakers, MCC, PCC and power points for all mechanical equipment and systems. The Electrical installation shall include direct power cable connections to the mechanical system's main motor control centers and further to equipment.

Earthing terminal in the Fire control Centre and all other plant rooms for supplementary equipotential bonding of mechanical equipment and systems.

Examination of Site

Prior to the submitting of bids, visit the project site and become familiar with all conditions affecting the proposed installation and make provisions as to the cost thereof.

The Contract Documents do not make representations regarding the character or extent of the sub-soils, water levels, existing structural, mechanical and electrical installations, above or below ground, or other sub-surface conditions which may be encountered during the work, based on examination of the site or other information. Failure to examine the drawings or other information does not relieve the EPC Contractor of responsibility for satisfactory completion of the work.

Excavation and Backfill

Where ever required provide trenches details, duly approved by the consultant with all relevant section etc. as per IS codes, minimum before 1 month of laying the pipes, etc. Coordinate with during the excavation, and ensure that the excavation and backfilling is being properly done as per requirement.

Where ever it is asked by the Owner/ Consultant for providing trenches in EPC Contractor's scope. It is deemed that the cost of the pipe is inclusive of trench digging and backfilling. The following points needs to be taken care of while making the trenches.

The trench shall be of widths necessary for the proper execution of the work. Grade bottom of the trenches accurately to provide uniform bearing and support the work on undisturbed soil at every point along its entire

length. Except where rock is encountered, do not excavate below the depths indicated. Where rock excavations are required, excavate rock to a minimum over depth of four inches below the trench depths indicated on the drawings or required. Backfill over depths in the rock excavation and unauthorized over depths with loose, granular, moist earth, thoroughly machine tamped to a compaction level of at least 95% to standard proctor density or 75% relative density or as specified by the Engineer. Wherever unstable soil that is incapable of properly supporting the work is encountered in the bottom of the trench, remove soil to a depth required and backfill the trench to the proper grade with coarse sand, fine gravel or other suitable material.

Excavate trenches for utilities that will provide the following minimum depths of cover from existing grade or from indicated finished grade as required by local authorities.

Trenches should not be placed within 3 meters of foundation or soil surfaces which must be resist horizontal forces.

Do not backfill until all required tests have been performed and installation observed by the Engineer. Comply with the requirements of other sections of the specifications. Backfill shall consist of non-expansive soil with limited porosity. Deposit in 15 cm layers and thoroughly and carefully tamp until the work has a cover of not less than 30 cm. Backfill and tamp remainder of trench at 30 cm intervals until complete. Uniformly grade the finished surface.

Cutting and Patching

All kinds of cutting and repairing of brick Walls or Partitions, etc. for the proper routing of pipe, cutting and repairing of RCC wall, or ceiling shall be in the scope of the EPC contractor.

Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of conduit or other equipment, layout the work carefully in advance. Repair any damage to the building, piping, equipment or defaced finish plaster, woodwork, metalwork, etc., using skilled trade people of the trades required at no additional cost to the Contract.

Provide slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required. Where these openings are not provided, provide cutting and patching to accommodate penetrations at no additional cost to the Contract.

Sealing of Penetrations

Air Tight Seals

All penetrations through the building fabric subject to suction or pressurization shall be sealed airtight.

Holes in Roof

Roof penetrations for passage of conduits or circular PVC and PVC Cables shall be sealed watertight using a flexible polypropylene conical sleeve manufacturer to seal the cable to the roof structure, regardless of the roof profile.

All sharp metal edges, which may come in contact with the cable, shall be suitably bushed.

Fire Rated Penetrations

Where services penetrate any fire rated barrier, the EPC Contractor shall seal the penetration with the use of an appropriate material to ensure the integrity of the fire barrier.

The EPC Contractor shall seal the cable enclosures through fire rated barriers to ensure the integrity and rating of the fire barrier.

Acoustic Penetrations

Where services penetrate acoustic barriers, sealant shall be supplied and installed to maintain the acoustic separation at least equal to the barrier penetration.

Mounting Heights

Verify exact locations and mounting heights with the Engineer before installation.

Supports

Support work in accordance with the best industry practice. Provide supports, hangers, auxiliary structural members and supplemental hardware required for support of the work.

Provide supporting frames or racks extending from floor slab to ceiling slab for work indicated as being supported from walls where the walls are incapable of supporting the weight. In particular, provide such frames or racks in electric closets and equipment room.

Provide supporting frames or racks for equipment which is installed in a free-standing position.

Supporting frames or racks shall be of standard angle, standard channel or specialty support system steel members, rigidly bolted or welded together and adequately braced to form a substantial structure. Racks shall be of ample size to assure a workman like arrangement of all equipment mounted on them.

Adequate support of equipment (including outlet, pull and junction boxes and fittings) shall not depend on ducts, pipe, electric conduits, raceways, or cables for support.

Equipment shall not rest on or depend for support on suspended ceiling media (tiles, lath, plaster, as well as splinters, runners, bars and the like in the plane of the ceiling). Provide independent support of equipment. Do not attach to supports provided for ductwork, piping or work of other trades.

Provide required supports and hangers for equipment so that loading will not exceed allowable loading of structure. Equipment and supports shall not come in contact with work of other trades.

Fastenings

Fasten equipment to building in accordance with the best industry practice.
Where weight applied to the attachment points is 45kg or less, conform to the following as a minimum:

Wood	: Wood screws
Concrete and solid masonry	: Dash Fastener of appropriate ratings-HILTI/FISHER
Solid metal	: Machine screws in tapped holes or with welded studs

Where weight applied to the building attachment point exceeds 45 kg, but is 135 kg or less, conform to the following as a minimum:

At concrete slabs provide 60cm x 60cm x 13cm steel fishplates on top with through bolts. Fishplate assemblies shall be chased in and grouted flush with the top slabs screed line, where no fill is to be applied.

At steel decking or sub-floor for all fastenings, provide through bolts and threaded rods. The tops of bolts and rods shall be set at least one inch below the top fill screed line and grouted in. Suitable washers shall be used under bolt heads or nuts. In cases where the decking or sub-floor manufacturer produces specialty hangers to work with his decking or sub-floor such hangers shall be provided.

Where weight applied to building attachment points exceeds 135 kg, coordinate with and obtain the approval of Consultant and conform to the following as a minimum:

Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall suitably weld or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.

For items which are shown as being ceiling mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements. Wall mounted equipment may be directly secured to wall by means of steel bolts. Groups or arrays of equipment may be mounted on adequately sized steel angles, channels, or bars.

Identification

Identify equipment with permanently attached black phenolic nameplates with 13 mm high white engraved lettering. Identification shall include equipment name or load served as appropriate. Nameplates shall be attached with cadmium plated screws; peel and stick tape or glue on type nameplates is unacceptable.
Services run shall be properly identified as per the requirements in the Contract. See individual section for additional identification requirements.

Prohibited Labels and Identifications

In all public areas, tenant areas, and similar locations within the project, the inclusion or installation of any equipment or assembly which bears on any surface any name, trademark, or other insignia which is intended to identify the manufacturer, the vendor or other source(s) from which such object has been obtained is prohibited.

Required test lab certification labels shall neither be removed nor shall identification specifically required under the various technical sections of the Specifications be removed.

Equipment Pad and Anchor Bolts

Provide all details with proper sections for the equipment pads and anchor. The equipment pads casting and making provision for anchor fastening shall be as per the final UNALTERED drawing duly approved by the Consultant, shall be in the scope of EPC contractor.

All equipment pads for all vibrating Equipment's, shall have cork vibration pads sandwiched between the finish surface and the bottom surface of required thickness suggested by the EPC contractor to ensure that the minimum vibration can travel below.

Provide galvanized anchor bolts for all equipment placed on concrete equipment pads, inertia blocks, or on concrete slabs. Provide bolts of the size and number recommended by the manufacturer of the equipment and locate by means of suitable templates. Equipment installed on vibration isolators shall be secured to the isolator. Secure the isolator to the floor, pad, or support as recommended by the vibration isolation manufacturer.

Where equipment is mounted on gypsum board partitions, the mounting screws shall pass through the gypsum board and securely attach to the partition studs. As an attached to 15 cm square, galvanized metal back plates which are attached to the gypsum board with an approved nonflammable adhesive. Toggle bolts installed in gypsum board partitions are not acceptable.

Miscellaneous:

A site order book will be maintained at site, which will be in the custody of the Owner, or his representative and all instructions given to the EPC contractor will be recorded in the site order book and the same has to be signed by the EPC contractor to comply with the instructions given therein.

After completion of the work the whole installation shall be tested by the EPC contractor. The tests shall comply the following I.E.E. Regulations and shall be submitted along with the final bill:

The result of the insulation test shall comply with the I.E.E. Regulations 1101 to 1108A and 1008B as may be applicable.

Test shall be carried out to ascertain that all the non-linked SP switches have been connected to the phase conductor.

The continuity test of the earthing system shall comply with I.E.E. Regulations 1108 to 1109 to the latest addition. If the result of the above tests does not comply with the I.E.E. Regulations, the EPC contractor shall be bound to rectify the faults so that the required results are obtained.

The EPC contractor shall be responsible to provide all the necessary test certificates of testing instruments, such as megger insulation tester, earth tester multi-meter, AVO meter etc. for carrying out the above tests.

The work will not be considered as complete and taken over by the Owner till all the components of the work after being completed at site in all respects have been inspected/ tested by the Consultant/Owner to his entire satisfaction and a completion certificate issued by the Owner/Consultant to this effect.

Shop drawing for electrical work e.g. equipment, cable earthing and conduit layout for all systems shall be prepared by the contractor and got approved before starting of the work.

At the completion of the work and before issuance of certificate of virtual completion, the EPC contractor shall submit 6 sets of drawing and soft copy of each drawing to Owner of each layout drawings drawn at approved.

EPCCContractor's Superintendence:

The contractor shall provide all necessary superintendence during the execution of the works and as long as there is necessity. The contractor or his competent and authorized agent or representative approved of in writing by the owner (which approval may at any time be withdrawn) is to be constantly on the works and shall give his whole time to the superintendence of the same. Such authorized agent or representative shall receive on behalf of the contractor, directions and instructions from the Engineer-in-charge or his representative.

The contractor shall provide detailed organization of the execution team deployed for the works with names and CV's, of all key staff before the commencement of work and get it approved of in writing by the Owner/ Consultant. Contact telephone or pager numbers for emergency and/or twenty-four (24) hour call shall also be included.

If in any case of withdrawal of any worker/ technician/ Engineer from the execution team, the replacement of the same shall be done with equivalent qualification, and shall be approved in writing by the Owner/ Consultant.

PRODUCT, TESTING & COMMISSIONING

Design Criteria

Electrical Details for Incoming Supply:

Supply Voltage: Multiple 11kV

Fault Level (Sym.) at supply point (Designated): 350MVA Neutral: Grounded

Voltage Regulations: +10%

Frequency Regulations: +3%

Combined Regulations: + 10%

11KV HT Power Distribution System:

Voltage: 11 KV

Frequency: 50Hz
Neutral: Grounded
Short Circuit Fault with stand capacity: as per calculations

LT Power Distribution System:

Voltage:415V
Frequency:50Hz
Neutral: Grounded
ShortCircuitFaultwithstandcapacity:10kAto50kAfor1Sec, as per calculations

Control supply for Electrical System:

The various supply voltage to be used in the control panels for the main equipment shall be as under:	
Spring charge motor	230V, Ac or 24V DC (Universal Motor)
Closing/Trip Coil	24V, DC
Alarm/ Indication/ Relays	24V, DC
Heaters	230V, AC

Painting of Panels:

Powder coating of approved shade as per Specification. (Refer clause of painting)

Painting of Cable Trays and Structural steel:

Powder coating of approved shade as per Specification. (Refer clause of painting)

Cable Details:

LT Control Cables: Copper conductor armoured PVC insulated 1.1KV grade.
LT Power Cables: Aluminium conductor armoured XLPE insulated.
Grounding Conductors: Copper/G.I. as per specifications

Drawings

The Tender drawings are enclosed along with this specification. These drawings are meant to give general idea to the EPC contractor regarding the nature of work covered by these specifications.

Any information/data shown/not shown in these drawings shall not relieve the EPC contractor of his responsibility to carry out the work as per the specifications. Additional information required by the bidder for successfully completing the work shall be obtained by him.

Shop Drawings

The EPC contractor shall prepare detailed coordinated electrical shop drawing indicating Panel layout, with other relevant services. The shop drawings shall indicate all setting out details and physical dimensions of all components with wiring and cable details including system operating write up in the system i.e. Control and Relay Panel and fixing details for the above-mentioned work. All work shall be carried out on the approval of these drawings. However, approval of these drawings do not relieve the contractor of his responsibility for providing maintenance free and full proof system including any missing component/accessories to meet with the intent of the specifications. Contractor will submit 2 (two) prints for preliminary approval and finally 6 (six) prints for distribution.

Manufacturer's Instructions

Where manufacturers have furnished specific instructions, relating to the material/Equipment's, to be used on this job, covering points not specifically mentioned in this document, manufacturer's instructions should be followed.

Completion Documents and Drawings

Three copies of operation manuals/catalogues of all standard equipment are to be furnished by the contractor immediately after commissioning of plant.

Three copies of write up on preventive maintenance, trouble shooting and operating instructions of the system along with as-built drawings are to be supplied by the Contractor at the time of commissioning.

On completion of the work in all respects, the Contractor shall supply five portfolios (300x450 mm), each containing complete set of drawings on approved scale, clearly indicating complete layouts, location; wiring and sequencing of

automatic controls, location of all concealed wiring and other services. Each portfolio shall also contain consolidated control diagrams and technical literature on all controls. The Contractor shall frame under glass, in the Panel rooms, one set of these consolidated control diagrams.

Materials and Equipment

All the materials and Equipment's, shall be of the approved make and design. Unless otherwise called from consultant, only the best quality materials and equipment shall be used.

Space Heaters:

Suitable number of adequately rated heaters thermostatically controlled with On-Off switch and fuse shall be provided to prevent condensation in any panel compartment. The heaters shall be installed in the lower portion of the compartment and electrical connections shall be made from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.

Fungistatic Varnish:

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on parts, which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

Ventilation Opening:

In order to ensure adequate ventilation, compartments shall have ventilation openings provided with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds.

Degree of Protection:

The enclosures of the control cabinet, junction boxes and marshalling boxes, panels etc. to be installed shall provide degree of protection as detailed here under.

Installed Outdoor	IP-66	
Installed in door in air-conditioned area		IP-31
Installed in covered area	IP-42	
Installed indoor in non-air conditioned area where possibility of entry of water Is limited		IP-41
For LT Switchgear (AC and DC distribution boards)		IP-42

The degree of protection shall be in accordance with IS: 13947 (Part-I) IEC-947 (Part-I). Type test report for degree of protection test, on each type of the box shall be submitted for approval.

Rating plates, Name plates and Labels:

LT panel and auxiliary items installed in the building is to permanently attach to it in a conspicuous position. A rating plate of non-corrosive material with engraved manufacturer's name, year of manufacture, equipment name, type or serial number together with details of loading conditions of equipment in question has been designed to operate and such diagram plates as may require by the owner. The rating plate of each equipment shall be in accordance with IEC requirement.

All such nameplates, instruction plates, rating plates shall be bilingual with Hindi inscription first followed by English. Alternatively, two separate plates on with Hindi and another with English inscriptions may be provided.

Quality Assurance Programmer:

To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the Contractor's works or at the Owner's site or at any other place of work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance program to control such activities at all points necessary. Such programmer shall be outlined by the Contractor and shall be finally accepted by the Owner after discussions before the award of Contract. A quality assurance programmer of the contractor shall generally cover the following:

His organization structure for the management and implementation of the proposed quality assurance programmer.

Documentation control system.

Qualification data for bidder's key personnel.

The procedure for purchases of materials, parts components and selection of services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.

System for shop manufacturing and site erection controls including process controls and fabrication and assembly control.

Control of non-conforming item and system for corrective actions.

Inspection and test procedure both for manufacture and field activities.

Control of calibration and testing of measuring instruments and field activities.

System for indication and appraisal of inspection status.

System for authorizing release of manufactured product to the Owner.

System for maintenance of records.

System for handling storage and delivery.

The Owner or his duly authorized representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Contractor / his vendor's quality management and control activities.

Quality Assurance Documents

The Contractor shall be required to submit the following Quality Assurance Documents within three weeks after dispatch of the equipment.

All Non-Destructive Examination procedures, stress relief and weld repair procedure actually used during fabrication and reports including radiography interpretation reports.

Welder and welding operator qualification certificates.

Welder's identification list, listing welders and welding operator's qualification procedure and welding identification symbols.

Raw material test reports on components as specified by the specification and/or agreed to in the quality plan.

Stress relief time temperature charts/oil impregnation time temperature charts.

Factory test results for testing required as per applicable codes/mutually agreed quality plan/standards referred in the technical specification.

The quality plan with verification of various customer inspection points (CIP) as mutually and methods used to verify the inspection and testing points in the quality plan were performed satisfactory.

Inspection, Testing and Inspection Certificates

The Owner and the Consultant or duly authorized representative shall have at all reasonable times free access to the EPC Contractor's premises or works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection, if part of the works is being manufactured or assembled at other premises or works, the EPC Contractor shall obtain permission to inspect as if the works were manufactured or assembled on the EPC Contractor's own premises or works. Inspection may be made at any stage of manufacture, dispatch or at site at the option of the Owner and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.

All equipment being supplied shall conform to type tests and shall be subject to routine tests in accordance with requirements stipulated under respective sections. Bidder shall submit the type tests reports for approval. The EPC Contractor shall intimate the Owner/Consultant the detailed programme about the tests at least three (3) weeks in advance in case of domestic supplies. If for any item type test were pending payment would be made on successful completion of type/routine test(s) actually carried out as per Consultant/Owner instructions.

The EPC Contractor shall give the Consultant/Owner thirty (30) days written notice of any material being ready for testing. Such tests shall be to the EPC Contractor's account. The Consultant /Owner unless witnessing of the tests is virtually waived will attend such tests within thirty (30) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed with the test which shall be deemed to have been made in the presence of Owner/Consultant and he shall forth with forward to the Consultant duly certified copies of tests in triplicate.

The Consultant/Owner within fifteen (15) days from the date of inspection as defined shall inform in writing to the Contractor of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and make the necessary modifications accordingly.

When the factory tests have been completed at the Contractor's or Sub-contractor's works, the Consultant/Owner shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the Consultant/Owner, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Consultant/Owner. Failure of the issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests or the issue of the certificate shall not bind the Owner to accept the equipment should, it, on further tests after erection, is found not to comply with the Specification. The equipment shall be dispatched to site only after approval of test reports and issuance of material inspection clearance certificate by the Owner.

For tests whether at the premises or at the works of the Contractor or of any Sub-Contractor, the Contractor except where otherwise specified shall provide free of charge such items as labor, materials, electricity, fuel, water, stores, apparatus and instruments as may be required by Owner/Consultant or this authorized representative to carry out effectively such tests of the equipment in accordance with the Specification.

The inspection by Owner/Consultant and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programmer forming a part of the Contract. The Consultant/Owner will have the right of having at his own expenses any other tests(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests to satisfy that the material complies with the specifications.

The Owner/Consultant reserves the right for getting any field tests not specified in respective sections of the technical specification conducted on the completely assembled equipment at site. The testing equipment's for these tests shall be provided by the Contractor.

Tests

Charging (Pre-commissioning tests):

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Owner/Consultant and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The pre-commissioning tests to be performed as per relevant I.S. / vendor/ bidder submittal and as included in the Contractor's quality assurance programmer

Commissioning Tests:

The available instrumentation and control equipment will be used during such tests and the Contractor will calibrate all such measuring equipment and devices as far as practicable. However, immeasurable parameters shall be taken into account in a reasonable manner by the Contractor for the requirement of these tests. The tests will be conducted at the specified load points and as near the specified cycle condition as practicable. The Contractor will apply proper corrections in calculation, to take into account conditions which do not correspond to the specified conditions.

All instruments, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.

Pre-commissioning test shall be carried out as per relevant IS and/or as specified in the relevant clause.

The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning of the equipment. However necessary fee shall be reimbursed by Owner on production of requisite documents.

Packaging

All the equipment's shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of availability of Railway wagon/truck/trailer sizes in India should be taken account of the Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Owner takes no responsibility of the availability of any special packaging/transporting arrangement.

Protection

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner.

Finishing of Metal Surfaces

General:

All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot-dip galvanized after fabrication. High tensile steel nuts and bolts and spring washers shall be electro galvanized. All steel conductors used for earthing/grounding (above ground level) shall be galvanized according to IS: 2629.

Painting:

All sheet steel work shall be degreased, pickled, and phosphate in accordance with the IS-6005 "Code of practice for Phosphate iron and sheet". All surfaces, which will not be easily accessible after shop assembly, shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swab shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

After Phosphate process thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stowing type zinc chromate primer. The first coat may be "flashing dried" while the second coat shall be stove

Powder coating/electrostatic painting of approved shade shall be applied.

The exterior color of the paint shall be as per IS-5 or as approved by consultant. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the Equipment's, if required.

In case the Bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures like electrostatic painting etc. the procedure shall be submitted along with the Bids for Owner's review and approval.

Handling, Storage and Installation

In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Owner or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level plumb, square and properly aligned and oriented.

Contractor shall follow the site procedure for transporting of materials, unloading, and safe storage. The equipment's after collection from store shall be erected, tested and commissioned as per contract specification, manufacturer guidelines and Engineer-in-charge instruction.

In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Owner/Consultant. Contractor shall be held responsible for any damage to the equipment consequent for not following manufacturer's drawings/instructions correctly.

Where assemblies are supplied in more than the one section, Contractor shall make all necessary connections between sections. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.

The Contractor shall submit to the Owner every week, a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site. Any demurrage, wharf age and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

The Contractor shall be fully responsible for the equipment/material until the same is handed over to the Owner in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by Owner, as well as protection of the same against theft, element of nature, corrosion, damages etc.

The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment, which require indoor storage.

The words 'erection' and 'installation' used in the specification are synonymous.

Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.

The minimum phase to earth, phase to phase and section clearance along with other technical parameters for the various voltage levels shall be maintained as per relevant IS.

Protective Guards

Suitable guards shall be provided for protection of personnel on all exposed rotating and / or moving machine parts. All such guards with necessary spares and accessories shall be designed for easy installation and removal for maintenance purpose.

The Contractor shall also conform to the general regulations governing personnel on the site and must keep to the working space allocated for their use.

The contractor shall be responsible for any kind of mishap, etc. happened with personnel. The Owner shall not take the responsibility for any of such kind.

Tools and Tackles

The Contractor shall supply with the equipment one complete set of all special tools and tackles for the erection, assembly, dismantling and maintenance of the Equipment's,

END OF SECTION

CONDUIT SYSTEM, CABLE TRAY, CABLE LADDER AND TRUNKING INSTALLATION

GENERAL

Work Description

This section describes the supply and installation of wiring facilities systems include conduits, cable trays, cable ladder and Trunking system, c/w associated fittings and accessories.

All cables running above the suspended false ceiling, columns, or on surface shall be supported by proper clamps, on cable tray. No free hanging of cable is allowed.

The cable routes shown in the drawings shall be used as a guide only. The cable routes may be physically examined and coordinated with other services before under taking the installation work in hand.

Uncoordinated and inaccessible routes after other services are installed, shall be relocated at the expense of the Contractor.

All conduits, trunking, cable trays and cable ladders shall be earthed in accordance to IS: 4043.

Standards

The complete wiring facilities system shall be manufactured, supplied, installed and tested in accordance with the latest revision of the Indian standards and the appropriate BS / IEC include:

Steel Conduit and Fitting Accessories	IS:9537(Part-II)/BS4568&BS731/CPWD
PVC Conduit and Fitting Accessories	IS-9537/1983(Part-III)/BS6099&BS4607/CPWD
Cable Tray	BS729/CPWD
Cable Ladder	BS729/CPWD
Cable Trunking	BS4678/CPWD

The complete wiring facility system shall conform to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in the approved specification and drawings.

Submissions

All technical submissions shall be approved by the EPC contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of consultant for its review and approval.

Routing of installation

Sample of proprietary factory-made accessories, elbows, risers, reducers, tees, crosses, etc.

PRODUCTS

Steel Conduit and Accessories (For Non Residential & Hostel Blocks)

Steel Conduit:

All conduits shall be of heavy gauge solid drawn ERW welded manufactured out of 16 (1.6mm) gauge MS Sheet up to 32mm dia and 14 (2 mm) gauge for sizes above 32mm.

Both inner and outer surfaces shall be smooth without burrs, dents and kinks.

Conduits shall be black to beenameled inside and outside. The cross-section of conduit shall be uniform throughout. The welding shall be uniform such that welded joints do not yield when subjected to flattening test. Welded joint shall not break when threaded or bent at an angle.

Conduit shall conform to specifications of IS:9537(Part-II) and the capacity of conduits shall be in accordance with the standards

The minimum size of the conduit shall be 25mm diameter.

Care shall be taken to ensure that all conduits are adequately protected while stored at site prior to erection and no damaged conduit is used.

Fittings

Samples of conduit fittings shall be submitted for approval prior to use on work.

Fittings shall be those intended for use with screwed conduits and shall comply with IS 9537. However, bends, elbows and tees shall not be installed.

Boxes and cover plates installed outdoors shall have fixing lugs exterior to the box so that fixing screws do not enter the box interior.

Adaptors used with flexible conduits shall conform to IS:9537.

Circular Boxes

Circular boxes shall be of malleable cast iron, galvanized and of standard pattern with spout(s). When used for connecting lengths of conduits, circular boxes shall be provided with cover plates of similar make that are complete with brass fixing screws.

Rectangular Boxes

Rectangular boxes (adaptable boxes) shall be of mild steel not less than 2.4 mm gauge and galvanized. When used as junction boxes, lids of the same gauge with brass fixing screws shall be used.

Boxes for Accessories

Boxes for accessories shall be suitable for surface mounting or recessed mounting according to the requirements. Surface mounted boxes and accessories shall be metal clad pattern. Recessed boxes and accessories shall be complete with insulated molded type cover plates conforming to IS: 5133 Part 1-1969.

Covers

All covers for boxes, etc. shall be made of galvanized steel of 1 to 1.2mm thickness.

PVC Conduit and Accessories (For Residential Blocks Only)

PVC Conduit

All conduits shall be high impact rigid 2mm thickness FRLS PVC heavy duty type and shall comply with I.E.E. regulations for non-metallic conduit as per IS-9537/1983 (Part-III).

All sections of conduit and relevant boxes shall be properly cleaned and glued by using epoxy resin glue and the proper connecting pieces.

Inspection type conduit fittings such as inspection boxes, drawn boxes, fan boxes and outlet boxes shall be of M.S. or otherwise mentioned.

Conduit shall be terminated with adaptor/PVC glands as required.

PVC Conduit Accessories

Accessories used for conduit wiring shall be of an approved type conforming to IS:3837-1966.

All accessories used shall be of standard white or black color, identical to conduit used.

Plain conduits should be jointed by slip type of couplers with manufacturer's standard sealing cement.

All conduit entries to outlet boxes, trunking and switchgear are to be made with adaptors female thread and male

bushes screwed.

PVC-switch and socket boxes with round knockouts are to be used. The colors of these boxes and the conduits shall be the same.

Standard PVC circular junction boxes are to be used with conduits for intersection, Tee-junction, angle-junction and terminal. For the drawing-in of cables, standard circular through boxes shall be used.

Samples of accessories shall be submitted for approval prior to installation.

All jointing of PVC conduits shall be by means of adhesive jointing. Adequate expansion joints shall be allowed to take up the expansion of PVC conduits.

Conduit Installation

Layout

The conduit layout and conduit routes shall be submitted for approval. Allowance for adjustments due to site conditions shall be made at no extra cost.

Conduit routes shall be chosen for easy, straight runs with minimum bends and crossings. Generally, they shall follow the structure of building, running at right angles or in parallel to floors and ceilings. Conduits shall be kept within 300mm of floor and ceilings when running parallel to them.

Outlet boxes for housing accessories shall be used as draw boxes. The total number of draw boxes shall be kept to a minimum and shall be provided so that conduit runs do not exceed 12 m or have more than two right angle bends.

All conduits shall be kept clear of gas and water pipes. In particular, conduits shall be at least 150 mm away from gas pipes. Where proximity to these pipes is unavoidable, they shall be effectively segregated e.g. using rubber or other insulating material to prevent appreciable voltage differences at possible points of contact. Segregation from extra low voltage circuits and telecommunication circuits shall also apply unless these are wired to the same voltage requirements as lighting and power circuits.

Conduits from different distribution boards shall not be connected to the same junction box. Each run of conduit shall be assembled complete with draw-in-wires.

Joints and Terminations

Electrical and mechanical continuity shall be maintained throughout all conduit joints and terminations. Conduit threads shall be thoroughly cleaned and tightly screwed. The conduit system shall be watertight after installation.

Conduits shall be connected using couples or via boxes. With a coupler, the ends of the conduit shall butt close to get her and the running coupler is screwed tightly on and tightened by a locknut.

Conduits terminating into boxes provided with spouts shall be threaded so that there are no exposed threads. For boxes with no spouts, the termination shall be made using a brass bush and a coupler. The conduit is pushed through the knockout or drilled entry and the bush is screwed tightly onto its end. The coupler is screwed to butt firmly against the exterior wall of the box.

Where conduits are not jointed or terminated in boxes, they shall be terminated in a screwed brass bush.

In all joints and terminations, conduit threads shall not be exposed. Where this cannot be avoided as in a running coupler, the exposed threads shall be coated with red lead paint to seal against the ingress of water.

Bends

Conduits shall only be bent cold with an approved type of bending block or bending machine, without altering the dimensions of their sections.

All conduit bends shall be such as to permit compliance to the requirements for bends in cables to as stated in the BS 7671.

Bends shall be made with as large a radius as the position of the conduit within the building permits. Where the bend is more than 90 degrees, circular or rectangular junction boxes are to be used for connecting conduits.

Cabling

The conduit system must be installed free of obstructions and sharp corners before any cables are drawn in. Conduits shall be thoroughly swabbed to remove moisture and dirt immediately prior to the drawing in of cables.

Cables shall be drawn with out crossing each other and shall not be pulled against the walls of the draw boxes. Slack cables shall have left in all draw boxes.

Cables shall be continuous throughout conduit lengths and no joints are permitted. There shall be no kink in cables, neither any cut, abrasion or chink in the cable insulation.

The same conduit shall carry the lead and return conductors bunched together. However, the same conduit shall not house cables from different distribution boards.

Cables for power and lighting circuits and extra low voltage systems shall not be drawn into the same conduit. Lighting and power circuits shall run in separate conduits except, where an adopter box is employed as final distribution point, a number of final circuits are grouped together in larger conduits between the distribution board and the adopter box provided that all final circuits in one conduit are of the same phase. In the case of three phase circuits, all three phases including neutral, if any, shall be drawn into the same conduit.

Conduits shall not constitute the earth continuity path for the electrical circuit. A separate circuit protective conductor shall be installed within the conduit. The whole conduit system shall be effectively earthed.

Flexible conduits shall have a separate earthing conductor installed within the tubing and connected at conduit ends. Flexible conduits in general shall not be used for more than 3m length.

Maximum number of PVC insulated 650/1100V grade/copper conductor cable conforming to IS:694-1990

Nominal	25m m		32m m		38m m		61m m		64mm	
Cross- Sectional area of Conductor in Sq.mm										
	S	B	S	B	S	B	S	B	S	B
1.0	4	5	6	7	8	9	10	11	12	13
1.5	10	8	18	2	-	-	-	-	-	-
2.5	8	6	12	0	-	-	-	-	-	-
4.0	6	5	10	8	-	-	-	-	-	-
6.0	5	4	8	7	-	-	-	-	-	-
10	4	3	6	5	8	6	-	-	-	-
16	2	2	3	3	5	5	10	7	12	8
25	-	-	3	2	5	3	8	6	9	7
35	-	-	-	-	3	2	6	5	8	6
50	-	-	-	-	-	-	5	3	6	5
70	-	-	-	-	-	-	4	3	5	4

Notes:

The above table shows the maximum capacity of drawing in of cables in conduits

The columns Head 'S' apply to runs of conduits which have distance not exceeding

4.25 m between draw in boxes and which do not deflect from the straight run by an angle of more than 15 degrees.

The columns heads 'B' apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.

Conduit sizes are the nominal external diameters.

Access and Drainage

The conduit system shall be rewirable, that is, draw boxes must be accessible for the purpose. Where boxes are concealed, their covers shall be flushed with the finished surface.

The need for accessibility notwithstanding, the conduit system shall be protected against the ingress of water and impurities. When installed, conduits shall be kept dry and free of debris with approved pipe plugs or caps. Such

plugging is especially essential prior to pouring concrete for concealed installation. As for boxes, they shall be covered by steel plates prior to concreting.

When installed outdoor, and in situations liable to condensation of moisture, conduits shall be arranged to be self-draining, so that water may drain to low points which are fitted with a drain plug. Conduits laid under concrete floors shall have watertight floor-traps of approved detail for access of these drainage points.

Conduits run on surfaces other than structural steel members shall be secured using galvanized space bar saddles and brass fixing screws. Spacing of saddles shall not exceed 1.2 m for conduit sizes up to and including 25 mm and 1.8 m for sizes 32 mm and above.

Conduits run on structural steel shall be secured using girder clips or an approved clamp. These conduits and those run in the vicinity of structural steel shall be bonded to the steelwork using an efficient and permanent metallic connection. The conduits shall not in any way be under mechanical stress.

All conduit boxes except loop-in patterns shall be fixed direct to the building structure in addition to the support provided by the conduits.

Conduits terminating into surface boxes shall be secured by a minimum of 3 saddles at not less than 32 mm, 150 mm and 300 mm respectively from the box.

Conduits shall be painted with an approved paint to blend with visual environment. A zinc rich undercoat shall be provided before painting the final coat.

Cable Tray

Cable tray shall be perforated type and construction with minimum 2.0 mm hot dipped galvanized mild steel for outdoor damp condition, and electro-galvanized mild steel for indoor installation. All cable trays shall be installed in a straight run parallel to walls where possible.

Cable trays shall be supported by electro-galvanized 'U' channel with galvanized threaded rod for indoor suspended tray and hot-dipped galvanized for area subject to weather.

All hangers shall be installed at 1-meter interval and shall be applied primer and painted to match with the surrounding building finish approved by the Engineer-in-charge.

The cable trays those are exposed to the weather, a hot-dip galvanized cover of 1.5mm gauge steel, flush fixing type with gasket, shall be installed on top of the tray.

Depending on the size of cable trays spare space of 25% shall be maintained for future expansion.

Copper earth link bar shall be fixed at every joint of the cable tray run.

Cable Ladder

All cable ladders and accessories installed indoors shall be heavy-duty electro-galvanized mild steel type. All cable ladders installed outdoors shall be heavy-duty hot dipped galvanized hot rolled mild steel. Thickness of the mild steel shall not be less than 2 mm.

Cable ladder shall have a 150 mm high longitudinal side member for ladders width of 800mm or above and 120 mm high longitudinal side member for ladder width less than 800 mm.

The rugs shall be at least 50 mm wide, with slots of 25 mm x 10 mm at 25 mm intervals covering the length of the rugs. The rugs shall be space at 300 mm apart along straight lengths of the ladder.

All nuts, bolts and washers for clips and brackets shall be zinc plated. Each cable ladder shall be in standard manufacturer's length and supplied complete with coupling sets consisting of fishplates, spine bolts, and nuts and locking washers.

The complete cable ladder installation shall be provided with all necessary proprietary factory-made elbows, risers, reducers, tees, crosses, drop-outs, etc. and any site fabricated items will not be permitted.

Separate flexible earth continuity connectors of at least 16mm² copper jumpers shall be installed between the ladder sections.

All cables ladders shall be supported from the ceiling concrete slab, steel structures or sidewalls using a frame system, with overhead hangers, support channels, hanger rods or angle brackets, beam clams and ceiling brackets.

Fixings and supports shall be installed at regular intervals not exceeding 1000 mm and 150 mm from all bends, tees, inter-sections and risers.

When cable ladder is refined to install across structure expansion joints, the ladder shall be in two sections between supports installed on either side of the expansion joint.

The ladder sections shall than be jointed with expansion joint fishplates, bolts, nuts and washers install in elongated holes permitting a length wise movement of 25mm from the initial fastening position.

For cable ladder that are exposed to the weather, hot-dip galvanized cover of 1.5mm gauge steel, flush fixing type with gasket, shall be installed on top of the ladder.

Copper earth link bar shall be fixed at every joint of the cable ladder run.

Cable Trunking

Cable trunking shall be manufactured from 1.6 mm minimum electro-galvanized mild sheet steel to BS4678 finished in oven-baked electro statically coated epoxy powder coating with color.

All trunking shall have removable lids extending over their entire lengths. Lids shall be fixed at interval not exceeding 1 meter by means of brass steel screws which and protected against corrosion by a finish of zinc coating or equivalent to zinc coating.

Factory-made bends, joints, elbow, riser, tee, reducer and accessories with same material shall be provided throughout the installation for trunking.

Trunking space factor shall be in compliance with latest IS standards. Copper earth link bar shall be fixed at every

joint of the cable trunking **Note:** All items mentioned in this section shall be manufactured to comply with the

specifications of National Electrical Code (NEC) and National Electrical Manufacturer's Association (NEMA).

END OF SECTION

WIRE AND CABLES

GENERAL

Work Description

The design, manufacturing, testing and supply of single core FRLS PVC insulated 1.1 KV grade stranded twisted wires shall comply with following standards with update amendments under the specifications.

IS-3961:Current rating for cables.

IS-5831:PVC insulation and sheath of electric cables.

IS-694:PVC insulated cables for working voltage up to and including 1100volts.

IEC-54(I):PVC insulated cable.

Copper / Aluminum stranded twisted conductor PVC insulated wires shall be used in conduit as per item of work. Aluminum wires for power cables and copper wires for control cables shall be used.

The wires shall be color coded - (red, yellow, blue) for Phases, black for Neutral and green for Earth.

Progressive automatic in line indelible, legible and sequential marking of grade, voltage, capacity and length in meters shall be embossed at every meter on the outer's sheath of cable.

The design, manufacture, testing and supply of the cable under these specifications shall comply with following standards latest edition of:

IS:8130:Conductors for insulated electric cables and flexible cords.

IS:5831: HRPVC/HRPVC insulation and LSZHs sheath of electric cables.

IS:3975:Mild steel wires, strips and tapes for armoring cables.

IS:3961:Current rating of cables.

The routing and minimum rated current carrying capacity of the LV power cables shall be indicated on the Drawing. The Contractor shall consider the manufacturer data and engineering for cable sizing and to ensure that it meets the conditions of grouping, ambient temperature etc.

All LT cables for normal power/control circuits within buildings shall be XLPE insulated and PVC sheathed Aluminum conductor and control cables shall be PVC insulated and PVC sheathed copper conductor respectively.

All LT cables, for emergency power circuits serving emergency light, Building Management System (BMS), Fire Protection System, Security Systems, emergency communication systems, and sump pump system and fire lifts etc. with back-up from UPS systems or incoming and outgoing from the Emergency Main Switchboard, shall be fire resistant as required.

Cables in service duct, open trench, direct-laid underground in soil shall be by means of armoured cables. Non-armoured cables shall only be laid in conduits, trunking sort tray/ladder for mechanical protection.

All L.T Cables to be used to feed smoke extraction , basement ventilation, Staircase pressurization & lift well pressurization will be of Standard Annealed Bare Copper Conductor /950 Degree Mica Tape Wrapped XLPE Insulation/Core Laid up together / FRLS inner Sheathed / GI Wire Strip Armoured / FRLS Outersheathed Fire Survival cables..

Standards

All cables shall be manufactured and constructed in accordance of the following standards with the latest revision:

1 .	IS:694	HRPVC/XLPE insulated (heavy duty) electric cables for working voltage up to and including 1100 volts.
2 .	IS:424-1475(F-3)	Power cable-flam ability test.
3 .	IS:7098(1)	Specification for cross-linked polyethylene insulated LSZHPVC sheathed cable for working voltage up to 1.1 KV.
4 .	IS:1554	Specification for PVC insulated (heavy duty) electric cables for working voltages up to and including 1100 volts.
5 .	ASTM-D:2863	Standard method for measuring the minimum oxygen concentration to support candle-like combustion of plastics (Oxygen Index).
6 .	ASTM-D:2843	Standard test method for measuring the density of smoke from the burning or decomposition.
7 .	IEEE:383	Standard for type of tests Class-IE, Electric cables, field splices and connections for power generation station.
8 .	ASTME: 662/1	Standard test method for specific optical density of smoke generated by solid materials
9 .	IS:10418	Cable drums.
10 .	IS-10810	Testing method of cable.
11 .	IS-6121	Cable glands.
12 .	IS-9537	Rigid steel conduit.

The manufacturing of the cable shall also conform to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in the approved Specification and Drawings of EPC contractor. Only more stringent specification shall be followed.

Submission

All technical submissions shall be approved by the EPC contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of consultant for its review and approval.

As a minimum requirement, the submission shall include the following:

Equipment submission with manufacturer's data

Sample submission

Shop Drawings of the cable route showing the co-ordinated routing of cables, arrangement on cable trays, methods of fixing of cable trays and cables, etc. All conduits including concealed conduit routing drawings shall also be included

Cable test reports and IS Certification

Cable schedule indicate the following data include:

Cable code and type and installation method

Cable feed from and serve to

Cable route length and voltage drop

Cable capacity and

Upstream protection breaker rating

The cable schedule shall be prepared in accordance to the cable manufacturer's data.

PRODUCT

LT Cables

The cables shall be suitable for laying in racks, ducts, trenches conduits and under- ground buried installation with uncontrolled back fill and chances of flooding by water.

They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating condition.

The aluminum/copper wires used for manufacturing the cables shall be true circular / sector in shape before stranding and shall be of uniformly good quality, free from defects. The conductor used in manufacture of the cable shall be of H2 grade.

The cable should withstand 2.5 kA for 1 Sec. with insulation armour insulated at one end. Bidder shall furnish calculation in support of capability to withstand the earth fault currents. The current carrying capacity of armour and screen (as applicable) shall not be less than the earth fault current values and duration.

The fillers and inner sheath shall be of non-hygroscopic fire-retardant materials and shall be suitable for the operating temperature of the cable. Filler and inner sheath shall not stick to insulation and outer sheath.

Progressive automatic in line indelible, legible and sequential marking (grade, voltage, capacity, length-in meters) shall be embossed at every meter on the outer's heath of all cables and at every 5 meter 'LSZH marking in case of 'LSZH cables.

IS: 3975 methods (b) for strip / wire armouring shall only be acceptable. For single core cable aluminium wire armouring shall be used.

Allowable tolerance on the overall diameter of the cables shall be +2mm.

The normal current rating of all HRPVC/XLPE insulated cables shall be as per IS:3961.

A distinct inner sheath shall be provided by pressure extrusion process for all multi cores armoured and unarmoured cables as per IS: 5831.

Outers heath shall be provided by extrusion process as per IS:5831.

The breaking load of armour joint shall not be less than 95% of that armour wire. Zinc rich paint shall be applied on armoured joint surface.

In plant repairs to the cables shall not be accepted.

All the cables shall be supplied in non-returnable drums as per IS:10418.

Fire Survival Cables

Multi core Al / Cu Conductor XLPE/ Cross linkable Low Smoke Halogen Free insulated with Fire rated Glass Mica Tape, LSZH inner and outer Sheathed, Armoured with GI Strip/ Wire Fire Survival Cable.

Basic design shall be as per BS 7846-2009,& IE C60502

Fire resistance of the cable shall be as per BS:8491-2008&8434-2:2003

Inspection

All cables shall be inspected on receipt of the same at site and checked for any damage during transit.

Joints in Cables

Cable drum length and sizes of cable lengths required may be checked carefully before cutting the cables from drum. The contractor shall take care that the cables received at site are distributed to various locations in single length as far as possible to ensure maximum utilization. Where the joints are unavoidable, the same is to be done with approval from the Owner/Consultant. The joints shall be done by qualified jointer strictly in accordance with manufacturer's instruction / drawings in presence of Engineer-in-charge.

Joint Boxes for Cables

The cable joint boxes shall be of appropriate size suitable for type of cable of particular voltage rating.

Cable Joints

All cable joints materials shall be of standard make and suitable to requirement. On jointing of cables in the joint box the cable compound shall be filled in accordance with manufacturer's instructions and in approved manner. All straight through joints shall be done in epoxy mould boxes with epoxy resins. Straight through joints shall not be permitted unless the length of run is in excess of cable drum.

End terminations of cables more than 1.1 KV grade shall be done with epoxy mould boxed and epoxy resin. Cable glands shall be 1.1 KV grade double compression type and made to tin plated heavy-duty brass casting and machine finished. Glands shall be of robust construction capable of clamping cable and cable armour, firmly without injury of cable.

All washers and hardware shall be made of brass tinned. Rubber components used in the glands shall be made of neoprene of tested quality.

Cable lugs shall be tinned copper/ aluminium solder less crimping type conforming to IS: 8309 suitable for aluminium or copper conductor.

Crimping of terminals shall be done by using Corrosion inhibitory compound, with crimping tool.

Fire resistant paint has to be applied 1 Meter on either side of cable joint.

The contractor shall liaise fully with all other contractors to achieve an efficient and properly coordinated installation where equipment has to be re-positioned due to lack of site liaison; no extra cost shall be incurred by the client.

XLPEHT Cables (Upto 11KV)

The cross-linked polyethylene (XLPE) cable shall be aluminium conductor PVC outer sheath steel strip armoured over inner sheath construction. XLPE cable shall conform to testing in accordance with IS: 7098 (Part-I) 1977 and (Part-II) 1973. The screening shall be done on individual cover. The armouring applied over the common covering shall be flat steel wires. Each and every length of cable shall be subjected to routine test.

The termination and jointing techniques for XLPE cables shall be by using heat shrinkable or push on cable jointing kits.

While laying underground cables in ducts care should be taken so that any underground structures such as water pipes, sewerage lines etc. are not damaged. Any telephone or other cable coming in the way shall be properly protected as per instructions of the Engineer-in-charge. The HT cable shall be laid at least 1200mm for cable up to 33 KV (E) below the ground level in a trench 450mm wide.

After laying and jointing work is completed High Pot test shall be performed in presence of Engineer-in-charge and test results submitted for approval in order to ensure that they have not been damaged during or after the laying of cables. In case, the test results are unsatisfactory, the cost of all repairs and replacement and all extra work of removal and relaying will be made good by the contractor without any extra cost.

Note: All other procedure will be followed as per L.T. cables.

EXECUTION

Erection of Cables

Notwithstanding the cable routes indicated on the Drawings the Contractor shall be entirely responsible for the supply of correct lengths of the cables to be installed and for all allowances for connecting and terminating the cables to the switchgears and transformers respectively

The Contractor shall submit proposed cable routes including details of supports for the cables for approval before installation. The cable shall not be run in places other than corridor, passageway, electrical riser or other designated areas subject to the Engineer's approval. The cost of support shall be deemed to have included in the Contract.

Cable Pulling

Winching of cables through ducts / pipes shall only be carried out with the approval of the Engineer-in-charge in which event a pulley eye shall be attached to the conductors. Cable shall be run in neat and orderly manner to allow space for future cabling and maintenance. Under any circumstances the cable shall not run diagonally across a room, cable basement, corridor, etc.

A cable sheath stocking may be employed on cables where no undue stress in the sheath is likely to occur.

Care shall be taken to ensure that the draw strain is applied to the armouring and protected during drawing against damage.

Cable Laying

The cable drum shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming links. At all changes in directions in horizontal & vertical places, the cable shall be bent with a radius of bend not less than 8 times the diameter of cable.

The cable of 1.1 KV grade shall be laid not less than 750mm below ground level in a 375 mm wide trench (throughout). Where more than one cable is to be laid in the same trench, the width of the trench shall be increased such that the inter axial spacing between the cables except where otherwise specified is at least 150mm minimum or as per site requirements or as approved by the Engineer-in-charge. Where single core cables are used in multiphase systems, the cables shall be installed in trefoil where possible.

In case the cables are laid in vertical formation due to unavoidable circumstance the depth per tier shall be increased by 200 mm (minimum). Cable shall be laid in reasonably straight line, where a change in direction takes place, a suitable curvature shall be i.e. either 20 times the diameter of the cable or the radius of the bend shall not be less than twice the diameter of the cable drum or whichever less is. Minimum 3-meter-long loop shall be provided at both sides of every straight through joint & 3 meters at each end of cable or as directed at site.

Greater care shall be exercised in handling the cable in order to avoid forming 'Kinks'. The cable drum shall invariably convey on wheels and the cable unrolled in right direction as indicated on the drum by the manufacturer. The cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains.

Cables laid in trenches in single tier formation, 10 CMS all-around sand cushioning is provided below and above the cable before a protective cover is laid. For every additional vertical tier. The 30 cm of sand cushion is provided over the initial tier. The cable shall be protected by 2nd class brick of size not less than 230 x 115 x 75mm, stone tiles / RCC curved channel be placed on top of the sand breadth wise for the full length of the cable and where more than one cable is to be laid in the same trench the brick shall cover all cables and project at least 8 CMS over the outer sides of the end cables.

Filling of trenches shall be done after sand cushioning and tiles or bricks lying and inspection is carried out by the Engineer-in-charge (Refer drawing). Back fill for trenches shall be filled in layer not exceeding 150 mm. Each layer shall be properly rammed & consolidated before laying the next layer.

PVC pipe shall be provided on all road crossing. The size of the pipe shall be above the size of the cable. Minimum 100 mm dia. Pipes are to be provided. The pipe shall be laid round with special arrangement and shall be cement jointed and concreting of 1:5:10 shall be provided as per relevant IS with latest amendment. Nothing extra shall be paid on this account. Cable route markers at interval of 30 meters and at the point of direction change shall be provided to indicate cable path. Aluminum strip cable tag of 20mm wide with engraved tag no. shall be provided at both ends of cable.

Where the cables are laid in ducts (pucca trenches) inside the building, they will be laid on MS rack / cable trays grouted on trenches walls. Cables passing through floors shall be protected from mechanical damage by steel channel to a height of one meter above the floor. Sleeve shall be provided in the wall for crossing of cables.

Where the cables are laid in open (in building) along walls, ceiling or above false-ceiling, cable rack (ladder type) or cable tray shall be provided. The size of the cable tray or rack shall depend on the number of cables to pass over that rack. Cable tray/rack shall be properly supported through wall/ceiling according to the site conditions. Cable laid on tray & riser shall be neatly dressed & clamped at an interval of 1000 mm & 750mm for horizontal & vertical cable run respectively either side at each bend of cable. All power cables shall be clamped individually & control cables shall be clamped in groups of three or four cables. Clamps for multi core cables shall be fabricated of 25x3 GI flats. Single

core power cable shall be laid in trefoil formation & clamped with trefoil clamps made of PVC/fiber glass.

Cable openings in wall/floor shall be sealed by the contractor suitably by Hessian tape & Bitumen compound or by any other proven material to prevent ingress of water.

After the cables are laid, shall be tested as per IS and the results submitted to Architects/Engineer and in case the results found unsatisfactory, all the repairing/ replacing of cables will be done by the contractor free of charge.

Internal Wiring

All the wiring installation shall be as per IS: 732 with latest amendment. PVC insulated copper conductor cables as specified in bills of quantity shall be used for sub-circuit runs from the distribution boards to the points and pulled into conduits. They shall be twisted copper conductors with thermoplastic insulations of 1100 volts' grade. Colour Code for wiring shall be followed.

Looping system of wiring shall be used, wires shall not be jointed. Where joints are unavoidable, they shall be made through approved mechanical connectors with prior permission of the Consultant. No reduction of strands is permitted at terminations. No wire smaller than 1.5 sq.mm shall be used. Wherever wiring is run through trunkings or raceways, the wires emerging from individual distributions shall be bunched together with cable straps at required regular intervals. Identification ferrules indicating the circuit and DB number shall be used for sub main sub-circuit wiring. The ferrules shall be provided at both end of each sub main and sub-circuit.

Where single phase circuits are supplied from a three phase and a neutral distribution board, no conduit shall contain the wiring fed from more than one phase. In any one room in the premises where all or part of the electrical load consists of lights, fans and/or other single phase current consuming devices, all shall be connected to the same phase of the supply. Circuits fed from distinct sources of supply or from different distribution boards or through switches or MCBs shall not be bunched in one conduit. In large areas and other situations where the load is divided between two or three phase, no two single phase switches connected to different phase shall be mounted within two meters of each other.

All splicing shall be done by means of terminal blocks or connectors and no twisting connection between conductors shall be allowed.

Industrial sockets shall be of polycarbonate and deeply recessed contact tubes. Visible scraping type earth terminal shall be provided. Socket shall have self-adjustable spring-loaded protective cap. Socket shall have MCB/ELCB/RCCB as specified in the schedule of work.

Fire Seal System

All the floor/wall opening provided for cable crossing shall be sealed by fire seal system.

The fire proof sealing system shall fully comply with the requirements of relevant IS/BS: 476 Part-B. The fire proof seal system shall have minimum one-hour fire resistance rating.

The fire proof seal system shall be physically, chemically, thermally stable and shall be mechanically secured to the masonry concrete members. The system shall be completely gas and smoke tight, anti-rodent and anti-termite.

The material used in fire proof seal system shall be non-toxic and harmless to the working personnel.

Type of fire proof seal system shall be foaming type or flame mastic type compound or approved equivalent.

After laying and jointing work is completed, high voltage test should be applied to all cables to ensure that they have not been damaged during or after the laying operation and that there is not fault in the jointing.

Cables for use on low and medium voltage system (1.1 KV grade cables) should with stand for 15 minutes a pressure of 3000V, DC applied between conductors and also between each conductor and sheaths. In the absence of pressure testing facilities, it is sufficient to test for one minute with a 1000V insulation tester in case the test results are unsatisfactory the cost of repairs and replacements and extra work of removal & laying will be made good by the contractor.

Cable shall be installed so that separations shown in the table below are observed.

1	HT Cable(11KV)	-	HV Cable(11KV)	50

.			m
2	ELV&LT230V/433V	-	m
.		ELV&LTcable23	50
		0	m
3	HT cables(33KV)	-	30
.		ELV&LVcables23	0
		0	m
			m
4	LTcables433V	-	35
.		Telephone/Instrum	0
		ent	m
			m
5	All cables	-All hot pipe work	20
.			0
			m
			m

Factory Tests

Each type of cable specified shall be fully type tested according to IEC 502 and the appropriate British Standards. The types and sizes of cables required are shown on the Drawings.

Should the Engineer require it, the Contractor shall submit reports issued by a national or international testing authority on type test that have been successfully performed on the cable for his approval.

The type test shall include the following test:

Partial discharge test;

Bending test, plus partial discharge test;

Tan δ measurement as a function of the voltage and capacitance measurement;

Tan δ measurement as a function of the temperature;

Heating cycle test plus partial discharge test;

Impulse with stand test, followed by a power frequency voltage test;

Medium-voltage alternating current test;

Type test(non-electrical) as stipulate in IEC 502, Table VI.

Cable routine test shall be conducted at factory in accordance with IEC 502 for the following tests: Measurement of the electrical resistance of conductor's Partial discharge test, 4-hour HT test

Site Acceptance Test

The Contractor shall supply all necessary testing Equipment's, for site testing. When required, these testing Equipment's, shall be calibrated at the expense of the Contractor at a recognized national laboratory.

The Contractor shall engage an Authorized Medium Voltage Testing Engineer who is recognized by SEB to perform all site tests.

In addition to SEB's requirements and those recommended by the manufacturer, the following tests shall be carried out:

Continuity test

Earth test

Polarity test

Insulation resistance test

DC high voltage test. The test voltage shall be in accordance with SEB's requirements and Engineer's approval.

END OF SECTION

LT PANEL BOARDS

GENERAL

Scope

The section covers the detailed requirements of medium voltage switch panel for 433 volts, 3 phases, 50 HZ, 4 wire systems. These shall be branded and or / assembled / fabricated of factory of repute. All switchgears shall be fully rated at an ambient of 50 deg C.

Type Of Panel

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

Air circuit breakers draw out type or fixed type

MCCBs of suitable Ics ratings. MCCBs shall invariably be current limiting type. Features like Double Break, positive isolation functions shall be preferred. Single break mechanism shall also be accepted

This specification covers the 'General Requirement' for the design, manufacture, supply performance, inspection, testing and commissioning including supply of indoor type low voltage switch boards panels up to 1100V including necessary termination cabling and bus work required for satisfactory operation.

The Panel boards including distribution boards and control panels shall be built in accordance with IEC-61439(Part-I & II) "Factory Built Assemblies for Low Voltage" or BS-5486 "Factory- built Assemblies of Switchgear and Control Gear for Voltage up to and including 1000V AC and 1200V DC.

Specific requirements shall be in accordance with single line diagram / specification. The technical parameters of switched are equipment's, transformers etc. shall be referred.

Standards

All equipment material and components shall comply with the requirements of the latest editions of Indian Standards with updated amendments. Standards and Regulations applicable in the area where Equipment's, are to be installed should be followed.

The equipment offered complying with other standards shall be submitted with copies of standard followed and full details indicating merits of adopted standard over to specified standards.

The Panel boards shall be engineered and constructed in accordance with the latest revision of the following Indian and British standards:

1	IS13947	:	A.C. Circuit Breakers
2	IS3427	:	Metal enclosed Switch gear & Control Gear
3	BS162	:	Safety Clearances
4	IS2705	:	Current Transformers
5	IS3156	:	Voltage Transformers
6	IS3202	:	Code of Practice for climate proofing of electrical equipment
7	IS375	:	Marking & Arrangement for Switch gear Bus Bars, main Connection sand auxiliary wiring.
8	IS722	:	A.C. Electric Meters
9	IS1248	:	Direct acting Electrical Indicating Instruments
1	IS3231	:	Electrical Relays for Power System Protection
0			
1	IS2544	:	Epoxy Cast Resin Insulators
1			
1	IS5082	:	Electrolytic Copper/ Aluminium
2			
1	IS5792	:	High Voltage HRC fuses
3			
1	BS88	:	Cartridge fuses for voltages up to and including 1000 VAC
4			

and 1500VDC.

BS89 : Direct acting electrical indicating analogue
electrical

Measuring instruments and their accessories.

BS142 : Electrical protective relays

BS159 : Bus-bar and Bus-bar connection

BS1433 : Copper for electrical purposes. Rods and bars.

BS : Circuit-breakers for over current protection for house hold and similar
E installations.

N

60898

BS 3938 : Current transformers

BS : Low-voltage switch gear and control gear, Part-2 circuit-breakers.

E

N

60947-2

BS 4794 : Control switches (switching devices, Part-1 including
contactor relays, for control and auxiliary circuits, for voltages up to and including 1000V AC and 1200V DC).
General requirements.

BS5419 : Air-break switches, air-break disconnections, and fuse
combination units for voltages up to and including 1000VAC and 1200V DC.

BS 5420 : Degrees of protection of enclosures of switch gear Part-I and
control gear for voltages up to and including 1000V AC and 1200V DC.

BS 5424 : Control gear for voltages up to and including 1000V AC and
1200VDC-Part-1 Contactors.

BS 5486 : Low-voltage switch gear and control gear Part I assemblies.

Part I: Requirement for type tested and partially type tested assemblies.

BS 5685 : Electricity Meters-Part-I: Class-0.5, 1 and 2 single phase
And poly phase, single-rate and multi-rate watt-hour meters.

BS 5992 : Electrical relays

BS 6004 : PVC insulated cables, (non-armoured), for electric power

And lighting.

BS 6231 : PVC insulated cables for switch gear and control gear wiring.

IS : Earthing

30

43/ BS7430

Submission

All technical submissions shall be approved by the EPC contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of consultant for its review and approval.

Detailed co-ordination with other services shop drawings for various electrical layouts such as equipment layout and earthing layout including equipment installation and cable termination details etc. prior to start of work.

Such drawings shall show the proposed method of construction of the cubicles, equipment, bus bar layout, method of supporting equipment and Bus bar electrical control wiring diagrams, equipment weight, colors, and surface treatment.

The drawings shall also incorporate full list of proposed materials. The construction shall not commence until the drawings are approved for construction.

Factory and site testing procedures and report formats shall also be included. Preparation of bill of materials for different Items as mentioned in Schedule of Quantities. Lighting / power panel schedule.

Inter connection drawing.

Protection co-ordination drawings/tables for complete power system.

Shop inspection and testing procedures. Field testing and commissioning procedures.

Preparation of as built drawings for the services rendered by the contractor.

Any other work or activity not listed above but necessary for completion of electrical system shall form part of the specification.

PRODUCTS

Panel Board

The switch boards shall be floor mounted free standing cubicle type totally enclosed and extensible type. The switch board shall be dust and vermin proof offering degree of protection not less than IP-42 and suitable for climatic conditions specified.

The design shall include all provisions for safety of operation and maintenance personnel. The general construction shall conform to IEC-61439(Part-I & II) for factory assembled switch board.

All factories-built assemblies subject to rain or wet conditions or located outside electrical switch room shall be of weatherproof construction conformation to IP 65 and able to with stand high impact strength of 60KN/m2 (min.) temperature resistant, flame retardant and corrosion resistant.

The switchgear cubicles shall be rigid and robust in design and construction fabricated out of CRCA sheet steel not less than 2 mm thick. Where ever necessary, such sheet steel members shall be stiffened by angle iron frame work

General construction shall employ the principle of compartmentalization and segregation for each circuit. Unless otherwise approved, incomer and bus section panels or sections shall be separate and independent and shall not be mixed with sections required for feeders. Each section of rear accessible type panel shall have hinged access door at the rear.

Overall height of the panel shall not exceed 2.4 Meters. Operating levers, handles etc. of highest unit shall not be higher than 1.7 Meters and 200mm from finish floor level.

Multi-tier mounting of feeders is permissible. The general arrangement for multi-tier construction shall be such that the horizontal tiers formed present a pleasing and aesthetic look. General arrangements shall be approved before fabrication.

Cable entries for various feeders shall be either from Top and Bottom of the panel. Through cable allies may be located in between two circuit sections either in the rear or in front of the panels.

All cable entries shall be through gland plates. There shall be separate gland plate for each cable entry so that there will not be dislocation of already wired circuits when the new feeders are added. Cable entry place therefore shall be

sectionalized. The construction shall include necessary cable supporters for clamping the cable in the cable alley or rear cable chamber.

Cubicle panels with more than 1000Amps bus shall be made of tested structural modular sections.

The each panel/board shall have 20% spare outgoing feeders for maintenance and 20% spare space with complete wiring & bus-bars etc. for future use.

All panels shall be of same height, width and depth. Panels shall be bolted together to form continuous flush front switch board suitable for front of board operation.

All doors, panels, removable covers shall be provided with non-deteriorating (neoprene) gaskets all around the perimeter.

Floor mounted cubicles shall be provided with a 75mm high channel base frame. The total height of the cubicle shall not exceed 2400mm keeping in view the operating height of top switch should not exceed 1750mm from FFL including base channel.

Bus-Bars & Bus-Bar Chamber

Rating

Bus bars shall be made of wrought aluminium or aluminium alloy, or electric grade copper, confirming to relevant Indian standard, as specified.

Current density

The bus bars shall be of sufficient cross-section so that a current density of 0.8A/1.0 Sq. mm is not exceeded at nominal current rating for Aluminium Bus Bars 1.0A/1.0 Sq.mm for copper bus bars.

Cross Section of Busbar

The cross section of the Neutral Bus bar shall be same as of the phase bus bar for the bus bars of capacities up to 200 A; for higher capacities, the neutral bus bar must not be less than half the cross section of that of the phase bus bar.

Insulation

Each busbar shall be suitably insulated with PVC sleeves/tapes in approved manner

Bus Bar Supports

Bus bar Support insulators shall be Class F insulators made of non -hygroscopic, noncombustible, track resistant and high strength FRP / SMC / DMC material, and shall be of suitable size and spacing to with stand the dynamic stresses due to short circuit currents. The spacing between two insulators should not exceed 250mm.

Bus Bar Clearances

The minimum clearance to be maintained for enclosed indoor air insulated busbar for medium voltage application shall be as follows:

Between	Min clearance
Phase to Earth	26mm
Phase to Phase	32mm

Note: For strip connection from busbar to switch gear, the above clearances do not apply.

Busbar Joints shall be thoroughly cleaned and suitable oxidizing grease shall be applied before making the joint.

High tensile bolts, plain and spring washers shall be provided to ensure good contacts at the joints.

The overlap of the bus bar at the joints shall be not less than the area of cross section of bus bars.

Busbars & busbar connections shall be of uniform microsection shall be suitable for carrying rated current continuously and short circuit current for specified duration without overheating. Normal operating temperature for bus bars shall be 85 Deg C. Short circuit rating of the bus bars shall be 20 to 65KA for 1sec as per calculations.

Direct access to accidental contact with bus bars and primary connections shall be avoided by providing shrouds. All apertures and slots shall be protected by barriers to prevent accidental short circuiting of bus bars. To provide a tight seal between cubicles, bushings or insulating panels shall be provided for bus bars crossing from one cubicle into

another.
All busbars shall be color coded as per IS:375.

Current Transformers (CT'S)

Accommodation shall be provided in the circuit breaker panel to mount one set of three number dual core ratio CT' s for metering and protection purposes. Access to the CTs for cleaning, testing or changing shall be from front, back or top of the panel.

Current transformers ratings shall be dual core and dual ratio CTs of suitable burden (but not less than 15 VA) shall be preferred with 5 Amp secondary.

Secondary terminals of CT shall be brought out suitably to a terminal block which will be easily accessible for testing and terminal connections.

The protection CTs shall be of accuracy class 5P 10 of IS 2705-Part-III-1992.

The Metering CTs shall conform to the metering ratio and accuracy class 0.5 of IS 2705 - 1992.

Current transformers shall conform to latest edition to relevant standards. The Current transformers shall be epoxying resin cast with bar Primary or ring type.

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

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

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

Current transformers (core) shall be used for metering and protection.

Potential Transformers (PT'S)

Potential Transformers shall conform to latest edition of relevant standards.

Potential transformers shall be dry, cast epoxy resin type. The PTs shall be of single-phase construction.

The PT'S shall be capable of operating continuously at 110% of the rated voltage without any damage. When star - star connection is required in non-effectively or ungrounded system, the PT'S shall be suitable for continuous operation with a persistent phase to ground fault.

Maximum temperature rises of the transformer at rated burden and with rated primary voltage and frequency shall not exceed 40 Deg's above an ambient of 45 deg C

Voltage transformer of burden not less than 100VA and of the proper ratio and of proper ratio as specified shall be provided at the incoming panel. The accuracy class for the VT shall be class 0.5 as per IS 3156 Part-I to III for incomer and class 1 for outgoing panels.

The transformer shall be of cast epoxy resin construction. It shall be fixed/ withdrawable type. HRC fuses/MCBs shall be provided on both HV & LV side. It shall be possible to replace PT fuses easily without having to de-energise the main bus bars. Prospective interrupting current rating of the fuses shall be same as the system fault level.

Voltage transformer ratio, output and class shall be as specified in the drawing & BOQ. Name plate as per relevant standards shall be provided on the PT.

Protective Relays

Relays type and numbers shall be in accordance with the protective scheme specified or as per drawings and schedule of quantities. All relays shall be numerical type Relays shall be enclosed in rectangular shaped cases suitable for flush mounting dust tight covers projecting from the front cover panel. The case shall be dust tight, damp proof and tropicals.

Relays shall be accessible for setting from the front. Access to setting devices shall be possible only after removal of front cover.

Protective relays shall be draw-out type. Where it is not possible to provide protective relays of the draw out pattern fixed type relays with facilities for plugging in a portable test plug shall be provided. Necessary test plugs shall be furnished along with the relays.

Relays shall be provided with positive action self-reset type with indicator. The indicators shall be visible from the front.

Relays conform to relevant standards in all respects.

Relays shall be provided with minimum two pairs of self or hand reset type contacts as specified. Auxiliary relays shall have the number of NO and NC contacts as specified in data sheet.

Incomer/Termination

Incomer termination shall be suitable for receiving bus trunking / underground cables. Cable shall invariably be through terminal blocks (Polyamide or Superior) or brought out solid terminals.

The housing material shall have unbreakable and fire-retardant characteristic. All the metal parts shall be made up of copper alloy including the screws. Mounting shall be DIN or G-Rail type. Screws shall be captive type. No protection cover is required and the block shall be touch proof.

Instrument/Indication Lamp

All Voltmeters and Ammeters shall be flush mounted of size minimum 96mm conforming to class 1.5 of IS: 1248 for accuracy. All voltmeters shall be protected with MCB.

Multi-function meter of CL 1.0 accuracy with RS 485 port shall be provided. On all the incomers of HT panels, ON/OFF indication LED lamps shall be provided and shall be suitable for operation on AC supply. Phase indicating lamps shall be associated with necessary ON/OFF toggle switch. LED type indicating lamps shall be provided everywhere except where low voltage filament type with series resistor called for.

Lamp covers shall be provided with interchangeable colored lenses of Perspex or equivalent unbreakable material. The lenses shall not discolor in course of time due to heat of the lamp. Bulbs and lenses shall be interchangeable and replaceable from the front.

Following colors shall be used for the function indicated:

Red	-	Circuit Breaker 'ON' Green-
		Circuit Breaker 'OFF'
White-		Continuous trip supply supervision Amber-
		Auto trip
Blue	-	Spring charged
R,Y,B-		Potential indication

Push Buttons

All push buttons shall be push to actuate the contact type.

Start & Stop push buttons shall be colored green and red respectively. Reset push buttons shall be yellow in color and test push buttons shall be blue in color. All other push Buttons shall be black in color.

Emergency stop push buttons shall be lockable in the operated position, i.e. push to operate and key to release type. Push buttons for emergency stop shall be recessed/shrouded type to avoid accidental operation.

Control & Selector Switches

Control and Selector switches shall be of rotary type, having enclosed contacts accessible only after removal of cover.

All control and selector switches for circuit breakers and instruments shall be mounted on the front of the panel. Control switches for space heater/s and control supplies shall be mounted inside the panel.

Circuit Breaker control switches shall be provided with pistol grip handles. Selector switches shall be provided with round, knurled handles. All handles shall be black in color. Properly designated escutcheon plates clearly marked to show the operating positions shall be provided on all switches.

Circuit breaker control switches shall normally have three position close - Normal - Trip with spring return to normal position. Switch operating mechanism shall prevent the switch from being operated twice successively in the same direction. Circuit breaker control switch shall have one NO-NC contact along with other contacts as required.

All other instruments and select or switches shall have stay put contacts.

Contacts of all control and selector switches shall be rated for 10Amps at 240V, AC or 20Amps at 220 VDC (inductive break). Switch for space heater supply and control voltage supply shall normally be two poles rated for 25A, AC.

Control Terminal Block

Box - clamp type, 650V grade line up terminals of minimum 2.5 sq mm size shall be provided. Connection to terminals shall be from front.

Not more than one wire on each side shall be connected on any terminal. Where duplication of terminals block/s is necessary, suitable solid bonding links shall be incorporated.

Terminal blocks at different voltage shall be segregated in to groups and distinctly labeled.

Current transformer secondary leads shall be brought to terminal blocks having facility for short circuiting and grounding the secondary.

Terminals shall be numbered for identification and grouped according to function. Engraved back on white PVC labels shall be provided on the terminal blocks describing the function of the circuit.

Separate terminal stems shall be provided for internal and external wiring.

Control terminal blocks shall be so located that control cables are fully segregated from power cables. Suitable insulated or earthed metal race ways shall be provided for control wiring. Separate unrolled removable gland plate shall be provided for the control cables at the bottom of each panel.

Minimum 20% of total numbers spare terminals shall be provided for future use.

Small Wiring

All wiring for Controls, Indication, protection, alarm and indicating circuits of all equipment shall be of suitable FRLS/HFFR (Halogen free fire retardant) copper conductor cable.

All wiring shall be suitably protected within switch board. Runs of wire shall be neatly bunched, suitably supported and clamped.

Means shall be provided for easy identification of the wires. Identification ferrules shall be used at both ends of the wires. Ferrules shall fit tight on the wires, without falling off when wire is removed. Ferrules shall be of white color with black lettering. Each wire shall be identified by letter to denote its function followed by a number to denote its identity at both ends.

Where wires are drawn through steel conduits, the work shall conform to CPWD General Specification for Electrical works Part-I-internal)-2005 and IS: 732 as the case may be.

All control wiring meant for external connections are to be brought out of terminal board. All wiring shall be color coded as follows:

Instrument Transformer AC circuit	-Red, Yellow & Blue wire associated by phases AC
Phase Wire	-White
AC Neutral	-Black
DC Circuits	-Grey
Earth connections	-Green

All unused auxiliary contacts of the circuit breaker and relays shall be wired up to terminal block

Safety/Protection & Interlocks/Features

Following interlocks and features shall be incorporated for equipment protection and personnel safety under mal-operation. No deviations on these interlocks and safety features are allowed. These interlocks and safety features shall be fail-safe positive and full-proof.

It shall not be possible to plug-in or isolate a closed-circuit breaker. An attempt to do so shall trip the breaker. (In case of breakers with vertical isolation, this will apply to raising and lowering). There shall be a positive locking facility to prevent closing of circuit unless it is in Service or Test position.

Closing and opening operations shall be possible only in discrete, well-defined Test and Service positions and not in any position midway. An extension adapter cable with plugs and sockets shall preferably be provided so that the closing and opening operation of the circuit breaker can be done in fully withdrawn position outside the cable.

Slow operation of circuit breakers shall be possible only in the circuit breaker in Test or Isolated position.

Isolating switches if provided shall be interlocked with respective circuit breakers to prevent them making or breaking the current.

1.No. bus earthing truck shall be supplied with each panel to earth the outgoing cable of the ACB breaker.

Automatic safety shutters for all openings which will lead to access to the live parts of the switchgear upon withdrawal or any operation the switchgear components/parts shall be provided, preferably with a padlocking facility.

Spring of motor operated spring charged mechanism shall not discharge until they are fully charged and charging means are fully disconnected.

Where interlocking key is employed tripping of closed-circuit breaker shall not occur if any attempt is made to remove the trapped key from the mechanism.

Any other interlock considered to be provided which manufacturer may deem to be required for safety and specifically specified separately required for the system shall be included.

All terminals, connections which may be live and exposed for accidental contact shall be adequately shrouded.

Components within cubicles shall be properly labeled to facilitate testing.

Earthing

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

All non-current carrying metal parts frames and equipment mounted in the switch board shall be bonded to earth bus.

Earthing of moving carriage of draw out equipment shall be achieved by scraping earthing device. The earthing device shall maintain positive earth continuity in all Service Test and Isolated positions.

It shall be possible to connect each circuit or set of three phase bus bars to earth either through earthing trucks or through the circuit breakers.

One earthing trolley suitable for earthing of cables & bus bars for all circuit breakers of the same type / rating shall be provided

Name Plates and Labels

One Name plate giving designation of the MV switchboard shall be affixed prominently on top of the switch board. Details of designation will be specified.

Labels with following details shall be affixed on each feeder panel:

Feeder Number.
Equipment reference Number & Description
Rating (HP/kW/kVA/Amp.)

All components whether mounted inside or on the door shall be permanently and clearly labeled with reference number / letter or their function. Rating of fuse shall be part of fuse designation. Paper labels, stickers or labels fixed with adhesives are not acceptable. All labels shall be properly fixed by screws with provision to prevent distortion due to expansion.

All labels shall be non-corroding, preferably laminated plastic or rear engraved Perspex with white letters on black background.

Labels for feeder panel designation fixed on front side shall be fitted with chrome plated, self-tapping, and counter sunk head screws. These labels shall be of identical size to permit interchange.

Space Heaters

Adequately rated anti-condensation space heaters shall be provided in each cubicle. Space heater/s shall be trip type, rated with operation voltage of 240V, 50Hz.A.Csupply. Each space heater shall be complete with a 2P MCB, 10KA and a control thermostat.

The space heater shall be rated for maintaining the panel inside temperature 10Deg.C above outside ambient temperature.

Cubicle Lighting

Each cubicle shall be provided with interior lighting by means of CFL light fixture. An ON/OFF switch/door switch shall be provided. The lighting fixture shall be suitable for operation from 240V single phase, 50 Hz. A.C. supplies.

Auxiliary Supply

Auxiliary supply for control, indication, space heater etc. shall be made available at one point on the switch board. Vendor shall provide suitable auxiliary supply in the switch board.

Fuses

Fuses shall be HRC cartridge link type (Diaz- zed Fuses are not acceptable) and shall be provided with operation indicator which shall be visible without removal of fuses from service.

Fuses shall be pressure fitted type and shall preferably have ribs on the contact blades to ensure good line contact.

It shall be possible to handle fuses during off load conditions with full voltage available on the terminals. Wherever required fuse pullers shall be providing. The fuse bases shall be so located in the modules to permit insertion off use pullers and removal off use links without any problems.

Mounting of fuse fitting shall ensure adequate dissipation of heat generated and shall facilitate inspection and easy replacement of fuse.

Contactors

The contactors shall be air break type, equipped with three main contacts and minimum 2NO + 2NC auxiliary contacts. The main contacts of a particular contactor shall have AC 3 ratings for unidirectional motors & AC 4 for reversible motors.

The auxiliary contacts shall be rated for minimum 5 Amps at 240V AC and 1.3 Amps at 110V DC (Inductive load).

Unless specified otherwise, the coil of the contactor shall be suitable for operation on 240V, (+) 10% & (-) 15% 1-0, AC supply. The drop off voltage of contractor shall be 15% to 65% of the rated coil voltage.

Single Phasing Preventer (SPP)

Unless specified otherwise SPP's shall be provided in all motor starter modules with contactor rating of 200 Amps and above. The SPP shall be of the current operated type and shall operate on the principle of sensing negative sequence component of current.

In case of single phasing, the SPP shall operate after a time delay of 2 to 3Secs. The relay shall be of the hand reset type and visual indication of the relay operation shall be available.

The SPP shall be suitable for protection of the non-reversible and reversible motors. There lay operation shall be independent of the loading and RPM of the motor prior to the occurrence of single phasing.

HYBRID FILTERS

SCOPE OF WORK

Design, fabrication, assembling, wiring, supply, installation, testing and commissioning of HPFC (hybrid power factor correction) panel having IGBTs, microprocessors, capacitors, reactors and other associated accessories, as explained below.

The HPFC panel shall be fabricated out of 14-gauge CRCA sheet steel in cubicle compartment, free-standing, floor-mounted, dust and vermin proof with reinforcement of suitable size, angle iron, channel, 'T' sections and/or flats wherever necessary. Pre-treatment of panel shall be carried out before epoxy powder coating with at least nine tank process. The HPFC panel shall adhere to IP 42 protection standard.

Cable gland plates shall be provided on top / bottom/ both of the HPFC panel. Lifting hooks shall also be

provided at least on all four corners of the panel.

The HPFC panel shall be suitable for 415V, 3 phase, 4 wire, 50Hz supply system. The Hybrid panel shall have a tolerance of 10% for the voltage and 2% for the frequency. Two numbers of earthing terminals shall be provided on either side of the panel of the hybrid filter panel.

Unless otherwise stated below, the active filter panel shall comply with the following standards (and their latest amendments):

IS13340-1993, IS13341-1992, IEC60831-1+2

ACB: IS3947/IEC60947

MCCB: IS13947(part2), IEC60947-2

Contactors: IS/IEC60947-4-1

AC capacitor: IS13340-1993

Detuned Reactors: IEC60289, IS-5553

DC capacitor: IEC60068-1, 60384-4, 60068-2-6

Gate Driver Card: IEC60068-1

SMPS: UL10212, UL60950, TUVEN60950 approved

Sensor: EN50178

Switch gear Control Gear Assembly: IS:8623 Part 1 to 3

The HPFC panel shall implement the following:

Power Factor Correction (for both leading and lagging current)

Harmonics Compensation upto 5th order

Load Current Balancing in the three phases

The **APFC panel** shall comprise 1200 KVAR. The APFC shall be dedicated to a single transformer.

The Panel shall be provided with one (1) no, incoming of 2500 MDO-ACB with protection.

The APFC System Shall Comprise:

Metering and Indication

R, Y, B indication lights for incomer MCCB

6A, SP, 10kA, C-curve MCBs for each of the three indication light.

A digital multifunction meter showing voltage, current, frequency, PF, KVA and other related parameters.

1000 KVAR HPFC shall comprise capacitor banks

On and Off indication

Start and Stop push buttons

Auto/Manual selector switch for auto mode (through the HPFC Panel's DSP microprocessor) or manual mode of operation of the capacitor banks.

One unit of 75/5A, 5VA, Class 1 CT.

One unit of analog am meter with a 75/5A dial.

APFC Relay

The power factor controller shall/be able to:

Microprocessor based and shall be able to sense the reactive current requirement of the network and shall switch ON / OFF the required stages of a capacitor bank.

In sensitive to wirings such as reversed CT connection, PT on a wrong phase etc.

Detect any stage size by automatic recognition and the switching sequence should be user defined. Detect the capacitor bank size if in case the present capacitor is replaced by a new capacitor of different rating

Is equipped with LCD display which shows at any time power factor, internal capacitor bank temperature and monitors the line frequency.

Suitable for 1A or 5 A current input and operating in temperatures up to +50 degrees C. The capacitor Bank and controller shall ensure that after the loss by fault of any one stage, it shall continue to operate automatically and shall follow rotational switching.

Recognize the connection of CT and Voltage and be able to automatically adjust itself to the phase angle difference. Regulator shall have capability to automatically search and set the C/K setting, it shall be also possible to program the C/K setting manually.

Have a minimum time delay of 120 seconds for switching on a capacitor into circuit, from its last disconnection from the circuit.

The ingress protection of the regulator shall be minimum IP 40.

The regulator must be panel mounted, shall be easily programmable and shall conform to safety guidelines as per IEC 61010-1:2001

The regulator must be suitable for 1 A or 5 A current input and shall be sensitive to a minimum current input of 40mA

The threshold value for the operating temperature and system harmonics shall be programmable and the regulator shall be able to switch off the connected capacitor stages if the actual values exceed these thresholds

Be equipped with RS 485 communication port.

Dual Cos Phi – The Controller should have programmable dual cos phi to differentiate the need in compensation (Cos Phi) when the operating condition changes. Like Peak Hour (2:30-3:30PM) when the target PF could be increased to 0.98) or Power factor correction needs with a utility supply changes when the input power is from a in house Generator.

The Power factor controller/regulator should allow the following readings.

Automatic initialization and stage rating detection

Any step sequence detection (User definable step sequence)

Measurement of capacitance per stage

Cap bank over load current ratio

THD Voltage

4Quadrant operation

Active, reactive and apparent power

Record of the Max temp internal of the capacitor or bank since set

System Voltage (V AC)

Frequency

Apparent Power(kVA)

Apparent current(A)

Temperature(DC)

Real time Cos phi

kVA r value to target Cos phi

The controller shall initiate alarms and warnings in the following events.

Temperature limit is exceeded

Insufficient capacitor output

Overload current ratio limit is exceeded

Under voltage, Over voltage

THDU limit is exceeded

Low power factor/under compensation.

Over compensation

Over current

Capacitor step defective

NOTES: The automatic power factor controller shall be manufactured in full compliance with and tested to the requirements of IEC 61326-1. IEC 61326-1 Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements.

Capacitors

Power Factor correction capacitor shall conform in all respects to IS140 / IS141, IEC 60831-1+2. Approval of Insurance Association of India should be obtained, if called for. The capacitors shall be 3phase, 415V rated, suitable for 525 V. at 50 Hz. Frequency, heavy duty and shall be available in single phase and three phase units of 5, 10, 15, 20, 25 & 50 KVAR sizes. The capacitors shall be suitable for indoor use up to ambient temperature of 50°C. A 3phase pressure switch disconnector for protection against internal faults, over pressure, etc. should be available. The pressure switch disconnector must isolate all the three phases simultaneously in the event of fault. To ensure full functionality of the pressure switch disconnector, its elastic elements must not be hindered, i.e.

Connecting lines must be flexible leads.

There must be sufficient space for expansion above the connections Capacitor shall have following feature:

Leakproof

Rustproof

Totally insulated

Self-healing

Self protected for switching surges,

Total operating loss less than 0.5W per kVAR

Suitable for modular construction

Vacuum impregnated with Non-PCB Polyurethane resin/non-PCB insulating oil/non-PCB inert gas

Explosionproof, scratchproof and no welded joints.

Discharge resistors

And it shall work continuously for 2.5 times the rated current

Overvoltage as per IS140.

Peak inrush current $300 \times I_n$.

Required KVA r as mentioned in the SLD shall be as per system voltage 415V and actual selection shall be done considering 14% detuned reactor.

Reactors

Space Provision for detuned reactors of suitable rating to avoid resonance to be considered.

Standards: There actor shall confirm to IS 5553.

Objective:

The objective of connecting a reactor in series with the capacitor is to avoid resonance between the inductive impedance of the supply transformer plus the line cabling and capacitors installed for power factor

Improvement in networks polluted with harmonics.

In order to avoid resonance to the 5th harmonic and above reactor should have a reactance of 14% i.e. a resonance frequency of 139 Hz for 50 Hz network.

Construction:

The reactors should be built with a core made of oriented grain iron sheet with spilt air gaps so as to give excellent anti saturation characteristics and very low losses. The coils can be made either with insulated copper bars or with aluminum sheet insulated with NOMEX. The input/output connections should be made through tinned copper bars. The coil windings should be provided with ventilation space for allowing adequate heat evacuation even hot ambience. The reactor should be vacuum impregnated with a varnish having high

Technical characteristics of the Reactor

Insulation level: 4.0KV

Tolerance of L: 3%

Linearity (5% OFL) to: $1.66 \times 2 \text{ RMS} = 1.8 \text{ In}$

Maximum ambient temperature: 45 DegC.

Internal insulation: Class F (155 deg C)

Maximum Load—continuous: 1.1 In.

Transient (1 min): 2 In.

Constructive standards: As per relevant IS/IEC Stds.

Losses Temperature Protection: Below 8 watts/KVAR/Micro switch (NC)

CONTACTORS (STAGE SWITCHING)

Depending on the requirements either electromagnetic contactors or electronically controlled thyristors contactor shall be used for switching PFC capacitors as indicated in SLD. For very fast and transient free switching, thyristors shall be employed that have a switching time of only a few milliseconds.

Electromagnetic contactor:

The contactors shall be of type three poles, specially designed for switching capacitors and shall be able to make against large transient current peaks at a high frequency of several kHz that can occur on capacitor switching. The contactors shall isolate all the three supply phases to the capacitor on switch off. The contactors shall have an electrical life time of min. 200,000 operations undecapacitive switching

conditions. Contactors along with damping resistors (AC6b) shall be used where there is a possibility of high inrush peak current to reduce it. The capacitor contactors shall be weld resistant up to a possible peak inrush current of $200 * IR$.

In case capacitor banks are supplied with Harmonic Blocking Reactors, contactors for capacitor switching shall be without damping resistors (AC3), because the peak current limitation is provided by Reactor impedance.

The contactors shall conform to IEC 947-4-1/ IEC 947-5-1. They should have a current rating of not less than 1.3 times the rated three phase capacitor unit current. They shall be tested as per IEC 269.

Active filter panel:

Active filter unit shall provide rated 450A (rms value) of required current in a step-less mode to meet the current requirement for power factor correction, harmonic compensation, neutral compensation and load balancing.

The active filter unit's hall comprise:

Two three phase, wire unit of 225A (rms value)

Active filter shall be 2 level topology

The active filter shall be rated at 415V, 50Hz, three phase power supply. The active filter shall be capable of providing full rating of 450A in each of the three phases (Red, Yellow, Blue) of the active filter.

Healthy and Trip Indication light for the active filter

On/Off selector switch for the active filter

Suitable number and rating (with sufficient margin for overload) of DC capacitor to meet the ripple current requirement in all the three legs of the active filter of 450A

Inductor chokes of suitable rating (with sufficient margin for overload) for the active filter of 450A. The Inductor chokes shall be installed for all the three legs of the active filter.

Resistor, cables, bus-bars and other associated hardware of suitable rating (with sufficient margin) and quantity to carry expected load of 450A continuously.

Advanced DSP microprocessor controller which shall monitor the voltage and current in the three phases (Red, Yellow and Blue) and Neutral conductor to compute the exact power requirement in the three phases, and thus, implement the following features - step-less compensation of leading and lagging power factor, harmonics compensation and load balancing.

Necessary control and firing cards with proper wiring and lugs of required rating shall be provided.

The APFC Panel shall have the following features, in addition to those already mentioned above:

Target PF level shall be programmable at the time of installation and commissioning.

Priority selection between the four features of the hybrid filter shall also be programmable at the time of installation and commissioning.

Fast response time of at least 100 micro-seconds for Active filter.

Heavy duty exhaust fans and suitably placed ventilation louvers for proper heat dissipation

Bus-bars or cables shall be suitably color coded and mounted using appropriate insulator supports. Suitable clearances shall be provided for the bus-bars and other live parts of the system as per international standards.

Inspection terminal strip, number ferruling, and other labeling shall be suitably provided.

Stickers marked with "DANGER" shall be provided wherever required

Detailed drawing and manuals shall be provided wherever required

Following protections shall be provided:

Over voltage (AC) protection

Over voltage (DC) protection

Over current protection

Over temperature protection

Protection circuits for the IGBT stack and its components

All components and wiring used in the system shall adhere to the relevant ISI and IEC standard.

Any number of detuned capacitor banks can be switched off even in the auto mode; however, the active filter needs to be in ON condition during the auto mode. An OFF condition of the active filter will not allow any PF/harmonics/Load balancing compensation

In the auto mode, upon switching on the hybrid filter, the active filter shall be switched on first.

Entire set of detuned capacitor bank shall not be switched on at the same time; they shall be switched on in a staggered manner at regular intervals- to be decided during commissioning- using the timer circuits.

User is strictly advised to not interface with the timing setting of the timer circuits. xiv. In the Manual mode of operation, any combination of the active filter and detuned capacitor banks can be kept in the ON/OFF condition.

Advanced DSP microprocessor controller which is installed in the active filter shall monitor the voltage and current in the four phase (Red, Yellow, Blue and Neutral) to compute the exact current requirement for power factor correction, harmonic compensation, neutral compensation and load balancing in the four phase.

PF correction requirement shall be shared between detuned capacitor banks and active filter.

The active filter microprocessor shall switch off some or all of the detuned capacitor banks when the reactive current requirement is too less so as to save energy.

Harmonics compensation shall be implemented by active filter; only the spare capacity (i.e. capacity after PF compensation to the desired level) of the active shall be available for harmonics compensation.

EXECUTION

Testing and Commissioning

All panel boards shall be inspected & tested in the presence of Engineer-in-charge / Consultant's representative. Engineer-in-charge after inspection shall issue inspection certificate for materials as per specification and commissioning the panels.

Generally, such tests in the factory and repeated at site are as follows:

All routine tests specified in relevant Indian / British Standards shall be carried out on all circuit breakers.

Test for protective relay operation by secondary injection method.

Operation of all meters.

Secondary wiring continuity test

Insulation test with 1000 Volts megger before and after voltage test.

HV test on secondary wiring and components on which such test is permissible (2KV for one minute)

Simulating external circuits for remote operation of breaker, indicating lights and other operations, if any.

Measurement of power required for closing/trip coil of the breaker.

Pickup and drop out voltages for shunt trip and closing coils.

CT Polarity test.

Power frequency voltage with stand test.

Earth continuity test;

Check of clearance and creep age distances;

Tests to prove correct operation of controls, interlocks, tripping and closing circuits, indications, etc.

Inter facing test with BMS control function

All other tests required by the Engineer-in-charge to verify compliance with the Specification.

All principal test records and test certificates shall be supplied in triplicate for all the tests conducted in accordance with the Specification to the Engineer-in-charge for approval before dispatch from the factory.

All materials, instruments and, labour, etc. required for conducting the tests shall be provided by the contactor at no extra cost.

Drawing and Information

The Vendor shall furnish following drawings/documents in accordance with enclosed requirements:

General Arrangement drawing of the Switchboard, showing front view, plan, foundation plan, floor cut-outs/trenches for external cables and elevations, transport sections and weights.

Sectional drawings of the circuit breaker panel, showing general constructional features, mounting details of various devices, bus bars, current transformers, cable boxes, terminal boxes for control cables etc.

Schematic and control wiring diagram for circuit breaker and protection including indicating devices, metering instruments, alarms, space heaters etc.

Terminal plans showing terminal numbers, ferrules markings, device terminal numbers and function details etc.

Relay wiring diagrams.

Equipment List.

Vendor shall furnish required number of copies of above drawings for purchaser's review. Fabrication of switch boards shall start only after purchaser's clearance for the same. After final review, required number of copies and reproducible shall be furnished as final certified drawings.

The information furnished shall include the following:

Technical literature giving complete information of the equipment.

Erection, Operation and Maintenance Manual complete with all relevant information, drawing and literature for auxiliary equipment and accessories, characteristics curves for relays etc.

A comprehensive spare parts catalogue.

Tools

One complete set of all special or non-standard tools required for installation, operation and maintenance of the switch board shall be provided. The manufacturer shall provide a list of such tools individually priced with his quotation.

Spares

The manufacturer/ tenderer shall be responsible for commissioning of the equipment supplied by them. During commissioning if any of the components fails the same shall be replaced with new spare part within the quoted price. Contractor shall ensure availability of commissioning spares and tools at site. The details for all such spare parts and tools shall be submitted in the tender. On commissioning of the system unutilized spares and tools shall be retained by engineer-in-charge and nothing extra shall be paid on this account. The delay in commissioning of system for want of spares shall be termed as delay in completion of contract and shall be dealt as per related terms of contract. The contractor shall also furnish minimum recommended spare parts required for 5 years with their prices. Availability of spares shall be guaranteed for rated life of the equipment.

Transportation

Panel boards are not allowed to be delivered to site until the electrical room or switch room is in clean and acceptable condition with lockable doors.

Panel boards, transported to site shall be fully covered with weatherproof covers and transportation eye bolts shall be provided for handling at site.

Panel boards, which are poorly packed and result in signs of corrosion, will be rejected.

All necessary measures to cover and protect the panel boards at site shall be provided. Such measures shall include a complete PVC blanket over the whole panel boards.

Rejection of Panel Boards

Deviation from specification must be stated in writing at the quotation stage.

In absence of such statement, it will be assumed that the requirements of the specifications are met without expectation.

If any of the above tests fail to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site, the Engineer may reject the item or defective component thereof, whichever is considered necessary, and after adjustment or modification as directed by the Engineer, the Contractor shall submit that item for further inspection and/or test. In the event of the defective item being of such nature that the requirements of this specification cannot be fulfilled by adjustment or modification, such item is to be replaced by the Contractor at his own expense, to the entire satisfaction of the Engineer. Delivery of panel boards on site without significant cable connection (Say 80%) shall not entitle progress payment certified for material delivery on site.

END OF SECTION

MULTI FUNCTION METER

General Provisions:

All setup parameters required by the Multifunction Meter shall be stored in non-volatile memory and retained in the event of a control power interruption.

The Multifunction Meter may be applied in three-phase, three- or four-wire systems as well as single phase

The Multifunction Meter shall be capable of being applied without modification at nominal frequencies of 45 to 65 Hz.

Measured Values:

The Multifunction Meter shall provide the following, true RMS metered quantities:

Real-Time Readings

Current (Per-Phase)

Voltage (L-L, L-N)

Real Power (Total)

Reactive Power (Total) Apparent Power (Total)

Power Factor (Total)

Frequency

Energy Readings

Signed Accumulated Energy (Real kWh\ Signed Reactive kVARh*,
Apparent kVAh) (Absolute)

Demand Readings

Demand Current Calculations (Per-Phase):

(i)Present(ii)Peak

Demand Real Power Calculations (Total):

(i)Present(ii)Peak

Demand Reactive Power Calculations (Total):

(i)Present(ii)Peak

Demand Apparent Power Calculations (Total):

(i)Present(ii)Peak

KW and kVARh are signed net consumption values.

Demand

All power demand calculations shall use any one of the following calculation methods, selectable by the user:

Block interval, with optional sub-intervals. The window length shall be set by the user from 1- 60 minutes in 1-minute intervals. The user shall be able to set the sub-interval length from 1- 60 minutes in 1-minute intervals. The following Block methods are available:

Sliding Block that calculates demand every 15seconds with intervals less than 15minutes and every 60 seconds with an interval between 15 and 60 minutes.

Fixed Block that calculates demand at the end of the interval.

Sampling

The current and voltage signals shall be digitally sample data rate high enough to provide true rms accuracy to the 15th harmonic.

The Multifunction Meter shall provide continuous sampling at a minimum of up to 32 samples/cycle, simultaneously on all voltage and current channels in the meter.

Current Inputs

The Multifunction Meter shall accept current inputs from standard instrument current transformers with 5-amp secondary output and shall have a metering range of 0-6 amps with the following withstand currents: 10 amps continuous, 50 amps 10 sec per hour, 120 amps 1 sec per hour.

Current transformer primaries through 327kA shall be supported.

Voltage Inputs

The Multifunction Meter shall allow connection to circuits up to 480 volts AC without the use of potential transformers. The Multifunction Meter shall also accept voltage inputs from standard instrument potential transformers. The Multifunction Meter shall support PT primaries through 1.6 MV.

The nominal full-scale input of the Multi-function Meter shall be 277Volts ACL-N, 480Volts AC L-L. The meter shall accept a metering over-range of 20%. The input impedance shall be greater than 2Mohm (L-L) or 1Mohm (L-N).

Accuracy

The Multifunction Meter shall comply with ANSI C12.16 and IEC-62053-21, Class 1

Functions performance class according to IEC 61557-12 (with CT ratio=1:1 and PT ratio=1:1) are, Class 0.2 for Voltage L-L from 30 Vac-480 Vac. Class 0.2 for Phase Current from 25% I_n < I < I_{max} Class 1.0 for Total Active Power from 1 % I_n < I < I_{max} and 0.5 I_n to 0.8 Cap. Class 1.0 for Total Active Energy from 0 - 9999999.9 kWh. Class- for Power Factor Vector from 0.5 I_n to 0.8 Cap. And Class 0.02 for Frequency from 45Hz - 65 Hz. (PM700)

No annual calibration shall be required to maintain this accuracy when the Multifunction Meter operates under specifications.

Input/Output

The Multifunction Meter shall be capable of operating a solid-state output to provide output pulses for a user definable increment of reported energy. Minimum relay life shall be in excess of one billion operations. The standard pulse output shall operate up to 240-volt AC, 300-volt DC, 96mA max, and provide 2.41 k Volt rms isolation.

All meters of main LT panel of all electrical substations shall communicate on Modbus RTU for necessary integration wherever required.

Control power

The Multifunction Meter shall operate properly over a wide range of control power including 110-415VAC, +/-10% or 125-250VDC, +/-20%.

Communications

The Multifunction Meter shall communicate via RS-485 Modbus protocol with a 2-wire connection at speeds up to 19.2 k Baud.

It shall be possible to field upgrade the firmware in the Multifunction Meter to enhance functionality. These firmware upgrades shall be done through the communication connection and shall allow upgrades of individual meters or groups. No disassembly or changing of integrated circuit chips shall be required and it will not be necessary to de-energize the circuit or the equipment to perform the upgrade.

Display

The Multifunction Meter display shall be back lit LCD for easy viewing, display shall also be antiglare and scratch resistant

The Display shall be capable of allowing the user to view four values on one screen at the same time. A summary screen shall also be available to allow the user to view a snapshot of the system.

The display shall include two different modes of visualization, IEEE and IEC for all quantities. The Display shall show 3 phase bar graphs

The Multifunction Meter display shall provide local access to the following metered quantities:

Current, per phase rms
Voltage, phase-to-phase, phase-to-neutral
Realpower,3-phasetotal
Reactive power, 3-phasetotal
Apparentpower,3-phasetotal
Signed Power factor, 3-phasetotal
Frequency
Demand current, per phase
Demand real power, three phase total
Demand apparent power, three phase total
Signed Accumulated Energy, (kWh, k VAh, and k VAR h)
Reset of the following electrical parameters shall also be allowed from the Multifunction Meter display:
Peak dem and current
Peak demand power (kW, k VA r, kVA)
Energy (MWh)and reactive energy (MVAR h)
Setup for system requirements shall be allowed from the Multifunction Meter display. Setup provisions shall include:
CT rating
PT rating (SinglePhase,2-Wire)
System type [three-phase,3-wire] [three-phase,4-wire] [2wire]
Watt-hours per pulse (PM200P Only)
Communication parameters such as address and baud rate

Upgrades

It shall be possible to field upgrade the firmware in the Multifunction Meter to enhance functionality. These firmware upgrades shall be done through the communication connection and shall allow upgrades of individual meters or groups. No disassembly, changing of integrated circuit chips or kits shall be required and it will not be necessary to de-energize the circuit or the equipment to perform the upgrade.

Installation

To ensure safety of goods and people, the installation category of the Multifunction Meter shall be III. The communication circuit shall be of SELV type (security extra low voltage) and shall provide a class II insulation level between distribution system connection and communication port. The meter shall withstand a Uimp of 6kV. (Uimp: impulse withstands voltage).

The Multifunction Meter shall be rated for an operating temperature range of 0°C to +60°C. Depth of the Multifunction Meter behind panel with communication port shall be equal or less than 50mm.

Standard

The multifunction meter shall comply with the following standards.

IEC62053-22-ActiveEnergyClass1

IEC61557-12

IEC61010-1-Safety

END OF SECTION

11kV HT Panel Specification

System

- 1. Medium Voltage Switchgear
- HT Panel**

Scope

This specification covers design, manufacture, shop testing, delivery at site, erection, testing and commissioning of type tested Indoor Air insulated 12KV up to 2500A, 26.3kA / 40kA (3sec), 3 Phase, metal clad, horizontal draw out type Switchboard with vacuum circuit breaker and all accessories, protective devices mounted and wired up.

Codes and Standards

The design, material, construction, manufacture, inspection, testing and performance of the Switch Board offered shall comply with all currently/latest applicable standards, regulations and safety codes in the locality where the equipments will be installed. Other National Standards are acceptable if they are established to be equivalent to or superior in performance specifications to the listed standards.

IEC: 62271 - 1 High-voltage switchgear and control gear - Common specifications.

IEC: 62271 - 100 High-voltage switchgear and control gear - Alternating current circuit-breakers.

IEC: 62271 - 200 High-voltage switchgear and control gear - AC metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV.*

IEC: 62271 - 102 High-voltage alternating current disconnectors and earthing switches

IEC: 62271 - 103 Switches for rated voltages above 1 kV up to and including 52 kV

IEC: 62271 - 106 High-voltage alternating current contactors

IEC: 60044 - 1 Current Transformers

IEC: 60044 - 2 Voltage Transformers

General

Design Basis

The switchboards shall be modular and extensible at site. They shall comprise functional units as defined by IEC 62271-200. The factory-made functional units shall be bolted together at the place of use. The equipment shall be suitable for operation in tropical climate considering design ambient temperature of 40°C. Temperature rise shall be as per IEC 62271-200.

Degree of protection shall be IP 4X. The functional unit outer enclosure shall have a degree of protection of IP3X {option;} [IP4X]. The partitions between compartments of the same cubicle shall have IP2XC. The cubicle shall be of LSC 2B (Loss of Service Continuity) and PM (Partition

Class) classes as defined by IEC standard 62271-200. And it shall comprise three high voltage compartments and one LV cabinet:

All the HV compartments shall be tested for Internal Arc of 26.3kA for 1 sec. Power frequency withstand voltage shall be 28KV rms. Impulse withstand voltage shall be 75KV peak.

The cubicles shall not require forced ventilation when the rated current is equal to or less than 2500A and service condition are normal.

Constructional Features

Switchboard shall be factory assembled, totally enclosed, metal clad, dead front cubicles. It shall be completely wired with all electrical accessories as specified in the tender.

Switchboard shall be dust, moisture and vermin-proof. All louvres shall have screens and filters. Vent openings shall be so arranged that hot gases or other material cannot be discharged through them in a manner that can injure the operating personnel. Pressurized gas shall get discharged only from the top of the respective HV compartments. Panel structure shall be of Aluzinc for extended panel life in saline, polluted atmosphere.

Sheet steel shall preferably be galvanized to avoid rusting. Sheet steel thickness shall be as per manufacturer's type tested design. Cubicles shall be fitted with removable gland plates of non-magnetic material with built in adjustable cable holding clamps. It is preferable to have fabricated cubicle with rivetted design.

Switchboard shall have separate vertical section (panel) for each circuit breaker.

Separate compartments shall be provided for circuit breaker, low voltage instruments, bus bars and cables. Current transformers shall be mounted in the cable compartment. Line potential transformers shall be mounted at the rear side of the respective breaker panel. Bus potential transformer shall be housed in a separate trolley, placed in a separate panel. Assembly of all current carrying parts shall be such that they shall be easily accessible for inspection and maintenance. Separate explosion vent shall be provided for each of the HV compartments; circuit breaker, bus bar and cable. The breaker shall be of Floor rolled mounted on trolley or with cassette arrangement.

Seal off bushing shall be provided between the breaker and bus bar compartment and also between the breaker and the cable compartment. The shutters for withdrawable parts shall be able to be locked out individually by a padlock.

The panel shall be designed for accommodating 5 runs of 1C X 630 sq.mm. cable or 2 runs of 3C X 400 sq.mm. cable. Head room clearance for cable termination shall be suitable for 11kV termination requirement. Power cable entry shall be from the rear bottom of the panel. Control cable entry shall be from the front bottom of the panel, along the either side of circuit breaker. Split gland plate with adjustable cable holding clamp shall be provided. Motorized option for rack in / rack out with door closed shall be preferred and if bidders can quote this option with extra price if design is available.

Switchgear shall be having following interlocks:

Movement of CB from test to service position shall be possible only when all the following conditions are met with.

The breaker is in OFF position.

The auxiliary plug and socket is engaged and locked.

CB compartment door is closed.

Rear covers are closed.

Earth switch is OFF.

Movement of CB from Service to Test position is possible only when the CB is OFF.

Front door of breaker compartment cannot be opened unless breaker is tripped and brought to test position.

Auxiliary plug and socket cannot be opened unless the CB is brought to test position.

Earth switch in the outgoing side (rear side) can be made ON only when circuit breaker is switched OFF and brought to test position.

Rear cable cover cannot be opened unless breaker is OFF and brought to test position & the earth switch is ON.

Metallic shutters shall be provided to prevent accidental contact with main stationary contact or other live parts when the circuit breaker is drawn out. When the circuit breaker is inserted back in the cubicle, it shall allow the circuit breaker to continue its travel until it fully engages the main stationary contacts. Suitable guides, slides and stops for proper positioning of the truck or trolley with the circuit breaker shall be provided to ensure easy removal, replacement and positioning of the circuit breaker. All circuit breakers of same rating shall be interchangeable with one another. Provision shall be made to prevent entry of circuit breaker of different rating even though the cubicle width remaining same. It is preferable to have cubicle width not exceeding 800mm.

Based on requirement each circuit breaker cubicle shall be provided with cable earthing switch at the rear side with due interlocks as stated earlier. Earth switch shall be tested for full fault make current, as well as short time rating. Provision shall be made for the operation of earth switch both from front as well as rear.

Instruments and relays shall be mounted on the hinged type front door of the metering compartment.

Sheet steel used for fabrication shall be ld rolled carbon annealed only and fabrication shall be done through CNC turret punch press and CNC bending machine. Painting is through epoxy based electrostatic powder spray or sheet steel shall be of aluzinc material without painting.

Breaker compartment door shall get locked at various points with one lever operation. It shall not necessitate bolting at various points for safety and reliability at all times. Doors and covers shall have several hinge points for proper locking to avoid opening of the same in the event of internal arc.

Busbars

The main busbars shall be of electrolytic copper/Al, with flat design for uniform field gradient.

The busbars shall be located in a separate metal clad chamber and shall be air insulated. Bus bars shall be extendible on either side.

The busbars shall be rated for 2500A (800A / 1250A / 2000A) continuous current, at 40°C ambient temperature. Temperature rise shall be as per IEC 62271-200.

The busbars shall be adequately supported on insulators or integral epoxy spouts to withstand dynamic stress due to the short circuit current specified.

The bus bars shall be sleeved for full voltage. Sleeve shall be heat shrinkable BTPM type of Reychem / equivalent make. No PVC sleeving in bus bar for 11 KV is acceptable.

Circuit Breaker

The breaking medium of circuit breaker, contactor shall be vacuum. The breaking medium of switch (switch-fuse combination function) shall be in Air. switchboard shall comprise indoor, metal clad, fully draw-out, Vacuum Circuit Breaker. The circuit breaker shall be trolley or cassette mounted and shall be operated by motor wound spring charged mechanism. It is mandatory for the switching devices that equip the functional units to be made by the switchboard supplier, or by a manufacturing plant that belongs to the same company.

Functional units shall be available with following withdrawable devices:

Withdrawable circuit breaker,

Withdrawable contactor with fuses,

Withdrawable earth connecting truck,

Each circuit breaker shall be provided with the following accessories:

ON-OFF indicator for indicating circuit breaker position.

Trip push button.

Shunt trip coil, operating between 70%-110% of rated control voltage.

Close coil, operating between 85%-110% of rated control voltage.

Spring charging motor, operating between 90%-110% of rated control voltage.

Dual tripping coils if required shall be provided in all the breakers.

Racking in and racking out operations shall be carried out only with the door closed and, for a circuit breaker or a contactor, when the circuit breaker or contactor operating auxiliaries are connected. It shall only be possible to open the door when the withdrawable part is in the “racked out or test” position.

The circuit breaker shall be designed so as to have class E2 (circuit breaker with extended electrical endurance) of electrical endurance, and class M2 (circuit breaker with extended mechanical endurance, mechanically type tested for 10 000 cycles) of mechanical endurance, as defined by IEC 62271-100.

Operation of switching devices

Handles shall be used for all operations (racking in/racking out withdrawable devices, open/close earthing switch, racking in/racking out fuses of VTs (if applicable)). {option:} It shall be possible to have motorized earthing switch to close/open Earthing switch remotely.

If there is extraction tool, there shall be mechanical interlock for the withdrawable devices extraction operation, in order to make it impossible to extract a device unless the extraction tool is solidly locked to the functional unit, and impossible to unlock the extraction tool unless withdrawable device is locked to the tool or in the functional unit.

The various operations of circuit breaker and earthing switch must be done in front of the switchboard. When the racking operations are completed, they shall be confirmed by means of a dedicated indicator.

Operations of circuit breakers and earthing switches shall be described solely in the form of explicit symbols and colour codes. Instruction using texts will not be accepted. There shall be indicators to show the positions of switching devices, of withdrawable parts and of earthing switches.

Wiring

Wiring for all control circuits shall be carried out with 1100 volts grade PVC insulated stranded copper conductor of size not smaller than 1.5 sq mm. CT circuits shall be with 2.5 sq mm. size conductor.

Control supply for closing and tripping shall be 110 Volts D.C. through external battery source. 230 Volts single phase A.C. supply shall also be available for the operation of spring charging motor and cubicle space heater. Wattage of closing and tripping coils shall be within 250 watts. Aux supply shall be suitably distributed along with switchgear in loop in loop out fashion.

All Switchgear panels shall be supplied completely wired internally up to the terminal block ready to receive external cabling.

All the secondary wiring in the panel shall have high quality PVC insulation and the same shall have conductor size of not less than 1.5 mm² of copper.

Colors of the secondary/auxiliary wiring should confirm to IS 375/1963 and latest amendment thereof if any. All wiring shall be neatly routed, and group of wiring shall be securely fixed by clips so that wiring can be checked without necessity of removing the clamps. Wiring between fixed and moving portion of the panel shall be run in flexible tubes and the same shall be so mounted to avoid any damage to them due to mechanical movements. Ferrules with number shall be provided on both end of the wiring.

All wires directly connected to trip the circuit breaker shall be distinguished by the addition of a red colored unlettered ferrule.

Earthing circuit

The earth conductors of all cubicles shall be connected to one another as well as connected to the main earth conductor. The main earth conductor shall be installed in the cable compartment.

There shall be a continuous copper earth bus of size 50x6 sq. mm running at the bottom of the panel. Earth bus shall be robust and shall carry full short circuit current for 1 second. Doors covers and all non-current carrying metallic parts shall be earthed through flexible copper wires. This also includes instrument casing and cable armor which are also connected to the earth bus.

Separate earthing truck shall be provided for bus earthing and cable earthing. The earthing truck shall be so designed that it is impossible to earth on live condition. It shall be provided with capacitive voltage divider and complete with audio visual annunciation.

In addition to scrapping earth in auxiliary plug and socket proper arrangement should be made so that during engagement of the breaker in service condition earthing contacts are made first before isolating power contacts are engaged.

Low Voltage Compartment

Low voltage compartment shall be mounted at the front on the top of breaker compartment and shall also have hinged type of door.

All wiring shall be routed through PVC ducts and shall be terminated on to stud type terminal with plastic cover.

For current transformer, terminals shall be disconnecting link type only. The wire shall be of 1.1KV grade and suitable for 2 KV rms for 1-minute power frequency high voltage.

Cable Compartment

It shall be at the rear side with rear bolted box type back covers.

The gland plate of cable chamber shall be of minimum 3mm thickness MS sheet in two halves section with built in adjustable cable holding clamp. In case of single core cable it shall be supplied with non magnetic gland plate. Cable box shall accommodate 2-3Core 400 sq. mm.

Sufficient headroom shall be provided for cable termination. The distance between gland plate and terminal shall be minimum 600mm.

Control cable entry shall be from front and there should be a possibility of terminating to LV chamber from both right hand and left hand side. Power cable entry shall be from rear bottom. Provision shall be available for entry of power cable or bus duct from rear bottom or rear top.

Current and Potential Transformer

Current transformers shall be double core window/bar primary for higher rating or wound primary for lower rating. Maximum VA burden shall be of 15 VA and shall be rated for full short circuit current for 1 or 3 second. Differential /REF CTs can be in one mould. In case of numerical relays 10VA burden shall be sufficient. CT shall be of a minimum accuracy of class 0.5/5P10 and CT Secondary rating shall be 1A unless otherwise specified.

Potential transformer shall be 3phase 3 limb type with 50VA per phase of class 0.5/3P accuracy and shall be mounted on incomer breaker truck. For bus connected P.T the same shall be mounted in a separate withdrawable truck in a separate vertical panel.

Pre-Treatment and Painting

Switchgear front and rear covers shall be painted for aesthetic purposes and Paint shade shall be RAL 7032. Or based on customer requirement.

Type Tests

The design of cubicle shall be proven through all the routine and type tests in accordance with IEC 62271-200.

Relays

Numeric Protection Relays

1. General description

The Protection and Control device shall be of numerical type and designed to meet a high degree of dependability and security.

The local human machine interface (HMI) shall be based on a user-friendly and menu-structured program. The device shall include a 64x128 LCD matrix display which supports mimic (e.g. single line diagram can be drawn) and freely assignable analogue values.

The device shall include navigation push buttons, freely programmable function push buttons with user configurable legend texts. The keypad buttons have to provide tactile feedback to safely operate the device HMI.

The device shall have control buttons for direct or select-execute CB control. Also the device has to have at least 12 LEDs with user configurable legend texts. At least 8 LEDs shall be freely programmable.

Access to protection setting mode shall be protected by a password that can be personalized by the user. There shall be at least three separate user levels with dedicated password protection at least two out of three of the highest levels.

CT 1/5A nominal current shall be available for phase and residual current input. Also option for 0,2A/1A nominal current for residual current shall be available. The current values shall be scalable. Rated voltage input shall be 100V and configurable for VT secondary's between 50-120 V.

One common relay's management software (based on standard Windows operating systems) shall provide all necessary tools and functions to operate the devices. Via the management software relay parameters, configurations and recorded data can be exchanged between PC and the device. Supporting the comtrade format, the management software also incorporates tools for analyzing relay events, waveforms and trends from data recorded but the device.

The device shall be provided with at least 16 digital inputs and 8 digital outputs (trip relays). The DI threshold should be 70% of the control voltage.

A minimum of four setting groups must be provided in the device. These shall be activated locally, remotely or via a dedicated input.

At least 1 alarm relay and 1 self-diagnostic output must be available

The operating temperature range shall be from -40°C to $+65^{\circ}\text{C}$ (or -40°F to $+149^{\circ}\text{F}$). Storage and transport temperature range shall be from -40°C to $+70^{\circ}\text{C}$ (or -40°F to $+158^{\circ}\text{F}$).

The 5A current inputs shall be capable of thermal withstanding: 20 A continuously, 100A for 10s and 500A for 1s and 1A current inputs shall be capable of thermal withstanding:

4 A continuously, 20A for 10s and 100A for 1s.

The devices shall meet the applicable IEEE/ IEC design standards. It shall have type test reports for Disturbance tests, electrical safety tests, mechanical tests and environmental tests which are within 5 years from the date of issue of the certificate.

The device shall have KEMA IEC61850 edition 2 certificates which are within 5 years from the date of issue of the certificate.

The device shall support webserver/web HMI through which we can monitor and control the relays over a ethernet Lan network.

The device shall support virtual simulation through which protection functions and logic testing can be achieved without any separate software.

At least 8 programmable Protection stages should be present along with the inbuilt protection Functions available in the relay.

All the relays shall be conformally coated complying to the IEC 60068-2-60 standard.

2. Protection functions

The device shall contain following necessary protections;

Incomer

Phase overcurrent (50/51), Directional phase overcurrent (67), SOTF(50 HS), Thermal overload (49), Earth fault (50N/51N), Directional earth fault (67N), Directional power (32), Phase undercurrent (37), Undervoltage (27), Overvoltage (59), Zero sequence voltage protection (59N), Over and Under Frequency (81), Under frequency (81U), Rate of change of frequency (81R), Magnetizing inrush (68F2), 5th harmonic detection (68H5), Circuit breaker failure (50BF), Cold load pick-up, Synchro check (25), CB wear, CTS (60), VTS (60FL), TCS, Lockout (86), Broken conductor (46BC), Auto recloser (79), Fault locator (21FL)

Buscoupler

Phase overcurrent (50/51), Directional phase overcurrent (67), SOTF(50 HS), Thermal overload (49), Earth fault (50N/51N), Directional earth fault (67N), Directional power (32), Phase undercurrent (37), Undervoltage (27), Overvoltage (59), Zero sequence voltage protection (59N), Over and Under Frequency (81), Under frequency (81U), Rate of change of frequency (81R), Circuit breaker failure (50BF), Synchro check (25), CB wear, CTS (60), VTS (60FL), TCS, Lockout (86), Broken conductor (46BC), Auto recloser (79).

Outgoing Feeder/transformer

Phase overcurrent (50/51),SOTF(50 HS),Thermal overload (49),Earth fault (50N/51N),Phase undercurrent (37), Magnetizing inrush (68F2),5th harmonic detection (68H5), Circuit breaker failure (50BF),Cold load pick-up & 2nd harmonic detection(68H2),CB wear, CTS (60),VTS (60FL),TCS, Lockout (86),Broken conductor (46BC),Auto recloser (79).

Outgoing Motor

Phase overcurrent (50/51),Thermal overload (49),Earth fault (50N/51N),Phase undercurrent (37),Start up supervision(48),Motor restart inhibit(66),Locked rotor (51LR),Magnetizing inrush (68F2),5th harmonic detection (68H5), Circuit breaker failure (50BF),Cold load pick-up & 2nd harmonic detection(68H2),CB wear, CTS (60),TCS, Lockout (86),Negative phase sequence overcurrent(46),Auto recloser (79).

Overcurrent protection shall have a wide range of time overcurrent protection curve settings, providing a choice of curve types:

Standard delay characteristics curve family: IEC, IEEE, IEEE2 and RI

Standard delay formulae with free parameters selecting a curve family (IEC, IEEE, IEEE2) and defining one's own parameters for the selected formula

Fully programmable inverse delay characteristics

Pick-up setting of three over current stages have to be able to control remotely.

Changing setting groups has to be able to do via: manually, digital inputs, virtual inputs, virtual outputs or LED indicator signals.

The device shall have force start and trip condition for testing.Any protection function has to be able to block by internal and external signals using block matrix.

*Functional Description:**

Overcurrent protection:

The relay shall have independent time delayed Non-Directional and Directional O/C stages, with selectable DT/IDMT characteristics. In addition to the standard IDMT curves, the relay shall also have the facility to build at least three user programmable characteristics .It shall also be possible to view the graph of IDMT curves on the Local panel display.

Non-Directional

The relay shall have three separately adjustable over current stages: I>, I>> and I>>>. The first stage I> shall be configured for definite time (DT) or inverse time characteristic (IDMT) with a setting range of 0.05 In to 5 In. The stages I>> and I>>> shall have definite time operation with the setting ranges of 0.1 In to 20 In and 0.1 In to 40 In respectively.

Directional

The relay shall have four separately adjustable stages available: Idir>, Idir>>, Idir>>> and Idir>>>>. The first two stages shall be able to configure for both DT and IDMT standard and programmable curves with the setting ranges of 0.1 In to 4In. The third and fourth stages shall have DT characteristics with the setting ranges of 0.1 In to 20 In. The directional characteristics angle setting ranges from -180 degrees to +179 degrees.

Earth fault protection:

The relay shall have independent time delayed Non-Directional and Directional E/F stages, with selectable DT/IDMT characteristics. The relay shall have the facility to choose the residual current which is either derived from the three phase current inputs or measured directly from dedicated neutral CT's. In addition to the standard IDMT curves, the relay shall also have the facility to build at least three user programmable characteristics. It shall also be possible to view the graph of IDMT curves on the Local panel display.

Non-Directional

The relay shall have five separately adjustable earth fault stages: Io>, Io>>, Io>>>, Io>>>> and Io>>>>>. The first stage Io> shall be configured for definite time (DT) or inverse time operation characteristic (IDMT) with a setting range of 0.005pu to 20 pu. The 2nd, 3rd, 4th and 5th stages shall have definite time operation with the setting ranges of 0.01 pu to 20 pu.

Directional

The relay shall have three separately adjustable stages available: Io dir> , Io dir >> and Io dir>>. All stages shall be able to configure for both DT and IDMT standard and programmable curves with the setting ranges of 0.005 pu to 20 pu for the first stage, and 0.01 pu to 20 pu for 2nd and 3rd stage. The directional characteristics angle setting shall range from -180 degrees to +179 degrees.

Over Voltage/Under Voltage

The relay shall have 3 under/over voltage stages each. Also the relay shall have residual over voltage protection which can be either measured from the broken delta connection or can be derived from the three phase to neutral voltages.

Measurements

The device shall offer complete set of measurement functions. The measurement functions cover phase, line and residual currents, current imbalance, system frequency and harmonics from phase currents. Condition monitoring has to monitor continuously trip circuits, breaker wear and current transformers. Phasor diagram view of currents should be available.

Diagnostics

Event buffer size can be modified from 50-2000 events

The device shall provide storage up to events 2000 based on the resolution.

The devices shall further provide disturbance records:

Triggering shall be settable on any selected measured signal (currents, voltages, status information of DI and DO)

The sample rate of the recording has to be settable from 32/cycle up to 1 per minute

Each record shall be able to contain 12 channels

Memory shall be at least capable of recording 24 faults.

The device shall provide 8 fault records per protection with the details of the fault, fault current, date & time.

Control

The device shall support customer defined programmable logic for Boolean signals. User configurable logic has to support also something that is not provided by the relay as default.

The device has to allow controlling of min. six objects (circuit breakers, disconnectors and grounding switches). Controlling has to be done by “select-execute” or “direct control” principle. Controlling has to be possible by: through local HMI, remote communication, via digital input or via function key.

Communication

The device shall have USB communication port in the front for the setting software use and at the back the communication ports shall be either 2xRJ-45 Ethernet port or 2xLC Ethernet ports.

The device shall support following communication protocols: Native IEC 61850.

The IEC 61850 communication has to support peer to peer communication (GOOSE). The IEC 61850 interface must be able to configure through setting software. Also the same setting software has to be able to generate ICD files.

Thermal Monitoring (Wireless)

Thermal monitoring shall be fitted on HV field cable/busbar connections, The monitoring shall be done by a battery less sensor that communicates wirelessly using Zigbee Green Power protocol.

ARC flash protection system with ACTIVE Arc flash protection:

Purpose of Active ARC flash protection is to protect the Indoor switchgear & Human resources in case of any internal ARC fault and also minimize the damage, maintenance cost and downtime of the system. The system should focus on minimizing the operation time to control the fault energy released in case of fault. The system should be designed to trip the respective feeder quickly in case of ARC flash fault to isolate the fault based on the location of the ARC fault.

The protection system should have a possibility to have AND logic for LIGHT and Over Current to prevent Mal Operation due to any external light. The ARC protection system should be based on Numerical based devices which are capable of working on ARC presence and over current logic. The protection system should operate quickly to limit the damage due to ARC flash fault inside panel by reducing the tripping time which should be less than 10 ms in case of a real ARC

fault. It should also have an additional High speed tripping contact of 2ms to ensure more faster tripping.

The ARC detection should be done by the Arc sensors (Optical detection~8000Lux intensity) installed at suitable locations to cover full switchgear and make sure that no ARC goes undetected. The Arc system should include three sensors per compartment for MV feeders, one in each compartment Bus Bar, breaker and cable.

Arc protection relays should have dedicated communication channels to achieve different operations mentioned in the schemes. The data (to achieve tripping) shall not be passed through substation communication networks (like scada network, GOOSE network) as it will bring substantial delay in operation time of tripping in the event of arc (especially for the fault occurring in breaker compartment and busbar compartment).

The Arc flash protection system should be based on Master Slave philosophy for flexible and scalable scheme which can be upgraded in future without major change in the existing scheme and additional modules should be able to increase the scalability of the system. The system should have selective operation based on ARC location and zone, system should be able to have ARC zones for flexible and selective operation.

OEM-manufactured panels to be quoted only. Partner-made panels are not accepted.

11kV HT Panel Make List: **ABB/Schneider/Siemens**

END OF SECTION

TTA Panel Specification upto 4000A

1. Main Low Voltage Switchboard

Enclosure

This section covers the detailed requirements of Main Low Voltage Switchboard for 415 volts, 3 phase, 50 Hz, 4 wire system.

STANDARDS AND CODES

The equipment proposed in this offer to be designed, manufactured, and tested according to the relevant IEC recommendations:

IEC 61439-1/2 Low voltage switchgear & controlgear assemblies – Part 2 Power switchgear and controlgear assemblies

IEC60529 Degrees of protection provided by enclosures

IEC60947-2 Low voltage switchgear & controlgear – part 2 Circuit breakers

IEC60947-3 Low voltage switchgear & controlgear – Part 3 Switches, disconnectors, switch-disconnectors & fuse combination units

IEC60 947-4-1 Contactors and motor starters

IEC60044-1 Current transformers

IEC60186 Voltage transformers

IEEE693 Environmental testing/ Seismic Withstand Level

IEC61140 Protection against electric shock – Common aspects for installation and equipment – Basic safety publication

IEC61641 TR Internal Arc Test report

General

LV Switchboards shall be certified by 3rd party Certification body as per IEC 61439-1 & 2. Test reports without certificate shall not be considered admissible proof of compliance. The Certifying Authority shall be qualified under ISO/IEC 17065 as per IEC 61439-1. IEC 61439 Certificate to be made available for all ratings of LV Switchboards as mentioned in Schedule of Quantities or Single Line Diagram for this project.

The Panels should be cubicle type indoor mounting, fully compartmentalised with hinged lockable detachable front & back openable, dust and vermin proof, floor mounting sheet steel clad switchboard fabricated out of 2 mm thick CRCA powder coated sheet steel suitable for use at 415 volts 3 phase 4 wire 50 cycle system and to withstand a symmetrical fault level of 50 KA at 415 volts. Panels shall be fabricated in easily transportable sections, length, height, depth etc. to match with site condition. All incomer breaker and Bus Couplers shall be interlocked electrically as shown in SLD and specifications. To ensure installation consistency during switchboard life cycle, installation system, switchgears, motor starter components and metering devices must be supplied by the same Manufacturer (OEM).

IEC 61439-1&2 compliance certificate to be submitted for all ratings of LV Switchboards as mentioned in Schedule of Quantities or Single Line Diagram for this project along with the tender.

The LV switchboards and the associated equipment including switchgear, control gear, Busbar supports, Busbar orientation, Busbar links etc shall be identical in construction to the assembly which has undergone certification as per IEC61439-1 & 2.

Certified design of switchboards shall be proven design from OEM (Original Equipment/ Switchgear Manufacturer). OEM name should be mentioned on top of each column of switchboard. Also, OEM Partnership Certificate shall be furnished by Panel builder.

To ensure installation consistency during switchboard life cycle, installation system, switchgears, motor starter components and metering devices must be supplied by the same Manufacturer (OEM).

Switchboards shall have a short circuit level withstand as per Schedule of Quantities and drawings. The enclosures shall be designed to take care of normal stress as well as abnormal electro-mechanical stress due to short circuit conditions.

Switchboards shall have Rated Impulse withstand voltage (Uimp) of 12kV for withstanding against transient Overvoltages, for which the values of clearances are referred applicable for ACB, horizontal & vertical busbars.

All covers and doors provided shall offer adequate safety to operating persons and provide ingress protection of IP 42 unless otherwise stated. Ventilating openings and vent outlets, if provided, shall be arranged such that same ingress protection of IP 42 is retained.

Switchboards shall be tested for Internal arc as per IEC61641. The test should be performed for arc starting place - at Horizontal busbar, Vertical busbar and in outgoing cable compartments. Internal arc test to be performed on switchboards having Aluminium busbar. Reports with Cu busbar design shall not be accepted as proof of compliance.

As Aluminium busbar are recommended for switchboard - Internal arc test to be performed on switchboards having Aluminium busbar. Reports with Cu busbar design shall not be accepted as proof of compliance.

To ensure right performance on Seismic risk, Switchboards shall be validated design for Seismic withstand for Ground Acceleration level of 2g. Test shall be performed in accordance with standard IEEE 693 : 2018.

Switchboards must have mechanical impact IK10 tested.

In order to facilitate access within the switchboard for maintenance, its covering panels must be dismountable on all surfaces for all IP degrees

To ensure maximum protection of people around the electrical installation, front plates must be installed in front of all control and protection equipment in order to avoid direct access without a tool to the devices and consequently to the live parts.

For safety reasons and especially when the door is open during switchboard operation, all busbars must be covered by Metallic barriers over whole perimeter of the busbar zone. IP2X (touch proof) protection shall be available.

As specified in the BOM the switchboard shall be form 3b. For forms of separation to be achieved, only metallic covers shall be used. Hylem/ PVC sheets shall not be allowed.

To enhance Sustainability, LV Switchboards shall have Green Premium Certification, with eco production, with product design in accordance with RoHS & REACH directives and with End of Life Instructions. All TTA Panels shall be fitted with such arrangement which will guide early detection of cable over heating.

The switchboard shall be supplied with a smartphone/web-based maintenance tracking system. A unique identifier (like QR code) shall be employed for each switchboard to enable quick access to switchboard details including but not limited to switchboard drawings, wiring diagrams, list of spares, Switchboard BOM etc. A maintenance schedule shall be provided by the manufacturer for switchboard and major components inside. There should be a provision to enable alerts for upcoming maintenance activities for the switchboard and components. The alerts shall be automated and provided to the maintenance staff appointed by the End-user in the form of smartphone notifications.

Switchboard Configuration

The Switchboard shall be configured with Air Circuit Breakers, MCCB's, MCB's, Motor Starter components, Metering devices and other equipment as called for in the schedule of quantities.

The MCCBs shall be arranged in multi-tier formation whereas the Air Circuit Breakers shall be arranged in Single tier or Two-Tier formation to facilitate operation and maintenance.

The Switchboards shall be of adequate size with a provision of spare space to accommodate possible future additional switch gear.

Constructional Features

The Switchboards shall be metal clad totally enclosed; floor mounted free-standing type of modular extensible design suitable for indoor installations. Switchboards, panels and cubicles shall be fabricated with CRCA Sheet Steel of thickness, same as that of tested assembly according to IEC61439-1 & 2. Sheet thickness for Load bearing frame structures shall not be less than 2.0 mm and shall be folded and braced as necessary to provide a rigid support for all components. Also, the doors and covers shall be fabricated from CRCA sheet steel of thickness not less than 1.6 mm.

All panels and covers shall be properly fitted and square with the frame. The holes in the panel shall be correctly positioned.

Panel shall be supplied with a double door arrangement. Global Door/ Front Door shall be fitted with transparent Glass to allow maintenance staff to visually access device status, meter readings, indicating lamp status without opening the door. IP level & Mechanical impact performance of the panel shall not be compromised in any scenario and shall remain at IP42/54 and IK10 level respectively, in all conditions.

Global door shall be provided with Ergonomic handles with locking (key RONIS n° 405).

Switchboards construction shall employ the principle of compartmentalized and segregation for each circuit.

Incomer and bus section panels or sections shall be separate and independent and shall not accommodate any outgoing feeder. The incomer panel shall be suitable for receiving bus trunking or LV cable of size specified.

Switchboards shall be made up of requisite vertical sections, which when coupled together, shall form continuous 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 upto 45 degree centigrade and humid tropical conditions suitable for pollution degree 3.

Ease of inspections, cleaning and repairs while maintaining continuity of operation shall be provided in the design.

Special care to be taken to ensure effective earthing of the frame and doors of the switchboards.

Each vertical section shall be provided with a rear or 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 live parts. The design of the switchboard shall allow standard extension chambers if required to accommodate cables.

Some switchboards may be required to be installed against the wall, for such applications, documented designs shall be available.

The painting of the sheet metal shall be done by electrostatic spraying of epoxy resin powder to give smooth finish to the equipment. Color used shall be RAL 7047 for the enclosure and RAL 9022 for the functional unit.

Switchboard panels and cubicles shall be fabricated with CRCA Sheet Steel of thickness, same as that of tested assembly according to IEC61439-1 & 2.

All the devices must be installed onto dedicated mounting plate designed for one or several switchgears of the same type. The objective of this point is to group protection equipment of the same type, as well as distinguish inside the switchboard the function of each device or group of devices and avoid identification mistakes.

Gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust and vermin proof to provide a degree of protection of IP 42/IP 54 as stipulated in schedule of quantities. The unused openings within the switchboards shall be closed using suitable grommets.

Switchboard Dimensional Limitations

The overall height of the switchboard shall be limited to 2000 mm for all the Busbar ratings and type of switchboards. Panel should have integral base frame of 75/100mm, The height of the operating handle push buttons etc shall be restricted between 300 mm and 1800 mm from finished floor level.

Other dimensional limits if any are specified separately.

Switchboard Compartmentalization

Switchboard design shall be completely compartmentalised with separate compartments for horizontal busbars, vertical busbars, Cable alleys and functional units consisting of ACBs, MCCBs, & MCB's.

Earthed metal or insulated shutters shall be provided between drawout 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 2X.

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.

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 in front of switchgear only.

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. 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.

Switchboard Bus Bars

Busbars shall be made of high conductivity, and high strength Aluminum E91E or high strength Copper of ETP grade.

Busbars shall be of rectangular cross sections, with 10mm thickness, better suitable for full load current for phase bus bars and half/ full rated current for neutral bus bar or as stipulated in schedule of quantities. Busbar shall be suitable to withstand the stresses of fault level as specified in schedule of quantities.

The maximum temperature of the busbars shall not exceed 90 degree Centigrade.

The bus bar system may comprise of a system of main horizontal bus bars and auxiliary vertical bus bars run in bus bar Chamber on either side of Switchgear chamber, so that busbars could be accessed with front access itself.

Design of LV Switchboard shall be such that, Phase and Neutral busbars should be together in same compartment. Also, the Neutral busbar shall always be in front to ensure safety, even when covers are open.

For ratings upto 1600A, design of LV Switchboards shall be such that Main Horizontal Busbar can be assembled at Top or at Bottom of Switchboard, to achieve less footprint, depending on site conditions viz. Cable Entry from Top/ Cable Entry from bottom etc.

The bus bars carrying full current of Switchboard shall be supported on non-breakable, non-hygroscopic epoxy resin or glass fiber reinforced polymer insulated supports that are Thermoset in nature, so as to be able to withstand high operating temperature of 135 deg C and mechanical forces, arising from a severe fault level as stipulated in schedule of quantities.

To ensure ability to resist ignition & to self-extinguish when ignited, Insulated supports shall be supplied from OEM only & confirm to Glow Wire Test The Busbar Support and the spacing should be same as per the type tested assembly.

Clearances & Creepage distances between phases should be in line with IEC.

Continuous earth bus sized for prospective fault current to be provided with arrangement for connecting to site earth at two ends of Switchboard.

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.

For unit ratings upto 160 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 shall be used for all rating of 200 Amps & above.

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 Assembly of panels & also busbar connections.

Drawout Features for ACB

Air Circuit Breakers shall be provided in fully drawout cubicles, unless otherwise stated. These cubicles shall be such that drawout is possible without disconnection of the wires and cables. The power and control circuits shall have self-aligning and self-isolating contacts. Mechanical latches shall be integrated in ACB at service, test and isolated position to ensure that Breaker is firmly latched in respective position. It shall not be possible to move the breaker from the position unless latch is manually operated.

Instrument Accommodation/Meters

All voltmeter and ammeter and other instruments shall be flushed mounted type of size 96 sq. mm conforming to class 1.5 to IS 1248 for accuracy. All voltmeter shall be protected with MPCBs.

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

The current transformers for metering and for protection shall be mounted on the solid copper/aluminium busbars 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 by MCBs.

Wiring

All wiring for relays and meters shall be with PVC insulated copper conductor wires. The wiring shall be coded and labeled 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 be used at both end of wires. All control wires meant for external connections are to be brought out on a terminal board. The cables and control wires shall be suitable for withstanding 105 deg C.

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 50 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 rule, the heaters shall be placed at the bottom of the cubicle.

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 recognised 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 50-micron thickness, of sheet approved by Engineer-in-Charge shall then be provided.

Testing at Works

Copies of Routine test carried out at the Panel Builder's Workshop shall be furnished along with the delivery of the switchboards. Engineer-in-Charge reserves the right to get the switchboard inspected by their representative at Panel Builder's works prior to dispatch to site to witness the followings.

Physical variation and dimensional check

Verification of bill of material

Functional check

HV test

IR test

Air Circuit Breaker

The ACB shall have following features

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ACBs shall be a sealed low voltage air circuit breaker operated as specified on the drawings with integrally mounted electronic trip units with option to add communication port.

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Circuit breakers shall have a maximum 5-cycle closing time. The closing time shall be less than or equal to 50 milliseconds for ratings <800A; 70 milliseconds for ratings <4000A; 80 milliseconds for ratings >4000A

•

ACB shall be equipped with anti-pumping function: If opening and closing orders occur simultaneously, the circuit breaker shall remain in the open position. After fault tripping or intentional opening using the manual or electrical controls, the closing order must first be discontinued, then reactivated to close the circuit breaker.

•

ACB shall not derate up to 50°C, as per testing guidelines prescribed in IEC 60947-2.

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All ACBs up to 2500A shall be of same frame size to enable quick replacement in the event of emergency and to optimize spares inventory.

•

All 4 Pole ACBs shall have 100% rated neutral pole.

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All EDO type ACBs shall indicate Ready-to-Close status of breaker (mechanically on front of ACB or electrical indication lamp of panel front door), after checking all the given conditions (UV release energized, Shunt release de-energized, spring charged, Breaker is not "ON", Breaker has not tripped on fault, Breaker is not mechanically interlocked with other breaker and ACB is not racked in completely in service position) ensuring safety for user and electrical distribution.

•

All ACBs shall be fully tropicalized as standard & suitable for terminating copper or aluminum bus bars. ACBs up to 2500A shall be provided with top horizontal and bottom vertical terminal adapters on both sides for proper cable connections/bus duct connections. ACBs rated for 3200A and above, shall have both side vertical terminal adaptors for effective heat dissipation and better thermal performance.

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All ACB trip unit shall be possible to view the percentage loading of three phases at once on trip unit via LEDs or LCD display to help the user in identifying the current load balancing of the network.

ACB - Breaking Capacity

The ACB interrupting rating shall exceed the available fault current.

The ACB range will offer several level of Icu capacity up to 150kA @415V to fit to the application. (for 2MVA < Traffo <=3MVA) ACB shall have the breaking performance $I_{cs} = I_{cu} = I_{cw} 1sec = 65kA$) or (for <=2MVA Traffo) ACB shall have the breaking performance $I_{cs} = I_{cu} = I_{cw} 1sec = 50kA$).

ACB - Protection Type

Instantaneous settings on the trip units with LSI protection shall be adjustable from 1.5 to 15 x In. The Instantaneous setting shall also have an OFF setting when short-time pick-up is provided. Long time overcurrent protection threshold shall be adjustable from 0.4 to 1 x In. Long time overcurrent protection time delay shall be adjustable from 12.5 to 600s at 1.5 x Ir, 0.5 to 24s at 6 x Ir and 0.7 to 16.6 x Ir. Short time overcurrent protection threshold shall be adjustable from 1.5 to 10 x Ir and short time overcurrent protection time delay shall be adjustable from 10 to 40ms of I2T.

Ground fault protection shall be adjustable.

ACBs shall have separately powered, individual fault trip indication LEDs (For overload, short circuit, earth fault and trip-unit failure) shall be available on the trip unit which shall function even in the absence of external power supply to the breaker.

All ACBs in main LT panel shall be provided with zone selective interlocking which helps in reducing the

thermal and dynamic stress on installation during short circuit and ground faults. The releases shall be suitable to communicate between incomer breaker and outgoing breakers enabling zone selective interlocking.

ACB - Release Functions

ACB - Release with Metering, Protection & Communication functions.

ACB - Release with Metering, Protection & Communication functions

Trip unit shall allow communication of device status (open, close, tripped); indication of fault types (LT, ST, instantaneous, ground fault); faulty phases; interrupted current.

Trip units shall calculate and display: Current, Voltage & Trip History.

ACB - Connectivity

The ACB shall connect to a remote monitoring system via Modbus RS485.

All ACB MP based release should be able to withstand temperature upto 120 degree Celsius.

Standalone Metering - Incomer

Power Quality Meter

The meter shall be compliant to IEC 61000-4-30 Class S. The meter shall be capable of measuring the following parameters: voltage, current, frequency, active, reactive, apparent power (total and per phase), power factor (total and per phase), current and voltage harmonic distortion to the 63rd, waveform capture, detection of voltage sags and swells. The meter shall detect the direction of disturbances. The meter shall be 0.1% for current and voltage accuracy and 0.2 Class for Active energy as per IEC 62053-22 (active energy). The meter shall record voltage and current waveforms at 256 samples per cycle. The meter shall support Modbus, ION, DNP3, IEC61850 with dual port ethernet for daisy chaining. The meter shall act as a Modbus Master connecting up to 31 downstream serial Modbus devices.

MCCBs

The MCCB shall have following features

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MCCBs shall comply with standards IS/IEC 60947-1 & 2.

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The breaking capacity performance certificates shall be available for category A to the above mentioned standards.

-

MCCB shall have a rated operational voltage (Ue) of 415V, insulation voltage (Ui) of 690 V (AC 50/60 Hz) & impulse voltage (Uimp) of not less than 8kV.

-

MCCB shall not have any line load bias. MCCB shall comply with the environmental directives like RoHS and WEEE.

-

MCCBs shall be current limiting type and shall have an encapsulated double break roto design having two fixed contacts, one moving contacts and two arc chutes per pole. The design is required to minimize the effects of short circuit currents i.e. to limit the let through energy and improve the life of cables. It shall be possible to fit lead seals to prevent unauthorized access to the settings.

-

MCCB's shall have push to trip function for checking the tripping mechanism healthiness. Also this checking shall be possible with or without rotary handle.

-

MCCBs up to 200A shall be thermal magnetic type, above 200A shall be microprocessor-based type.

-

MCCBs accessories (Shunt Coil, Auxiliary Contacts, UV Coils, etc.,) shall be considered as per SLD.

MCCBs - Type

MCCBs shall be fixed type.

MCCBs - Protection Type

Adjustable thermal protection from 0.7 to 1.0 x the current rating. Fixed magnetic protection for current ratings up to 200 A. Adjustable (from 5 to 10 x the current rating) for current ratings greater than 200A. Electronic Long-time protection will have a selectable I_r threshold settings from 36% to 100 % of the trip unit rating. Short time protection I_{sd} will have a threshold which shall be adjustable from 1.5 to 10 x the thermal setting I_r . The time delay shall be adjustable at 40ms. Instantaneous protection will have a threshold that shall be adjustable starting from 1.5 x I_n and up to a value between 12 and 15 x I_n , depending on the rating. It shall be possible to adjust ground fault protection down to 16A and deactivate ground fault protection.

On units above 630A selectable I_r threshold settings from 40% to 100% of the trip unit rating with adjustable t_r time delay. Short time protection I_{sd} threshold settings from 1.5x I_r to 10x I_r with adjustable t_{sd} time delay. Instantaneous protection I_i shall have an adjustable threshold settings from 2x I_n to 15x I_n with an OFF position. Ground Fault protection (GF) adjustable I_g threshold settings and t_g time delay.

All MCCBs with earth fault protection shall display the type of fault (overload, short circuit, earth fault, instantaneous tripping), the phase concerned and interrupted current value, on occurrence of fault and shall store last 5 trip record.

MCCBs - Control

It shall be possible to hand operate the device using a lockable rotary handle. The handle shall be mountable to either the front of the device or extended to be mounted the front of the enclosure.

MCCBs - Embedded Metering

There shall be no embedded metering on the MCCB.

MCCBs - Connectivity

The outgoing MCCBs shall have no communication.

All microprocessor based MCCB release should be able to withstand temperature upto 120 degree Celsius.

Standalone Metering - Outgoing

Multi-function Meter

The power meter shall measure the following parameters: Energy, Active and Reactive power, Voltage, Current, Frequency, Power Factor and THD to the 31st harmonic (Over Communication). Power Meter (PM) needs to comply to Active energy accuracy of Class 0.5S as per IEC 62053-22. Relevant type test documents tested in third party lab to be produced. Power Quality Meter (PQM) needs to comply to Voltage, Current, Active Power, Power Factor, Frequency as per IEC 61557-12.5. Power Meter (PM) needs to be capable of storing 12am Snapshot (Time Configurable) for Voltage, Current, Power, Energy delivered and capable of retrieved during the 24 hours of the day. Power Meter (PM) needs to be capable of inbuilt 02 energy counters for KgCo2 and Energy Cost. 6. Power Meter (PM) needs to be inbuilt with Calibration Pulse LED configurable from 1 to 9999000 pulses/k_h (kWh, kVAh, or kVARh) unauthorized access and Heart beat LED for communication Status. 9. Power Meter (PM) needs to be capable of onboard data logging up to 2 parameters with option to select from Power (W, VA, VAR) Bi-directional energy (+/-Wh, +/- VAh, +/- VARh), Demand (W, VA, VAR) with configurable interval and duration (e.g. 2 parameters for 60 days at 15 minutes interval). Power Meter (PM) needs to needs to have RS 485 port Modbus RTU and disabling RS485 port through front panel keys against unauthorized access.

Thermal Monitoring Wireless Sensors (Temperature & Humidity)

Thermal monitoring wireless sensors shall be fitted at least on LV field cable connections and ACB connections (upstream and downstream) as well as bolted copper connections. The monitoring shall be done by a battery less sensor that communicates wirelessly using Zigbee Green Power protocol.

Smart Wireless Sensors (Cable Heating Detection)

Switchboards, non-forced air ventilated, shall be enabled with a DIN rail wireless sensor capable of monitoring the system and generate three-levels of alerts on overheating wire connections or overheating cables depending on the severity of the detected situation.

Each column of the electrical switchboard shall include one wireless sensor at the top, to help user to prevent electrical switchboards from being damaged, by analyzing gas and particles in the air and sending alerts before any smoke or insulator browning occurs.

Sensor shall be able to analyze gases and microparticles inside the switchboard, by concentrating air into the sensor (with the help of an aspiration fan), applying a smart algorithm to sort internal cable issues from overheating, and sending alerts via email or notification to a smart phone application, enabling the switchboard's digital management.

Temperature and humidity inside the switchboard should be measured by the wireless sensor and values to be communicated through the network. Wireless sensor for early detection of overheating wire connections or overheating cables, should fulfill ISO 14025 PEP ecopassport® program requirements.

Sensor device should not replace any fire protection device of the installation.

Total selectivity solutions

Panel builder and Switchgear Manufacturer must ensure total selectivity between Upstream and Downstream Breakers (ACB, MCCB, MPCB and MCBs) for entire electrical distribution network (i.e. right from Final Distribution Board and PCC, till the Main LV Panel). If required, Panel builder and switchgear manufacturer shall use higher incomer breaker ratings to achieve total selectivity w.r.t. downstream Breaker. Switchgear manufacturer shall submit Total Discrimination report along with techno-commercial offer.

Panel Builder shall use the adequate size of the Busbars, as per rated current of the breaker suggested by switchgear manufacturer based on discrimination study.

Panel shall be as per IEC61439-1&3

Panel shall be tested per IEC 61641 (50 KA for 0.3 sec minimum). The test should be performed for arc starting place - at Horizontal busbar, Vertical busbar and in outgoing cable compartments.

Panel must have QR code to download all drawings of Panel, breaker manuals, warranty card, maintenance history, etc.

Panel must have safety equipment to notify the facilities manager for overheating of cable due to a loose connection.

Make: Siemens, ABB, Schneider partners

End of Section

Distribution Board (DB) Specification

ul System

1. Final Distribution Boards

Enclosure Type

All final Distribution Boards (hereafter will be referred as DBs) shall be selected from the same range, based on installation requirement. Irrespective of the installation method (flush or surface mounted), they shall designed and manufactured as per Indian Standard IS 8623-1 and 3.

The Distribution Board shall be a combination of GI & CRCA Sheet Steel, with U-box or wraparound being made up of GI sheet only. It shall be powder coated with dust/dirt repellent white colour (Powder coating thickness shall be minimum 50 to 100 micron on all the plane surfaces) after seven tank process.

The DBs must be completely type tested as per IEC 61439 – 1&3 by any neutral testing authority (viz. NABL accredited or ERDA or CPRI).

The Ingress Protection for entire range of DBs must be certified by any neutral testing authority (viz. ERDA or CPRI) as per standard IS/IEC 60529 for the degree of:

IP30 for DBs with Single Door

IP43 for DBs with Double Door with EPDM (Ethylene Propylene Diene Monomer) Gasket

The Impact Protection for entire range of DBs must be certified by any neutral testing authority (viz. ERDA or CPRI) as per standard IEC 62262 for the degree of:

IK08 for DBs with Single Door

IK09 for DBs with Double Door

The manufacturer must submit the test report for IP and IK testing by neutral testing authority (viz. ERDA or CPRI) as per above mentioned standards. For internal connections DBs shall be supplied with suitably rated colour coded FRLS wire set with Pin type lugs on both the ends.

DBs shall be supplied with 63A rated Insulated fork type Busbars made of Copper with Tin plating to avoid copper oxidation.

DBs shall be provided with Side mounted shrouded & isolated 63A rated Brass Neutral Bars. Neutral Bar shall be fastened on the U-box.

The DIN rail shall be Zinc plated and must not have any injurious sharp corners. DIN rail shall be provided with MCB stopper arrangement in order to achieve the comfort in centre plate assembly. All the TPN DBs shall be provided with removable DIN rail chassis.

DBs shall be provided with rotary knob and shall have flexibility to change to field fittable Key lock.

DBs shall be provided with removable Gland plates on top and bottom with adequate numbers of knock-out holes of appropriate size and mounted on DB with minimal possible screws to save installation time.

Neutral Terminator shall be provided to terminate the Incoming Neutral in case of 3P MCCB incomer DBs.

DB shall be provided with door earthing.

Centre plate of double door DB shall be provided with user friendly knob for safe and ease of removal from U-box.

DB shall have adaptability to upgrade to IP43 from IP30 post installation, as well.

DB shall have all standard/common combi-head screws for Frame and Centre plate assembly.

In case of IP43 DBs, door shall be reversible to have flexibility to open from either side.

TPN DBs shall be ready to upgrade to Per Phase Isolation DB configuration, so as to give better continuity of supply and only respective phase isolation in case of fault in any phase.

The DBs shall have two nos. of external Earth Stud to ensure better Earth continuity and shall have embossed earthing symbol for easy identification.

DB shall be able to accommodate all types of Modular devices viz. Protection Devices (MCBs, RCDs, SPDs, Auxiliaries), Controlling Devices (Isolators, Changeover switches, Contactors, Impulse Relays, Push Buttons) and Indication Devices (Indicators, Meters etc.).

Cement spill protector shall be provided with the double door DBs, so as to avoid entry of dust & dirt at the time of the civil work. Also, full length plastering guide shall be provided to help ease and correct levelling of plaster along the DB sides.

DB shall be provided with 5 holes (1 keyhole for DB positioning and 4 nos capsule holes for DB fixing) for ease mounting on wall.

DB shall comply with RoHS and REACH standard and shall have high Strength-to-Weight ratio to avoid burden on building structure.

Protection Devices

MCB

Miniature circuit breakers shall be of approved design and make and must be tested and validated as per IS/IEC 60898, IEC/EN 60898 and IEC 60947-2 standards.

MCBs shall be suitable for operation at 230V/415V, 50Hz supply. The MCB ratings shall be available from 1--125A in 1P/2P/3P/4P versions. The rated short circuit capacity acc to IS/IEC 60898 shall be of 10,000A. MCBs shall be offered with B, C or D tripping characteristics as per the BOQ requirements. The MCBs shall be suitable for mounting on a 35mm DIN rail.

MCBs shall carry ISI and CE marking. The MCB manufacturer (through the bidder) has to submit the valid BIS license certificate at the time of offer submission.

MCBs shall ensure complete electrical Isolation of downstream circuit or equipment, when the MCB is switched OFF (to be marked on the MCB in symbolic form)

IP 20 Degree of Protection shall be ensured to prevent electrical shocks by accidental touch to any live parts, by providing finger touch proof terminals.

Energy Limitation Class-3 shall be to ensure minimum let through energy in the event of a fault, for safety & longevity of downstream circuit equipment. (to be mentioned on the MCB as per standards)

MCBs shall have bi-connect facility to terminate fork type busbar and wires, simultaneously. Terminal capacity shall be minimum 25 sq.mm. for ratings up to 25A, and 35 sq.mm. for ratings 32A & above to ensure perfect termination of wires and cables. Terminals of MCBs shall have captive screws.

Basic technical parameters, rating, operating voltage, energy limiting class 3 etc. shall be printed on front face of MCB for ease of identification.

The devices must be capable of heavy-duty operation and to that end, the manufacturer shall guarantee the following performance levels, defined by IEC / EN 60947-2 standards:

suitability for isolation

rated insulation voltage: 500 V

pollution degree: 3

rated impulse-withstand voltage: 6 kV

Discrimination for power continuity

Validated Cascading tables as per standard IEC 60947-2

Operating knob shall have provision to lock in ON / OFF condition without affecting any automatic tripping

Circuit-breakers shall be capable of operation under ambient temperature up to 50 °C, without derating of their overload tripping threshold with respect to their rated operating current. The same must be tested and validated as per IEC 60947-2 standard.

The material used to manufacture MCB shall be 100% recyclable and must comply to RoHS and REACH standards.

MCBs shall be suitable for field-fittable Protection auxiliaries (viz. Over-voltage release, Under-voltage release, Shunt trip) and Indication Auxiliaries (like Auxiliary Contact, Trip alarm contact).

The circuit breakers shall be communication ready to indicate the status of the device (On/Off/Trip), Number of On/Off cycles and Number of Tripping over universally open Modbus and Ethernet (TCP IP) protocol so as to have seamless connectivity with any Energy and Building Management System. In addition the circuit breaker should be able to communicate through GSM module the status of the device (On/Off/Trip) through mobile phone.

RCDs

RCDs shall be of approved design and make and must be tested and validated as per respective IS 12640 -1 & IEC 61008 standards for RCCBs IS 12640 -2 & IEC 61009 standards for RCBs. shall carry CE marking. RCDs shall be suitable for operation at 230V/415V, 50Hz supply RCDs shall have IP 20 Degree of Protection shall be ensured to prevent electrical shocks by accidental touch to any live parts, by providing finger touch proof terminals.

Basic technical parameters, rating, operating voltage, etc. shall be printed on front face of RCDs for ease of identification.

RCDs shall have clear indication of 'Tripping on fault' on front facia.

RCDs must be voltage independent and purely current operated.

For electrically disturbed networks, Super Immunised type RCDs shall be provided, which shall be immune to electrical impurities (viz. Harmonics, pulsated DC components, transient over-voltages) and Corrosive atmosphere (viz. humid environments, chemical gases, dust etc)

Operating knob shall have provision to lock in ON / OFF condition without affecting any automatic tripping

The material used to manufacture RCDs shall be 100% recyclable and must comply to RoHS and REACH standards.

RCDs shall be suitable for field-fittable Protection auxiliaries (viz. Over-voltage release, Under-voltage release, Shunt trip) and Indication Auxiliaries (like Auxiliary Contact, Trip alarm contact).

The residual current circuit breakers shall be communication ready to indicate the status of the device (On/Off/Trip), Number of On/Off cycles and Number of Tripping over universally open Modbus protocol, so as to have seamless connectivity with any Energy and Building Management System.

Residual Current Circuit Breakers (RCCBs)

RCCBs must conform to IS12640 -1 and IEC/EN 61008 standards.

RCCBs shall be suitable for operation at 230V/415V, 50Hz supply. The RCCB ratings shall be available from 25A-125A in SPN and TPN versions with the sensitivity of 30mA (for personal protection) and 100/300mA (for Fire protection), as per the BOQ requirements.

RCCBs shall carry ISI marking. The RCCB manufacturer (through the bidder) has to submit the valid BIS license certificate at the time of offer submission.

RCCBs shall have bi-connect facility to terminate fork type busbar and wires, simultaneously. Terminal capacity shall be minimum 25 sq.mm. for ratings up to 32A, and 35 sq.mm. for ratings above 32A, to ensure perfect termination of wires and cables. Terminals of RCCBs shall have captive screws.

RCCB with Over Current Protection (RCBOs): 2 module version

RCBOs must confirm to IEC/EN 61009 standards

RCBOs shall be suitable for operation at 230V/415V, 50Hz supply. The RCBO ratings shall be available from 6A-40A in SPN version with the sensitivity of 30mA (for personal protection) and 300mA (for Fire protection), as per the BOQ requirements.

RCCB with Over Current Protection (RCBOs): RCD Add on module version.

RCD Add on module must confirm to IEC/EN 61009 standards.

RCD Add on module, when integrated with MCB shall provide protection against Over load, Short Circuit and Earth Leakages

RCD Add on module shall be adaptable to mount MCB as per desired rating of the loads and wires to ensure precise protection to the installation

RCD Add on module shall be suitable for operation at 230V/415V, 50Hz supply. The RCD Add on module ratings shall be available till 125A in SPN, TP and TPN version with the sensitivity of 30mA (for personal protection) and 100/300mA (for Fire protection), as per the BOQ requirements.

Surge Protection ■ circuits shall be fitted with type 2 surge protection.

End of Section

UNINTERRUPTIBLE POWER SUPPLY

GENERAL

Summary

Scope: Provide design and engineering, labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for a solid state uninterruptible power supply (UPS) as required for the complete performance of the work, and as shown on the Drawings and as herein specified.

UPS System description

Transformer less, IGBT Rectifier & IGBT Inverter (Minimum 3 Level Inverter Topology) ____ Number of ____ kVA
UPS system in standalone/parallel Configuration

Inverter Switching Frequency: ≥ 18 kHz. Inverter shall be PWM controlled using DSP logic. Analog control shall not be acceptable.

Each UPS shall be of modular architecture with sub power modules rating from 25 kW to 50 kW.

Failure of any sub power module in individual UPS Frame shall not lead to entire Frame Capacity Down but only the failed sub power module capacity shall go down. i.e. In case of Failure of any one Sub Power module, rest of the available power module in the frame shall continue to operate in normal double conversion mode of operation with reduced capacity. This shall also be applicable to all UPS's operating in parallel configuration also.

The UPS shall consist of easy to repair rectifiers/inverters.

The UPS shall be provided with separate feeds for rectifier/inverter and the static bypass switch.

Modes of operation: The UPS shall operate as an on-line system in the following modes:

Normal mode: The UPS provides power to the connected load from mains. The UPS converts mains to conditioned power for the connected load while recharging the batteries (float or boost charge).

Battery mode: The UPS transfers to battery mode if the mains supply fails. The UPS provides power to the connected load from the connected batteries for a finite period. When the mains supply returns, the UPS transfers back to normal mode.

Frequency converter mode: In frequency converter mode, the UPS presents a stable output frequency (at 50 or 60 Hz) and the static bypass switch is not available.

Battery recharge: Upon restoration of the input source, the UPS shall simultaneously recharge the battery and regulate the power to the load.

Static bypass mode: The UPS supplies the load with power from the bypass source. If the conditions for normal or battery mode are not met, the load will be transferred from the inverter to the bypass source with no interruption in power to the load.

ECO mode: In ECO mode the UPS is configured to use static bypass mode as the preferred operation mode under predefined circumstances. The inverter is in standby in ECO mode and in case of interruption to the mains, the UPS transfers to battery mode and the load is supplied from the inverter.

Maintenance bypass mode: In maintenance bypass mode, the mains is sent via the (internal) maintenance bypass breaker (MBB) to the load. Battery backup is not available in maintenance bypass mode.

Auto-restart mode: When auto-restart is enabled, the UPS automatically restarts the inverter and bypass when the mains returns. By default, auto-restart is enabled.

The UPS shall be provided with RS485, USB, and dry contact signaling and Web/SNMP integration. This system must provide a means for logging and alarming of all monitored points.

The UPS shall be housed in a freestanding cabinet with casters and shall contain the following breakers/switches.

Unit input (UIB)

Static switch input (SSIB)

Unit output (UOB)

Maintenance bypass (MBB)

The UPS shall contain a bypass static switch: and a display. The UPS shall be of the double conversion on-line topology with power factor corrected inputs.

Each UPS shall be provided with phase sequence correction at Input i.e., In case of phase reversal at input, the UPS shall not transfer to battery and shall continue to operate in double conversion mode.

Each UPS Frame shall be sized for kVA = kW load i.e. Unity Output power Factor.

The UPS battery shall be sized for ____ minutes at a power factor of 0.8/0.9 for > ____ minutes with each UPS Frame.

The UPS shall be provided with an EPO.

Printed Circuit Boards in the UPS frame shall be 100% conformally coated.

UPS shall have built-in feature to test UPS at 100% Load without the need of any external Load Bank. In case this feature is not available within the UPS, Vendor shall provide a External Load Bank equal to UPS Capacity which will be kept at the site till the Warranty period ends.

System input

Nominal Input voltage rating: 3×400 V (adjustable for 3×380 V or 3× 415 V).

Input voltage window: 342 V to 477 V at full load.

Input frequency range: 40-70 Hz

Input power factor: > 0.99 for full linear loads

Total harmonic distortion: < 3% for full linear loads

System output

Nominal output voltage rating: 400 V 3-phase.

Output voltage regulation (static): +/- 1%

Dynamic load response: 20 ms.

Output frequency: 50 Hz.

Output voltage harmonic distortion:

<3% at 100% linear load.

<5% at 100% non-linear load.

Overload capability

110% for 60 minutes.

125% for 10 minutes.

150% for 1 minute.

Output power factor: 1.0.

AC-AC Efficiency in normal operation from 25% load to 75 % Load shall be > 95%.

Audible noise at full load at 1 m from UPS shall be ≤65 dBA

Static bypass switch

The static switch shall consist of fully rated Silicon Controlled Rectifiers (SCRs). Part rated SCRs with a wraparound contactor are not acceptable.

The static bypass switch shall automatically transfer the load to bypass input supply without interruption after the logic senses one of the following conditions:

Inverter overload beyond rating.

Battery runtime expired and bypass available.

Inverter inoperable.

Control system inoperable.

Mechanical

UPS shall be housed in a freestanding cabinet with casters.

The cable entry shall be from the back/rear bottom of the UPS.

Ingress level of minimum IP20

Dust Filters and Rodent Mesh shall be provided with each UPS Frame.

Display, controls, and alarms

A display shall be located on the front of the system. The display interface shall consist of a touchscreen display, and status LEDs.

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

Year, month, day, hour, minute, second of occurring events

Input voltage

Input current

Input frequency

Output voltage

Output current

Output frequency

Battery voltage

Battery current

Battery temperature

The display shall allow the user to display active alarms.

The following controls or programming functions shall be accomplished by use of the display unit. Push button membrane switches shall facilitate these operations.

Silence audible Alarm

Set the display language

Display and set the date and time

Transfer load to and from static bypass

Test battery condition on demand

The LEDs for alarms shall be provided at UPS front panel

Battery Backup

The UPS shall use an open cell, a valve-regulated sealed lead-acid heavy duty industrial battery & shall also be capable to operate with li-ion battery solution.

Each Individual UPS shall be sized for ___ minutes at a power factor of 0.8/0.9 for > ___ minutes with each UPS Frame with 12V valve-regulated sealed lead-acid battery, designed for auxiliary power service in a UPS application.

Battery voltage shall be battery temperature compensated.

Battery charge current limit: The selection shall be made from the display. The battery charge current limit should be software and hardware current limit.

Deep discharge protection shall be available.

The battery charging circuit shall remain active when the PFC operates normally.

Battery protection shall be provided by thermal-magnetic molded-case circuit breakers with UV Coil Protection in each battery Rack for an external battery.

Technical Compliance (To be filled by the UPS Vendor)

	Description		Required Parameters	Compliance, Yes/No along with the Values
1	UPS Capacity	:	kVA = kW	
2	UPS configuration		___ Number of ___ kW UPS in standalone/parallel Configuration	
3	Operating mode	:	Online Double Conversion, VFI	
4	Battery Sizing & Back up		___ Minutes backup at kVA, 0.8/0.9 PF	
5	Type Of Battery	:	12V VRLA	
6	Ampere Hour & No of Battery	:	Required along with Battery Sizing sheet	
7	Construction	:	Modular Architecture: Each UPS shall be of modular architecture with sub power modules rating from 25 kW to 55 kW. Failure of any sub power module in individual UPS Frame shall not lead to entire Frame Capacity Down but only the failed sub power module capacity shall go down. i.e. In case of Failure of any one Sub Power module, rest of the available power module in the frame shall continue to operate in normal double conversion mode of operation with reduced capacity. This shall also be applicable to all UPS's operating in parallel configuration	
8	Technology	:	Transformer less, IGBT Rectifier & IGBT Inverter (Minimum 3 Level Inverter Topology)	
9	Inverter Switching Frequency		≥18 kHz	
10	Input Voltage Range at 100% Load		342 V - 477V	
11	Input Frequency Range	:	40 Hz - 70 Hz	
12	Input power factor	:	0.99	

13	Input THDI at 100 % Load		<3% for Linear Loads <5% for Non Linear Loads	
14	Output Voltage		380/400/415V AC	
15	Output voltage regulation (static)		± 1%	
16	Output THDU at 100% Load		<3% for Linear Loads <5% for Non Linear Loads	
17	Dynamic load response		20 milliseconds	
18	Duty condition	:	kVA = kW	
19	Elevation without derating		0 -1000 m	
20	Overload Capacity	:	110% for 1 hr 125% for 10 min, 150% for 1 min	
21	Crest factor		3:1	
22	Noise level		<65 dBA	
23	Output Power Factor	:	1.0 (Unity), Incase, Vendor does not comply, the next higher UPS rating shall be proposed	
24	Static Switch		Bypass path and Output path Static Switch for transferring the load to the input source during clearing overloads that exceeds the capability of power electronics. Special Hybrid bypass transfer switch shall be provided (Make before brake technology).	
25	Overall efficiency @25% - 75% Loading Condition	:	>95%	
26	UPS Load Bank Testing		UPS shall have built-in feature to test UPS at 100% Load without the need of any external Load Bank. Incase this feature is not available within the UPS, Vendor shall provide a External Load Bank equal to UPS Capacity which will be kept at the site till the Warranty period ends along with Cabling & Breakers.	
27	Phase Sequence Protection required (Inbuilt or External)		Required	
28	Phase Sequence Correction/Corrector required (Inbuilt or External)		Required	

29	Breakers/Switches within UPS frame		Input, Output, Bypass, Maintenance Bypass Breakers/Switches required, rated for full frame capacity. If not provided in-built, then separate termination panel with 4 breakers to be considered by UPS vendor.	
30	Event Log	:	Minimum 100 time stamped events logged	
31	Inverter Short circuit handling capability		220% for 100 msec	
32	The unit should be able to work without the batteries connected to it.		Required	
33	Conformal coating of PCBAs	:	Required	
34	Cable Entry for UPS		Rear Bottom	
35	Dust filter & Rodent Mesh with each UPS		Required	
36	Each UPS Weight & Dimension		To be provided by the UPS Vendor	
37	Each 12V Battery Rack Weight & Dimensions		To be provided by the UPS Vendor	

END OF SECTION

EARTHINGSYSTEM

GENERAL

Work Description

This section covers design, and setting of the complete earthing network for individual earthing systems, circuit protective conductors and bonding conductors and, supply, installation, testing, commissioning of earthing system.

A complete earthing network comprising cables, copper tapes, electrodes and earth bonding of all relevant necessary non-current carrying metal parts of Equipment's, / apparatus shall be connected as required.

The system shall have a common earthing system as described in the specification and as shown on the drawings. Individual earthing systems as per drawing shall be provided for following:

HT Electrical Earthing
LT Electrical Earthing
DG Generator Earthing
ELV Earthing
Data Communication Earthing

Main HT / LT / Generator Electrical Earthing shall have two earth connections to the earthing system.

Sufficient numbers of electrodes interconnected by Cooper / GI (as per requirement) to form earthing mat so that the overall earth resistance is less than 1 ohm for each individual earthing mat.

The Contractor shall test the resistivity of soil at site and determine the exact number of earth electrodes to achieve the required earth resistance value with approval of Engineer-in-charge. Earth plate, earth mat detail to achieve the earth resistance value shall be included in the Contract for complete earthing installation.

The Contractor shall have approval of materials from engineer-in-charge before use on work. Execution of earthing shall be carried out only in the presence of the Engineer or the representative.

Standards

Complete earthing system shall be designed and executed in accordance with the latest revision of the following standards and the appropriate BS/IEC:

IS:3043	Earthing
BS6651	Lightning Protection System
IEC61024-1-2	Lightning Protection System

The detail of the Earthing System shall also conform to the requirements of all relevant local codes as applicable together with the additional requirements referred to in the Specification and Drawings, whichever is the more stringent and acceptable to the Engineer-in charge.

Submission

All technical submissions shall be approved by the EPC contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of consultant for its review and approval.

As minimum requirement the submission shall include the following:

Shop Drawing and Sample Submission

Builder's work requirement

Testing procedures and report format for testing of the earth electrodes and/or earth strips

Soil resisting test report with calculation report for the details of the earthing system detail including quantity and layout of earth electrodes and/or earth strips to achieve the required earth resistance. The report shall be endorsed by the Contractor's Installation Engineer who supervise and endorse the installation upon completion

Proposed details of earthing system including quantity and layout of the earth electrodes and/or earth strips according to the calculation result.

PRODUCT

General

The resistance between earthing system and the general mass of earth shall not be greater than 1 ohm.

The earth loop resistance to any point in the electrical system shall not be in excess of 0.5 ohms in order to ensure satisfactory operation of protective devices.

There is trace to earth shall be measured at the following: -

At each electrical system ground or system neutral ground.

At one-point each grounding system used to ground electrical equipment enclosures.

At one point each grounding system used to ground wiring system enclosures such as metal conduits and cable sheaths or armoured.

All earthing conductors shall be of high conductivity copper/ G.I. and able to protect against mechanical damage as per requirement. The cross-sectional area of earth conductor shall not be smaller than half that of the largest current carrying conductor. However, the contractor shall use the sizes specified in the bill of quantities of the Tender. Common earth mats of resistivity of less than one (1) ohm shall be constructed below the lowest floor structure prior to any ground work construction. The earth mats shall comprise the complete earth electrodes, earth strips/grids, earth inspection chambers, earth leads, main earth terminals, earth test link boxes at ground level, etc. Each individual earthing system shall have earth leads connecting its main earth terminal directly to an earth electrode underground as specified.

All earthing products/accessories shall be in accordance to IS standards.

The mating surface of all tapes at joints etc. shall be cleaned before clamping and riveted with proper connector or exothermic welded. All connections to electrical apparatus shall be made by bolted connection in a visible and accessible position

Pipe Earth Electrode

G.I. pipe shall be of medium class 100mm Dia and 3m in length.

G.I. Pipe electrode shall be cut tapered at bottom and provided with holes of 12mm dia drilled not less than 7.5cm from each other up to 2m of length from bottom.

Commented [A1]:

The electrode shall be buried in the ground vertically with its top being 20cm minimum below ground level.

Clamping of the earth leads to the earth rod shall be made by earth clamp. The clamps shall be capable of providing high pressure contact between the earth rod and the earth leads to achieve low contact resistance.

When two or more electrodes are driven to form a group, the heads of the electrodes in the group shall be bonded to each other by means of a 25 mm x 3mm GI / Copper strip, laid at a depth of at least 600 mm in soil.

Recommended water seal insert sleeve approved by Engineer-in-charge shall be provided with all earth electrode penetrations through basement water proofing membranes and the installation shall be done under strict supervision.

Plate Earth Electrode

The plate earth electrode shall consist of copper plate or G.I. plate as per item of work. The plate electrode shall be buried in ground with its faces vertical and top not less than 4.5m below Ground level. The plate shall be filled with charcoal dust and common salt filling, extending 15cm around it's on all sides.

A watering pipe of 50 mm Dia of medium class G.I pipe shall be provided.

The top of the pipe shall be provided with a funnel and a G.I. mesh screen for watering the earth. In the case of pipe electrode, a removable plug shall be provided.

The earthing lead from electrode onwards shall be suitably protected from mechanical injury by suitable dia medium class G.I. pipe in case of wire and size according to strip size.

The over lapping of strips at joints shall done in approved manner

GI strips shall be riveted with rivets/bolted and welded.

Copper strips shall be riveted with rivets/ bolted brass nuts, bolts and washers and brazed.

The protection pipe with in ground shall be buried at least 30cm deep (to be increased to 60cm in case of road crossing and pavements).

The portion within the building shall be recessed in walls and floors to adequate depth.

In the case of plate earth electrode, the earthing lead shall be securely bolted to the plate with two bolts, nuts, check nuts and washers.

In case of pipe electrode, it shall be connected by means of a through bolt, nuts and washers and cable socket.

Main earthing conductor is taken from the earth electrode with which the connection is to be made.

No earth pit shall be fixed within 1.5 M of a wall of foundation. The location of the earth electrode will be such where the soil has reasonable chance of remaining moist. Effort shall be made to locate them in grass lawns or near flower beds or water taps.

Earth Inspection Chamber

Earth electrode shall be fitted with a heavy-duty precast concrete inspection chamber/pit complete with heavy-duty cover as specified on drawings.

For earth electrodes located outside or on the apron of the building, earth inspection chambers shall extend to a depth of not less than 300 mm below finished ground level and kept free of soil.

For earth electrodes located inside building, earth electrodes shall be buried not less than 100 mm below the floor slab structure. Each earth electrode shall be clearly marked '**Safety Electrical**

Earth Connection-Do Not Remove'.

The chamber and cover shall be heavy duty detail to consider the traffic load at the location of installation. The cover shall be recessed cover to receive the Architectural floor finish at the location of installation.

Earth Strip

Earth strips/grids shall be of bare GI/Copper strips of 25mmx3mm as specified.

Earth strips shall be riveted or joint with proper connector to earth electrodes underground below the floor slab structure, and shall be buried not less than 300 mm below the floor slab structure.

In order to minimize the mutual in distance between strips, earth strips shall be positioned at a distance not less than 6m apart unless otherwise specified.

EARTHBONDING

Circuit Protective Conductor

Circuit protective conductor (CPC) is a system of conductors joining to gather all exposed conductive parts and connecting them to the main earth terminal.

The purpose of circuit protective conductor is to provide a path for earth fault circuit so that the protective device will operate to remove dangerous potential differences during a fault condition. The circuit protective conductors shall take the form of separate cable with as heat in green/yellow color or copper tape of minimum size 25mm x 3mm.

All exposed non-current carrying metal parts of light fittings, switchgears, motors, enclosures, etc. shall be effectively earthed by circuit protective conductors for earth continuity protection. For equipment where an earth terminal is provided, the earth continuity wire shall be firmly clamped. Where no earth terminal is provided, the exposed metal part shall be cleaned of paint and surface rust before welding the earth continuity lead.

The minimum size of the principal protective conductors shall be in accordance with the current edition of IS: 3043/ BS7671 and BS7430.

The external earth terminal on the outside of the end panel of any switchboard shall be connected to the main earth bar provided in two independent points.

Circuit protective conductors shall be provided in electrical and mechanical rooms and along the routes for the bonding of all exposed conductive parts and extraneous conductive parts. A suitably sized earth terminal shall be provided at each zone of the building for this purpose. All exposed conductive parts shall be effectively connected in an approved manner to the principal protective conductors. The circuit protective conductors shall be single core copper cables or high conductivity annealed copper tapes specified. Unless otherwise specified, the minimum cross-sectional area of the circuit protective conductors shall be selected in accordance with IS: 3043/ BS7671.

END OF SECTION

LIGHTNING PROTECTION SYSTEM

General

Work Description

This section comprises the engineering, supply and installation, testing necessary for the Lightning Protection System for all buildings and of open areas (storage, leisure, office areas etc.) It includes the protection against the electrical consequences due to the lightning current flow through the lightning protection system.

Notes:

This standard does not cover the protection of electrical equipment's or system against voltage surges of atmospheric origin which are transmitted by networks entering the structure.

Other standards describe lightning protection systems using simple rod lightning conductor, stretched wires and meshed conductors.

The Lightning Protection System shall be installed generally in accordance with IS / IEC 62305-3 & IS 3043 and additional requirements of this specification. The system shall consist of air terminations, down conductors, joints and bonds, testing joints, earth terminations and earth electrodes. The general arrangement shall be as indicated on the drawings.

The lightning protection system shall comprise: -

Air terminal (as per rolling sphere or mesh or protective angle method or any combination thereof.)

Down Conductors

Joint and Bonds

Test Links

Maintenance free earthing system based on chemical earth compound

Lightning protection system employing steel structural and reinforcement system as part of the down conductors shall be adopted as per Drawing specified. All requirements in the specification included cast-in re-bar down conductors shall be applied unless otherwise specified.

Standards

Complete supply and installation of the lightning protection system shall be followed for engineering, construction and installation in accordance of the following standards and with the latest revision with update amendments:

IS / IEC 62305-3 & IS lightning arrestor air terminals 3043

IS/IEC62561 Lightning and Earthing Material

The detail of the lightning protection system shall also conform to the requirements of all relevant local codes, as applicable, to gather with the additional requirements referred to in this Specification and Drawings, whichever is the more stringent and acceptable to the Engineer.

In the adoption of standards and requirements, the Contractor shall take the following precedence:

Engineer's decision

Local codes of practice

Drawings

Specification

International standards and requirements

Submission

All technical submissions shall be approved by the EPC contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of consultant for its review and approval.

A prior survey may be conducted to determine the protection level to be considered, the ESE lightning conductor location(s), the down -conductor path(s), the earth termination system location(s) and type(s). All technical submissions shall be approved by the Engineer prior to the respective stages of construction.

Architectural constraints may be taken into account in the lightning protection system design and the design shall be based in a manner so that there is no reduction in the lightning protection system effectiveness.

As a minimum requirement, the submission shall include the following:

Equipment submission with manufacturer's data;

Sample submission;

Shop Drawings showing the co-Ordinator outting of air terminations, down conductors bonding to re-bar and foundation earth terminations, methods of fixing etc.

Builder's works requirement.

Proposal on testing procedures and report format for testing of the Lightning Protection System.

Detail of the Contractor's installation Professional Engineer who supervise and end or se the installation for occupation permit application.

PRODUCT

AIRTERMINAL

General

Lightning Protection System shall be in accordance with IS/IEC62305-3&IS3043

Zone of Protection

The zone of protection of a lightning conductor defines the space within which Air Terminal provides protection against a direct lightning strike with probability of protection as per LPL.

LPL (Lightning Protection Level)

LPL is a number associated with a set of lightning current parameters relevant to the probability that the associated minimum & maximum values do not exceed the normally occurring lightning. LPL can be determined by Risk analysis as explained in IS / IEC 62305-2.

LPL level sand probability of protection:

Lightning protection Class	Lightning current peak value MINIMUM	Lightning current peak value MAXIMUM	Interception probability
LPL1:	3kA	200kA	98%
LPL 2:	5kA	150kA	95%
LPL 3:	10kA	100kA	88%
LPL 4:	16kA	100kA	81%

Components of External LPS

Air terminal (as per rolling sphere or mesh or protective angle method or any combination thereof.)

Down conductor

Earthing

Air termination system:

No drilling is allowed in the terrace for fixing the air terminal, if the roof is made of concrete. Parapet wall is exception to this.

Values of Rolling sphere radius, Mesh size and protection angle as per Class of LPL/LPS.

Class of LPL/LPS	Rolling sphere radius(m)	Mesh size(m)	Protection angle
1	20	5*5	Referfigure1
2	30	10*10	Referfigure1
3	45	15*15	Referfigure1
4	60	20*20	Referfigure1

Material and Dimensions

Material of air terminal, down conductor, earth termination etc. shall be as below:

Material	May be destroyed by galvanic coupling with
Copper (Solid)	Gland Aluminum
Hot galvanized steel (Solid)	Copper
Stainless steel (Solid)	
Aluminum (Solid)	Copper

Dis similar metals (e.g. Copper with Aluminum) must be connected only by using bimetal connectors.

Minimum thickness of metal in air termination system for LPL/LPS

Material	Thickness(a)in mm	Thickness(b)in mm
Galvanized steel	4	0.5
Stainless steel	4	0.5

Copper	5	0.5
Aluminum	7	0.65

Material, Configuration and terminal & down conductors

Minimum cross-sectional area of air

Material	Type	Minimum cross Section area	Remarks
Copper	Solid tape	50sqmm	2mm min thickness
Copper	Solid round	50sqmm	8mm dia
Aluminum	Solid tape	70sqmm	3mm min thickness
Aluminum	Solid round	50sqmm	8mm Dia
GI	Solid tape	50sqmm	2.5mmminthickn ess
Stainless steel	Solid tape	50sqmm	2mmmin thickness

Air terminal holder:

Concrete Roof structure: Conductors shall be securely fixed on the terrace by means of air terminal holder which is fixed on the roof by adhesive of good quality taking care of varying weather conditions. Air conductor holder is an insulator & should be of minimum 50 mm height so that even small amount of water logging on terrace is below the level of conductor holder.

Metal Roof structure: Conductors shall be securely fixed on the terrace by means of air terminal holder which is fixed on the roof by metal conductor holder of good quality which is tested for lightning current as per IEC standard. Vendor need to give proof. As metal roof structures are normally tapered at an angle, there is no min. height criteria for metal conductor holder.

Recommended distance between air terminal holders:

Arrangement	Recomm ended distance	Recommended distance For ROUN D
Horizontal conductor on	500 mm	1000mm
Horizontal conductor on vertical surface	500 mm	1000mm
Vertical conductor from Ground to 20m height	1000mm	1000mm
Vertical conductor above 20m	500 mm	1000mm

If antenna, air cooler or any other electrical equipment is present above terrace level, the same have to be protected by using vertical air terminal after calculating the safety or separation distance. The vertical air terminal has to have

suitable supports to hold it. Wind speed need to be taken into account. Vertical air terminal must be connected to horizontal air terminal by using suitable connectors.

t the crossings of the horizontal air terminals, suitable Cross connector has to be used for secure connection which is tested for lightning current as per IEC standard. Vendor has to provide proof.

Safety or Separation distance:

It is must to calculate safety or separation distance in order to avoid flashover to the electrical equipment when the lightning current is passing through the vertical air terminal.

Safety/Separation distance(S) in $m = (k_i * k_c * L) / km$

Coefficient k_i depends on class of LPL/LPS $k_i = 0.08$ for LPL1,

$k_i = 0.06$ for LPL 2 $k_i = 0.04$ for LPL3 and 4

Coefficient k_c depends on no of down conductors:

$k_c = 0.66$ for 2 down conductors

$k_c = 0.44$ for 3 or more down conductors Value of coefficient $km = 1$

Value of List he totals distance between the equipment to be protected (fore. g. Antenna) to the equip-potential bonding bar situated just above the ground.

Expansion piece

In order to take care, the expansion of the metal in summer and contraction of the metal in winter, expansion piece with suitable connectors have to be used at every 20m distance of horizontal air terminal.

Joint and Bonds

The lightning protective system shall have few joints as far as possible & air terminal & down conductor have to be straight. Where it is not possible, it should NOT be bent at 90 degrees (right angles) & should have a curved path of 45-degree bend.

Down conductor system

In order to reduce the probability of damage to electronic/electrical equipment, the down conductors shall be arranged in equip distance in such a way that from the point of strike to earth, several parallel current paths should exist & length of the current path should be minimum. Down conductors can be installed separately or more wisely it can be part of natural components of the building. Examples are steel reinforcement in RCC columns, metal facades, profile rails, metal doors & windows.

Down conductors should be installed at each exposed corner of the structure as minimums.

Value of distance between down conductors as per Class of LPL/LPS

Class of LPL/LPS	Typical distance(m)
1	10
2	10
3	15
4	20

Test joints:

At the connection of the earth terminal, a test joint should be fitted on each down conductor at a height of 1 m from the ground, except in the case of natural down conductors combined with foundation earth electrode. The purpose of test

joint is to measure the earth resistance value. The remaining portion of down conductor (i.e., after the test joint should be mounted inside a plastic pipe of minimum 3 mm thickness.)

Earth Terminations

Earth mat is most preferable. Where earth mat is not possible, ring earthing is the next best method. Ring earthing must be 1 meter away from the building and 0.5m below the ground level. Resistance of earthing system shall not exceed 10 ohms per IEC 62305. Lower earth resistance is more preferable

For earth termination system, 2 basic types of earth electrode arrangements are applicable. Type A & Type B arrangement.

Type Arrangement: Comprises of horizontal or vertical earth electrode installed outside the structure to be protected connected to each down conductor.

In type Arrangement, the total number of earth electrodes shall not be less than two.

Type Arrangement is suitable in places where electronic equipment are not located.

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 can also be meshed. For structures with extensive electronic systems or with high risk of fire, type B earthing is most preferable method. Corrosion proofing band has to be used wherever down conductor is connected to earth termination system. Bitumen has to be applied at the point of inter-connection. In potentially corrosive areas, Stainless steel must be used.

References:

IS/IEC 62305-PROTECTION AGAINST LIGHTNING:

Part1: General Principles Part2: Risk Management

Part3: Protection of structures

Part4: Protection of Electrical & Electronic equipment within structure

IS3043:1987: Code of practice for Earthing.

TESTING&COMMISSIONING

The contractor shall conduct his own inspection and test reports certified by their engineer shall be submitted to the Engineer-in-charge for his approval and submit a request for joint inspection.

Joint inspection shall be carried out by the engineer-in charge or his authorized representative. Test results shall be checked and compared with the report submitted. All equipment, transportation, manpower and other necessary costs for the joint inspection shall be borne by contractor.

The system shall be tested once in every month intervals for earth resistivity, resistance to earth of the electrodes and electrical continuity of the system. The record of readings / results of these tests shall be maintained by contractor during defect liability period by the contractor and after that by Engineer-in charge.

The contractor shall supply one set of portable Air terminal test meter suitable for operation on batteries for maintenance and check of system. The meter should be suitable:

To test the individual charge sensor

To test the individual triggering terminal

To identify the faulty air terminal

To give alarm in case test meter is defective.

The Contractor shall submit a detailed layout drawing showing the positions of testing carry out on site.

END OF SECTION

WIRING DEVICES

GENERAL

Work Description

The drawings for the lighting and power points indicate approximate position of all lighting fittings, switches, power outlet points, isolating switch points etc. The actual position of all fittings, switches, the wiring details and cable routes shall be coordinated with other trades at site and submitted for the approval of the Engineer-in-charge. All time and cost required for adjusting the layout or complete installation to suit site requirement is included.

To determine the exact positioning of lighting and power points due consideration shall be given, for selection of the most accessible routes for wiring, convenience of switching and operational requirement of the installation.

No extra cost will be paid should the final positions be relocated within the same room.

For the purpose of specification and related drawing, each lighting & power point circuit shall be coded with a prefix to indicate the corresponding distribution board number.

The electrical equipment/system may develop sudden changes due to low frequency or direct electric current components such as fluorescent lamps, contactors, etc. shall be fitted with radio and television interference suppression components suitable to meet the levels specified in BS: 800 "Limits of Radio Interference".

This section included the specification of the following:

- Distribution boards
- Miniature circuit breakers
- Earth leakage circuit breakers
- 6A Switch Socket Outlet
- 16A Switch Socket Outlets
- Shaver Outlets
- Isolating Switches
- Conduit Boxes
- Contactors
- Dimmers Switch
- Time Switch
- Cooler Control Units
- Water Heater Switches
- Bell Push Switches

Standards

The complete wiring installation shall be engineered according to manufacturer data and constructed in accordance with the latest revision of the IS and the appropriate BS/IEC

In the adoption of standards and requirements, the Contractor shall take the following precedence:

- Engineer's decision
- Local codes of practice
- Drawings
- Specification
- International standards and requirements

Submission

All technical submissions shall be approved by the EPC contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of consultant for its review and approval.

The submission shall include the following as a minimum requirement,

Equipment catalogues submission with manufacturer's data

Sample submission include all wiring accessories

Shop Drawings of the lighting and power positions, circuit numbers, cable routings, switching arrangement, mounting height, etc. The positions and mounting heights shall be coordinated with other services. Fixing details of all wiring accessories shall also be included.

Drawings showing the installation details

Labeling system

Builder's works requirement.

PRODUCT

Lighting Point Installation

The various types of light fittings to be supplied and installed are described in the Schedule of Lighting Fittings on Drawing

Surface mounted light fitting shall terminate at junction box having entries appropriate to the run of conduit. This shall be complete with porcelain / PVC connector suitable for the size and number of connections and wiring points to be connected with the specified fitting. Wiring to the light fittings within the false ceiling space shall be by means of heat resistant (butyl or silicon rubber insulated to BS 6500) cables i.e. between the junction box and the lamp holder/terminal blocks, in flexible conduits.

At every light fitting an approved type earth terminal shall be provided for connection of the circuit protective conductor of the final circuit.

Ferrous metal work shall be of minimum of 1mm thickness and treated against corrosion by galvanizing after welding or lead primer or other approved process. Metal work shall be painted with one priming coat, one under-coat and two final coats with stove-enameled matt white paint unless otherwise specified.

Cables used for internal wiring of the lighting fittings shall be with appropriate type and size, number with conductor of size not less than 1.5 sq mm single core. The insulation of the cables shall withstand the maximum temperature throughout the life of the fitting. It will be subject to normal use without deterioration which could affect the safety of the fitting.

Cables within the lighting fittings shall be neatly bundled by nylon self-locking cable ties. Wiring shall be properly routed and secured away from control gear etc. wherever possible.

All cable terminations within the light fittings shall be suitably shrouded.

All light fittings shall be supported with appropriate fixing accessories such as clips, supporting brackets, suspension sets, nuts, washers, screws etc. for their proper installation on different types of ceiling panels. Suspension sets shall be of adjustable type suitable to carry the weight of the lighting fittings unless otherwise stated or indicated on drawings. The suspension sets shall be generally of 900mm length. Exact lengths required shall be provided to suit the site requirement.

All lamps in operational condition with proper control gear shall be provided together with the light fittings as required and specified.

Switches

Lighting switches unless otherwise specified, shall be single pole, quick make and break, silent action type and totally enclosed for flush or surface mounting modular type as required.

Lighting switches shall be suitable for indoor or outdoor service according to location housed in standardized purpose manufactured galvanized steel boxes completed with conduit knockouts made up into single or multi-gang units employing a grid switch system of fully interchangeable components at standardized fixing centers of matching switches of different types and ratings but of identical dimensions, push buttons, neon indicator lamps, blanking units, grids, steel boxes and plates all capable of integration into standard composite assemblies in any combination as required.

Grids shall be adjustable for variation in depth of plaster and for squaring errors and of the same type for surface or flush mounting.

Switches in mechanical plant rooms and electrical sub-stations and switch rooms shall be of the metal clad type approved by the Engineer-in-charge mounted in flush or surface conduit boxes as specified.

Switches located on brick or concrete walls shall be mounted in horizontal arrangement in plaster depth steel boxes or in galvanized steel boxes using box suspension straps and cover plates. Countersunk screws shall be provided for fixing to the conduit boxes.

Switches for external use shall be of weatherproof construction with IP-65 rating unless otherwise specified.

Samples of all switches, conduit boxes and plaster depth boxes shall be submitted to the Engineer for approval prior to installation.

Switches shall be rated for 6Amps (minimum light switch rating 6Amps), 16Amps or 20Amps (as determined by circuit load). Inductive lighting circuit shall be assessed at twice the steady state connected load current. One- or two-ways switch as indicated on the drawings be fixed generally at a height of 1200mm from floor level in rooms. The switch shall possibly be located inside the room on the handle side of the door as close as practicable.

Earth continuity terminal shall be provided and connected to the circuit protective conductor at every lighting switch position.

Single pole switches shall be connected to break the phase wire of the supply. The neutral wire shall not be routed through switch boxes.

Switches which are mounted in the same location shall be of multi-gang type, of the maximum number of gangs available.

All switches used shall be of approved or prescribed items as required by local Authorities.

Circuit from different phase and circuit from emergency power should have separate switch plate.

Isolation Switch

Isolating switches shall be of the current ratings and number of poles (generally double pole for single phase and 4-pole three phases) as indicated on the Drawings.

Isolating switches shall be of the totally enclosed pattern, metal-clad or polycarbonate with positive quick-make and quick-break action.

Switches shall be capable of passing and interrupting their full rated current safely and without damage.

Ferrous materials shall be galvanized, switch handles shall be interlocked to prevent opening the cover with the switch "ON".

6AMP Switch Socket Outlets (With Antibacterial Properties)

Switch socket outlets shall be as per BS:1363 single pole 6 A mp3 round pin shuttered outlets, one or two gang for indoor service except otherwise specified and suitable for surface or flush mounting according to location.

Switches shall be of the quick-make and break type silent action totally enclosed with solid silver alloy contacts. Switched socket outlets for indoor use shall be housed in suitable galvanized steel boxes as per BS: 4662 with conduit knockouts. Types and finishes of socket plates shall match those for the lighting switches.

Generally, switch socket outlets shall be positioned 300mm above floor level except in plant rooms, kitchen, etc. where they shall be positioned 1400mm above floor level or 150mm above counters or benches as per requirement.

Switch socket outlet in all mechanical plant rooms, electrical switch rooms shall be of the metal clad type, with recessed or protected switch dolly, mounted in flush or surface conduit boxes as specified.

All switch socket outlets used shall be of an approved quality.

16 AMP Switch Socket Outlets (With Antibacterial Properties)

16Amp switch socket outlets shall be 3pin round type to BS: 546 shuttered, of finished similar to 6Amp switch socket outlets and flush mounted in galvanized steel conduit boxes to BS: 4662 requirements.

Weather proof Isolator (Industrial Type)

Weatherproof enclosure shall be of the high impact, water resistant to IP-65. The isolator provided shall complete with lockable device. Isolators shall be 2-pole, 4-pole as specified.

Floor Box-Access Outlet.

All plates shall be made from stainless steel or equal approved, heavy duty trap cover. All plates are to be mounted flush with surface and are to be aligned correctly. Access Outlet should carry service plates for providing services i.e. Power, Data & Telecom. The system must comply the relevant specification & IEC 61084 standards. The system should have Positive Double Earthing connections.

Lighting Dimmers Switch (With Antibacterial Properties)

Lighting dimmer switch shall be solid state, variable load and thyristor-controlled type suitable for controlling fluorescent or in can descent lighting circuits operating at $230V \pm 6\%$, 50Hz single phase AC supply.

Dimmer switch shall be manufactured to eliminate TV and radio frequency interference in compliance with IS.

The ratings of the dimmer units shall be suitable for lighting circuit specified on Drawing.

Time Switches

Time switches shall be self-contained unit suitable for mains operation. All units shall have self-started synchronous motor with single-pole fuse in the motor circuit, 3-way terminal block and thirty-six (36) hours spring reserve complete with an automatic solar dial.

The solar dial shall be capable of switching ON The lighting at sunset and OFF at sunrise throughout the year by control of a secondary calendar dial with month and day settings. The automatic switching time shall be adjustable.

Time switches shall be cast in dust-tight metal casing having hinged front cover with clear Perspex window. The casing shall be effectively earthed.

An annual bypass switch shall be incorporated with the time switch to facilitate maintenance of the latter.

Miniature Circuit Breaker

The MCB shall be suitable for manual closing, opening and automatic tripping under overload and short circuit. The MCB shall also be trip free type.

Single pole/three pole versions shall be furnished as required. The MCB shall be rated for 10KA fault level.

The MCB shall be suitable for housing in the lighting boards and is suitable for connection at the outgoing side by tinned cable lugs and for bus-bars connection on the incoming side.

The terminal of the MCB and the open and close condition shall be clearly/indelibly marked.

The MCB shall generally conform IEC/IS:60898

Earth Leakage Circuit Breaker

ELCB shall be 4 pole 415 volts 50Hz, 30-300mA sensitivity. These shall be of approved make.
. The rating of the ELCB shall be as required. These shall be suitable for manual closing and opening and for automatic tripping under earth fault circuit of 30-300 mA as specified in item of work.

The enclosure of the ELCB shall be moulded from high quality insulating material. The material shall be fire retardant, anti-tracking, non-hygroscopic, impact resistant and shall withstand high temperature.

All parts of switching mechanism shall be non-greasing, self-lubricating material so as to provide consistent and trouble-free operation.

Operation of ELCB shall be independent of mounting position and trip free type.

Lighting/Small Power Distribution Boards

Distribution boards shall be of standard make with MCBs as per approved make given. Distribution boards shall be of steel sheet construction double door all welded enclosure of IP42 protection and powder coated painted.

Ample clearance between the conductors of opposite pole and sheet steel body shall be maintained in order to obviate any chance of short circuit. Removable conduit entry plates shall be provided at top and bottom to facilitate drilling holes at site to suit individual requirements.

Additional / separate adopter box of suitable size shall be provided to accommodate wires, cables and No. of conduits etc. at no extra cost.

The MCB shall be mounted on high grade rigid insulating support and connected by electrolytic copper bus bars.

Each incoming MCB isolator shall be provided with solder-less cable sockets for crimping.

Phase separation barriers made out of arc resistant materials shall be provided between the phases. Bus bars shall be colour coded for phase identification.

Distribution boards shall be recessed in wall or mounted on surface of wall with necessary mounting arrangement.

The mounting height shall not exceed 1200mm from finished floor level. Distribution board shall be provided with proper circuit identification name plate and danger sticker/plate as per requirement.

All the distribution boards shall be provided with engraved name plates with 'lighting', 'power' or 'UPS' with DB Nos., as the case may be.

Each DB shall be provided with circuit list giving details of each circuit. All the outgoing circuit wiring shall be provided with identification ferrules giving the circuit number & phase.

Each distribution board shall have separate neutral and earth connection bar mounted within the DB each having the same number of terminals as the total number of outgoing individual circuits from the distribution board. Conduit & cable armouring shall be bonded together & connected to the distribution board earth bar.

Where oversized cables are specified due to voltage drop problems, it shall be contractors' responsibility to ensure that satisfactory terminal arrangements are provided without an extra cost.

Telephone Outlets

Telephone outlets where called for shall be single or twin flush mounted type suitable to receive the plug-in telephone cable led to the approval of the Telecom. The finish of the telephone outlet plates at various areas shall be as specified for lighting switches.

Water Cooler Drinking Fountain Switches

Flush-mounted double pole AC switch of 20Amps rating shall be provided for water cooler and marked "water cooler".

Associate d connector units shall be provided next to the water cooler. The switches and the connector shall be IP-65 waterproof rating.

Bell Push Switches

Bell push switches shall be flush-mounted having single-pole AC switch of 6Amps rating and marked with bell symbol.

Shaver Outlets

Shaver outlets shall comprise a 20VA continuously rated double wound isolating transformer to provide an earth-free AC supply at mains frequency, complete with self resetting thermal overload device fitted in the primary circuit an insulated voltage selector switch to provide either 115 or 230volt output, one ON-OFF switch and one universal socket outlet suitable for British, American, Continental and Australian razor plugs, all contained in recessed sheet steel box with insulated moulded front plate suitable for flush, mounting and suitably inscribed to give clear indication of the voltages available at the outlet and the service of the outlet.

Cooler Control Units

Cooler Control Units shall be flush mounted double pole AC switch of rating 30 Amps complete with pilot indicating lamps and with self-adhesive plastic identification label mounted on a removable chassis contained within steel box finished aluminum stove enamel provided with conduit knockouts and earthing terminals. The cover plates shall be of the same finish as those specified for the lighting switches.

Associated connector units shall be provided adjacent to the cooler units.

Wrings between the cooler control units and associated connector units shall be provided in concealed conduits.

Water Heater Switches

Water heater switches shall be flush mounted having double pole AC switch rated at 20amps fitted with pilot lamp and marked "water heater". The cover plates shall be of the same finish as those specified for the other switches. Associatedconnector units shall be provided next to the water heater units.

Power Supply for Lighting at Wet Condition

Residual Current Circuit Breakers shall be provided individually for each circuits serving lighting subject to wet condition.

END OF SECTION

INTELLIGENT ADDRESSABLE FIRE ALARM SYSTEM

CHAPTER: A GENERAL

SCOPE OF WORK

These specifications shall cover the Design, Supply, Erection, Testing, and Commissioning of Intelligent Addressable Fire Alarm Systems

The work is to be carried out as illustrated in the drawings attached. These drawings are open to as per suitable design submitted by the tenderer.

A.2.2 The tender drawings indicate only the general scheme of requirement and the extent of work covered in this contract. The equipment and their associated works such as Cabling, etc. may be re-arranged in the space allotted subject to the approval of Engineer-in-charge. It is the Contractor's responsibility to ensure that his work is coordinated with the work of other agencies/client.

SCHEDULE OF REQUIREMENTS

Intelligent Addressable Fire Alarm System requirements are shown in the tender drawings and described briefly in other chapter of these specifications.

Tenderers are advised that the location of detectors and other accessories etc. as given in these drawings and specifications are indicative and for tenderers guidance.

It is the intent of these specifications to define a state-of-art integrated Fire Alarm System, which is user friendly, modular, flexible and expandable. The system is to be designed, installed, customized, tested, commissioned and supported by a local office or agent of the manufacturer by Engineers skilled in providing functional and efficient solutions to the needs of the Engineer in charge.

The contractor shall have an in-place support facility in India equipped with Competent Support Staff, Spare Parts Inventory and all the necessary Test and Diagnostic Equipment to provide

support within 24 hours of any breakdowns.

A.3.5 All electronic equipment shall conform to the pertinent regulations governing radio frequency electromagnetic interference and should be so labelled.

A.3.6 All system components and sub-systems are to be fault tolerant and provide satisfactory operation without damage at $\pm 10\%$ of the rated voltage and at ± 3 Hz variation in line frequency.

CONTROL PANEL

The fire alarm control panel shall be microprocessor-based using multiple microprocessors throughout the system, providing rapid processing of smoke detector and other initiation device information to control system output functions.

There shall be a watchdog circuit, which shall verify the system processors and the software program. Problems with either the processors or the system program the panel shall activate a trouble signal and reset the panel.

The system modules shall communicate with an RS-485 network communications protocol. All module wiring shall be to terminal blocks, which will plug into the system card cage. The control panel shall be capable of expansion via up to 100 SLC's. Maximum system capacity shall be at least 2500 intelligent initiation devices per panel.

The system shall be capable of supporting unshielded wiring applications.

System Components:

The Device Loop Card loop shall be capable of 252 intelligent devices distributed between two SLC circuits. 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. Card shall not limit the address selection for sensors and input/output devices. This module shall also provide the signaling to the field devices for the controlling the output of specific initiation devices. The on-board microprocessor provides the Device Loop Card loop with the ability to function even if the main microprocessor fails. LEDs on the board shall provide annunciation for the following: Power, Card Failure, Network Failure, Gnd. Fault, Alarm, Trouble, Short Zone 1, Short Zone 2, Class A Open Zone 1, and Class A Open Zone 2. The card shall support I/O modules with build-in isolation capability. The system display shall provide the specific device which has detected a loop short trouble, when a loop short is present anywhere on the data communication circuit. This card shall plug into the system card cage.

The Signal Line Circuits (SLC) shall be tested for opens, shorts and communications with all addressable devices installed 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. After initial testing replace the test panel and proceed with complete testing.

The Operator Interface shall provide the system information on hi- resolution ¼ VGA Color LCD, with Touch Screen and LED display. Event Color is user defined and specific for each event type i.e., MNS, Fire Alarm, Gas, Trouble, etc. Graphic user interface shall be menu driven with tabs showing the level and the total events for each tab. The tabs shall be: Alarm, Supervisory, Trouble and Security. At least five (5) events shall be shown simultaneously with two full lines of text message for each event. Each event shall have a 32-character custom message describing the event's location. In addition, the time stamp and category of the event (i.e., Smoke, Water flow, Manual, etc.) shall be displayed. When configured for Canadian operation, nine (9) events shall be displayed simultaneously. The LED displays shall indicate Power, Audibles On or Silenced, and Partial System Disabled. Systems not having the above LEDs shall provide separate LEDs within the control panel enclosure with appropriate labels. Selection buttons shall be backlit to aid the operator in the selection process. There shall be controls for scrolling throughout the event list. A button shall provide zoom in and zoom out control for the amount of information desired for a

specific entry. The operator interface shall be capable of monitoring the power supply loading and show available capacity for future expansion planning. The operator interface shall provide a "More Info" button which can display addition device information such as a graphical map of the event, its device type and system address. This More Info button shall also have the ability to display a detailed screen that provides the following:

200-character custom message associated with the group of the device and physical location in the building to alert personnel

NFPA symbols representing fire service equipment in the area

NFPA symbols representing hazards in the area

NFPA symbols representing people in the area

Number of devices in the associated group that are in alarm

Name and phone number of emergency contact

The operator interface shall also have the ability to display a bitmap of a floor plan showing a "You are Here" symbol to tell the responding person exactly where they are in the building in relation to the event. Systems without this type of display shall supply a UL listed Graphics package with their system. The LCD shall have a keyboard screen to allow the technician ability to enter test and numbers for passwords or text changes. The operator interface shall also have a Context Sensitive Help button. A globally configured operator interface shall have the ability to view events, acknowledge, silence and reset networked FACP systems. A globally configured operator interface shall also have the ability to arm and disarm input and output points on the FACP systems. A globally configured operator interface shall have the ability to be configured for control of the entire network, control of the local FACP System, or annunciation only. In a networked configuration, the Partial System Disable LED shall be indicative of all networked FACP's. A globally configured operator interface in a networked configuration shall have the ability to store 6 maps for every FACP panel. Capable of at least 10 globally configured operator interfaces shall be supported in a network. The operator interface International (International Version) shall provide Spanish, Portuguese or Canadian overlays. The operator interface shall have the ability to be configured display text in Spanish, Portuguese, Hebrew or French while having the ability to swap in English text at anytime by a simple button press at the panel.

The system card cage shall provide the mounting of all system cards, field wiring, and panel's inter-card wiring. All power limited field wiring shall connect to the top of the card cage. All non-power limited internal wiring shall be connected to the bottom of the card cage. The card cage shall hold the systems cards and have capability of connecting multiple card cages to meet system demands. All terminal blocks are removable.

The Switch Control Module shall be a supervised module with eight (8) switches and two LEDs per switch for controlling such items as speaker/strobe or telephone circuits. The switches shall also be used as generic inputs into the system. The Switch Control Module shall be mounted in the door for easy access. These modules shall be connected to the control area network and have a maximum distance of 1000ft (305m).

System response time from alarm to output shall be an average of three (3) seconds.

To expedite system troubleshooting, the system cards shall have ground fault detection and diagnostic LEDs by card.

All system cards and modules shall have Flash memory for downloading the latest module firmware.

Passwords:

Maintenance/Control Password - There shall be a 5-character password that a user must enter into the control panel in order to perform such maintenance- and control-related functions at the panel as:

Arming and disarming devices.

Activating, deactivating or modifying detector ASD and sensitivity settings.

Activating and deactivating the History Log function, and deleting obsolete entries.

Changing the system time and date.

Function Key Password - There shall be a 5-character password that a user must enter into the control panel in order to access the panel's Function Keys: touch screen buttons which perform custom-programmed system functions.

Reports Password - There shall be a 5-character password that a user must enter into the control panel in order to access the panel's reporting functions.

Walktest Password - There shall be a 5-character password that a user must enter into the control panel in order to access the panel's walk testing functions.

Acknowledge Silence Reset Password - There shall be a 5-character password that a system user must enter into the control panel in order to acknowledge events, turn silenceable audibles and visuals on and off, and perform panel resets.

Degrade Mode Alarm Activation:

Each data gathering panel shall support the ability to have its corresponding Zone initiating circuits and output devices on a device loop card's loop activate when the device loop card or conventional detection card is in Degrade Mode (has lost communication with the operator interface's control panel). For example, if the device loop includes detectors with relay bases and lamps, the relays and lamps will activate upon any system alarm when the device loop card is in Degrade Mode.

Smoke Control: The fire alarm system panel shall have the ability to be configured as a smoke control station that complies with UL/UUKL (UL 864) and NFPA 90A and ULC/ORD-C100 requirements. The system shall have the capability to monitor and override smoke control systems and equipment provided at designated locations within the same building.

Software Modifications: The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made. Systems that require the use of external programmers or change of EPROMs are not acceptable.

Logic: The fire alarm system shall support generic functions that deal with binary states (True/False, high/low), and produce desired outputs from one or more binary inputs (for example, alarm outputs from spot detectors, VESDA detectors, monitor modules or manual station inputs). AND, OR, NOT, Any N, D Latch, RS Latch, Time Base Control, Start Timer, Restart Timer are generic functions. Generic functions can be used as inputs to other function. The system shall support 2500 logic functions.

History: The system shall store 5000 events in history while in straight mode and 4500 in circular mode. In straight mode, trouble warnings will occur at 4000 and 4500 events. In circular mode, the control panels shall maintain a 2000 event Alarm History buffer, which consists of the 2000 most recent alarm events from the 4500-event history file.

Reports:

The system shall have the ability to provide configuration, status, queue and history reports.

Configuration reports shall provide the following information:

- Custom Messages
- Database information
- Entity type
- Device usage
- Device category
- Firmware revision

Status reports shall provide the following information:

- Disarmed cards and devices
- ASD settings
- Sensitivity in %/foot
- Alarm threshold in %/foot
- Temperature in degrees F
- LOW TEMP DETECTOR Condition

Walktest

Queue reports shall provide the following information:

Alarm events with custom message and event time
Supervisory events with custom message and event time
Security events with custom message and event time
Trouble events with custom message and event time

History reports shall provide Address, History Type, Description, Time & Date and Custom Message. The following event types shall be reported:

Alarm events
Supervisory events
Security events
Status changes
Alarm verification
Output activation from logic
System Reset
Event Acknowledgements
Block Acknowledgements
Audible Silence System Flag Changes
Sensitivity Changes
Arm / Disarm Commands
Arm / Disarm By Logic
Manual Output Overrides
Output Overrides By Logic
Time Changes
Menu Logins
ASD Changes
Walktest
Device Input to Logic Activations/Deactivations

POWER SUPPLY

The system Power Supply/Charger shall be a 12-amp supply with battery charger. The power supply shall be filtered and regulated. The power supply shall have a minimum of 1 power limited output rated at 4 amps, and a minimum of 1 output rated at 12 amps. The system power supply can be expanded up to 48 amps. The auxiliary power supply module shall share common batteries with the primary power supply. The system power supply shall have 4 relays, 1 for common alarm, one for common trouble and two programmable relays. The power supply shall be rated for 120/240VAC 50/60Hz.

The battery charger shall be able to charge the system batteries up to 100 AH batteries. Battery charging shall be microprocessor controlled and programmed with an optional Thermistor for monitoring battery temperature to control charging rate shall be available.

The power supply shall have a plug for an AC adapter cable, which allows a technician to plug in a laptop computer for up or downloading program information or test equipment.

Transfer from AC to battery power shall be instantaneous when AC voltage drops less than 90% or brown out conditions it is not sufficient for normal operation.

REMOTE POWER SUPPLY FOR NON-VOICE NOTIFICATION APPLIANCES

The power supply unit shall be an addressable NAC distributed controller to provide power to visual strobe circuits or supply auxiliary power to such items as Door holder circuits. The power supply unit shall communicate on the SLC loop to the Fire Alarm Control Panel. It shall provide status monitoring, device level fault indications and individual NAC control using a single address on the SLC. The power supply

unit shall provide a constant 24VDC nominal output voltage to each NAC-independent of voltage fluctuations on the primary or secondary power source.

Shall be a self-contained unit with 24VDC power supply and batteries housed in its own locked enclosure. Enclosure shall be made of 16 GA cold rolled steel, lockable and having the same key as the other control enclosures. Shall have 2 sizes (1 unit and a 2 unit) and colors (red and black).

Power supply unit shall be UL 864 listed and available in 6A and 9A models and 120 or 240VAC.

The power supply unit shall be able to support up to 18AH batteries in a single unit and 35AH in a 2-unit enclosure. Shall be able to support up to 100AH batteries in a separate enclosure.

The power supply unit shall have four independent 3 amp rated NAC circuits, expandable to a total of eight (8) Class B or four (4) Class A circuits or a mixture of each.

Ability to add one of two types of expansion cards which take one additional address on the SLC:

An expansion card that shall provide additional NAC circuits and can be configured with two (2) Class B or one (1) Class A releasing circuits with on board service disconnect switches.

An expansion card that shall provide for four (4) Class A or B conventional detection zone input circuit or shorting device (non-alarm) input circuits

The power supply unit shall be a class X isolating device residing on the SLC loop.

Each NAC output can be configured as an Aux Power output or a non-alarm closure input circuit.

Complete status monitoring to the individual circuit level at the main FACP and on-board LED status and diagnostic indicators.

The power supply unit shall be fully configurable through the manufacturer's system configuration tool.

The power supply unit output circuits shall be configurable individually as Steady On, Temp 3, Temp 4, March Time 30, 60 or 120PPM.

All NAC circuits shall have synchronized strobe outputs. Any combination of power supplies and expansion cards, up to a total of 32, shall be able to synchronize on the same loop.

The power supply shall have a dedicated Bell Follower circuit that can be used to achieve synchronization across multiple SLC loops.

Shall be able to accept a range of End of the Line (EOL) resistor values (2.2K to 24K Ω) without having to program or configure unit.

SYSTEM ENCLOSURE

Enclosure needed to hold all the cards and modules as specified with at least spare capacity for extra cards. The enclosure outer door shall be either black or red. Provide the color as to the local AHJ requirements. The outer doors shall be capable of being a left hand open or a right hand open. The inner door shall have a left-hand opening. System enclosure doors shall provide where required ventilation for the modules or cards in the enclosure.

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.

FIREFIGHTERS' TWO-WAY TELEPHONE COMMUNICATION SERVICE

There shall be a dedicated, two-way, supervised, telephone voice communication links between fire-alarm control unit, the fire command center, and remote firefighters' telephone stations. The supervised telephone lines shall be connected to talk circuits by controls in a control module. Provide the following:

Selective-talk type for use by firefighters and fire wardens.

Controls to disconnect phones from talk circuits if too many phones are in use simultaneously. An indicator lamp shall flash if a phone is disconnected from the talk circuits.

Addressable firefighters' phone modules to monitor and control a loop of firefighter phones. Modules shall be capable of differentiating between normal, off-hook, and trouble conditions.

Audible Pulse and Tone Generator, and High-Intensity Lamp: When a remote telephone is taken off the hook, it shall cause an audible signal to sound and a high-intensity lamp to flash at the fire-alarm control unit, fire command center.

Selector panel controls to provide for simultaneous operation of up to six telephones in selected zones. Indicate ground faults and open or shorted telephone lines on the panel front by individual LEDs.

Display: Digital graphic to indicate location of caller.

Remote Telephone Cabinet: Flush or surface mounted cabinet as indicated, factory-standard red finish, with handset.

Install a one-piece handset to cabinet with vandal-resistant armored cord. Silk-screened or engraved label on cabinet door, designating "Fire Warden Phone" or "Fire Emergency Phone."

With "break-glass" type door access lock.

Remote Telephone Jack Stations: Single-gang, stainless-steel-plate mounted plug, engraved "Fire Warden Phone" or "Fire Emergency Phone."

Handsets: Push-to-talk-type sets with noise-canceling microphone stored in a cabinet adjacent to fire-alarm control unit in the fire command center.

FIREFIGHTERS' SMOKE-CONTROL SYSTEM REQUIREMENTS SHALL INCLUDE

Initiation of Smoke-Management Sequence of Operation:

Fire-alarm system shall provide all interfaces and control points required to properly activate smoke-management systems.

First fire-alarm system initiating device to go into alarm condition shall activate the smoke-control functions.

Subsequent devices going into alarm condition shall have no effect on the smoke-control mode.

Addressable Relay Modules:

Provide address-setting means on the module. Store an internal identifying code for control panel use to identify the module type.

Allow the control panel to switch the relay contacts on command.

Have a minimum of two normally open and two normally closed contacts available for field wiring.

Shall be listed for controlling HVAC fan motor controllers.

INTELLIGENT INITIATING DEVICES

General

All initiation devices shall be insensitive to initiating loop polarity. Specifically, the devices shall be insensitive to plus/minus voltage connections. Except when built in isolation is used polarity sensitivity is required for the devices configured in isolation mode.

Smoke Detectors – Advanced with ASA (advanced signal analysis) - Multi-Criteria Addressable Series

The detectors shall be guaranteed in writing not to false alarm when configured by the factory trained certified technician. The detectors must provide up to 26 different environmental algorithms that allow the detector to provide superior false alarm immunity without the need for additional alarm verification delays.

The detectors shall have a tri-color LED to streamline system maintenance/inspection by plainly indicating detector status as follows: green for normal operation, amber for maintenance required, red for alarm.

Detectors shall utilize state of the art forward/backward light scattering technology, with improved detection for smoldering and flaming fire signatures. The detectors shall replace the need for ionization detectors due to improved response characteristics to flaming fires.

Detectors shall provide pre-alarm signal at 0.2% obs/ft. and a full alarm at 1.0% obs/ft. to meet the performance requirements of NFPA 76 - National Fire Protection Association Standard 76, Fire Protection of Telecommunications Facilities as a Very Early Warning Fire Detector (VEWFD).

The forward/backward light scattering technology shall provide improved immunity to spurious activation (deceptive phenomena). The detectors shall have a “No False Alarm Guarantee”.

The detectors shall be RoHS-compliant: it shall meet standards for Reduction of Hazardous Substances (RoHS) by reduction in lead content and other restricted substances.

The multi-criteria fire detectors shall be an intelligent digital photoelectric detector with a programmable heat detector. Detectors shall be listed for use as open area protective coverage, in-duct installation and sampling assembly installation and shall be insensitive to air velocity changes. The detectors’ communications shall allow the detectors to provide alarm input to the system and alarm output from the system within four (4) seconds. So as to minimize the effort required by the installing and maintenance technician to appropriately configure the detector to ensure optimal system design, the detectors shall be programmable as application specific. Application settings shall be selected in software for up to 26 environmental fire profiles unique to the devices installed location.

The detectors shall be designed to eliminate the possibility of false indications caused by dust, moisture, RFI/EMI, chemical fumes and air movement while factoring in conditions of ambient temperature rise, obscuration rate changes and hot/cold smoke phenomenon into the alarm decision to give the earliest possible real alarm condition report.

The detectors shall be capable of being field programmed for simultaneous and /or independent functionality, depending on the application. For example, the detectors shall be capable of utilizing the optical, heat, and/or CO sensors together for enhanced fire detection (multi-criteria) and simultaneously provide independent outputs for CO gas life-safety, smoke, and heat detection. Any combination of the sensors is possible.

The detectors shall be UL listed for operation in a 95% relative humidity (RH) environment.

The detectors shall be designed to eliminate calibration errors associated with field cleaning of the chamber.

The detectors shall support the use of a relay, or LED remote indicator. Low profile, white case shall not exceed 2.5 inches of extension below the finish ceiling.

The detectors shall support the use of an ambient temperature warning signal at the panel. This temperature shall be user-configurable for the set temperature of the warning and the event type generated by the warning. This event can be used to trigger system logic.

For the detectors where required, there shall be available a locking kit and detector guard to prevent unauthorized detector removal.

UL Listed as “direct in-duct” mounting.

UL 268 7th edition listed or greater.

Detector shall have built-in standard isolation.

Available models:

Multi-Criteria incorporating 2 Optical sensors and 2 Thermal sensors with an operating temperature range of 32°F to 120°F (0°C to 49°C). Nineteen selectable profiles. Polarity insensitive installation wiring. Three color LED.

Smoke Detectors – Standard Addressable Detectors:

The smoke detectors must provide at least 2 environmental parameter sets to assist in device sensitivity configuration.

UL 268 7th edition listed or greater.

Shall have built-in isolation.

The detectors shall have a tri-color LED to streamline system maintenance/inspection by plainly indicating detector status as follows: green for normal operation, amber for maintenance required, red for alarm.

The detector shall be RoHS-compliant: it shall meet standards for Reduction of Hazardous Substances (RoHS) by reduction in lead content and other restricted substances.

The detectors shall be UL listed for operation in a 95% relative humidity (RH) environment.

The detectors shall be designed to eliminate calibration errors associated with field cleaning of the chamber.

The detectors shall support the use of a relay, or LED remote indicator without requiring an additional software address. Low profile, white case shall not exceed 2.5 inches of extension below the finish ceiling.

For the detectors where required, there shall be available a locking kit and detector guard to prevent unauthorized detector removal.

Available models:

Multi-Criteria incorporating 1 Optical sensor and 1 Thermal sensor with an operating temperature range of 32°F to 100°F (0°C to 38°C). Available in four parameter sets. Polarity insensitive installation wiring (polarity sensitive is required for use of the built-in isolation feature). Detector includes a three (3) color status LED.

Photoelectric Smoke detector with an operating temperature range of 32°F to 120°F (0°C to 49°C).

Available in three parameter sets. Polarity insensitive installation wiring (polarity sensitive is required for use of the built-in isolation feature). Detector includes a three (3) color status LED.

Heat Detectors – Addressable

Thermal Detectors shall be rated at 135°F(57°C) and 15°F (8.3°C) per minute rate of rise. Detectors shall be constructed to compensate for the thermal lag inherent in conventional type detectors due to the thermal mass, and alarm at the set point of 135°F(57°C). The choice of alarm reporting as a fixed temperature detector or a combination of fixed and rate of rise shall be made in system software and be changeable at any time without the necessity of hardware replacement.

The detectors furnished shall have a listed spacing for coverage up to 2,500 square feet and shall be installed according to the requirements of NFPA 72 for open area coverage.

Detectors shall have built-in isolation.

Advanced heat detector shall have the following temperature settings:

Fixed temperature at 135°F(57°C), 145°F(63°C), 155°F(68°C), 165°F(74°C), 174°F(79°C)

Rate of Rise at 15°F/min (8.3°C) at 135°F (57°C)

Rate of Rise at 15°F/min (8.3°C) at 174°F (79°C)

Low temperature warning at 40°F (4.4°C)

Duct Smoke Detectors – Addressable

For duct detector applications, the smoke detector shall be an intelligent digital photoelectric detector. The detectors shall be listed to comply with an air velocity range from 0 to 4000ft/min (0 to 20m/s) and be listed for open air mounting, direct in-duct mounting, or listed sampling assembly.

The detector communications shall allow the detector to provide alarm input to the system and alarm output from the system within four (4) seconds. The detector shall be mounted in a duct detector housing listed for that purpose. The duct detector shall support the use of a remote test switch, relay or LED remote indicator. The duct detector shall be supplied with the appropriate sampling tubes to fit the installation.

Where duct detectors are exposed to the weather a weatherproof enclosure shall be available. A NEMA-3R and NEMA-4X option shall be available. The duct housing cover shall include a test port for functional testing of the detector without cover removal. The duct housing shall include a cover removal switch capable of indicating cover removal status to the fire alarm control panel.

An intelligent duct detector shall be available. Where required there shall be available a duct housing with an on-board relay. Also, where required, there shall be a standalone housing available with its own power supply and test/reset switch that does not require connection to a fire alarm control panel.

Duct smoke detector housing shall allow use in duct systems with air velocity ranging from 100 to 4,000 feet per minute, within temperature ranges of 32°F to 120°F (0°C to 49°C), and with relative humidity ranging from 0 to 95%.

Duct Housings and Accessories:

Air Duct Housing for Conventional and Addressable Detectors

Air Duct Housing for Addressable P2 Detectors with Relay Application

Air Duct Housing for Conventional Detectors with Relay Application

Air Duct Housing for Conventional Detectors with Relay Application and Built-in Power Source

Weather-Proof housing to accommodate all versions of Air Duct Housings

Remote Test Lamp for Conventional Detectors

Detector Bases – Addressable

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, 4in square or octagonal electrical outlet box.

Multi-Criteria Fire Detector shall be listed as providing CO detection in duct application.

The large standard base shall be a 6in version.

The small standard base shall be a 4in version.

Manual Pull Stations – Addressable

Provide addressable manual stations where shown on the drawings, to be flush or surface mounted as required. Manual stations shall contain the intelligence for reporting address, identity, alarm and trouble to the fire alarm control panel. The manual station communications shall allow the station to provide alarm input to the system and alarm output from the system within less than four (4) seconds.

The manual station shall be equipped with terminal strip and pressure style screw terminals for the connection of field wiring. Surface mounted stations where indicated on the drawings shall be mounted using a manufacturer's prescribed matching red enamel outlet box.

A single action pull station shall be available. It shall provide built-in isolation capability. The operator display shall indicate which specific device has detected a wiring fault on the data communication line.

Where required, there shall also be available pull stations with break glass, capable of explosion proof installation, capable of weatherproof installation, reset key operation, and metal housings.

Addressable Interface Devices

Addressable Interface Devices shall be provided to monitor inputs (contacts) and control outputs (relays) to and from the fire alarm system and associated devices. These interface devices shall be able to monitor single or dual contacts. An address will be provided for each contact. Where remote supervised relay is required the interface shall be equipped with a SPDT relay rated for 4 amps resistive and 3.5 amps inductive.

Devices shall have built-in isolation. Shall be capable of a full class X loop compliance up to 252 devices in isolation mode.

Where needed, a Conventional Zone Module shall connect to the Signal Line Circuit, which will allow the use of conventional initiation devices. This module shall have the ability to support up to 15 conventional smoke detectors and an unlimited number of contact devices.

Devices include (but not limited to):

Single or Combination input/output control modules.

Remote test lamps

Remote test switches

Monitoring applications include (but not limited to):

Water-flow switches

Tamper switches

PIV switches

Damper position – All 3 states on one input

Conventional devices (e.g., Smoke detectors, beam detectors, flame detectors, etc.)

Duct Detectors

Control applications include (but not limited to):

Notification appliance circuits (NAC)

Telephone zones

Speaker zones.

Damper position

Solenoids for sprinklers

Where applicable, all interface devices shall have built in isolation.

Where applicable, all interface devices shall meet NFPA 72 Class X requirements for survivability.

DEVICE PROGRAMMING UNIT

Device Programming Unit: The programming tool shall program the intelligent devices with addresses.

The unit shall test the device to respond to its address. Dipswitches and rotary switches shall not be acceptable. The programmer shall be available with carrying case.

ADVANCED FIRE ALARM NOTIFICATION APPLIANCES (LED based)

Horns, Strobes, and Horn/Strobes

Strobes and horn/strobes shall be listed for UL Standard 1971 (Emergency Devices for the Hearing Impaired) for Indoor Fire Protection Service.

Audibles devices shall be UL Listed under Standard 464 (Fire Protective Signaling).

All appliances shall meet the requirements of FCC Part 15 and ICES-003.

Visual appliances shall produce a flash rate of one (1) flash per second over the Regulated Voltage Range and shall incorporate a Light Emitting Diode (LED) as the light source with a rugged Lexan® lens.

The appliance shall be a “low profile” device.

The appliances shall be of low current design.

The LED strobe flash duration shall be 20ms. Where Multi-Candela appliances are specified, the strobe intensity shall have 4 field selectable settings at 15, 30, 75, and 110 candela for wall mount applications.

The selector switch for selecting the candela shall be tamper resistant.

Audible appliances shall have a minimum of two (2) field selectable settings for dBA levels and shall have a choice of continuous or temporal (Code 3) audible outputs.

The strobes shall not drift out of synchronization at any time during operation. If the sync fails to operate, the strobe shall revert to a non-synchronized flash rate and still maintain (1) flash per second over its “Regulated Voltage Range”.

Finish shall be red or white.

Special lettering, ALERT, CO and No lettering, shall be available.

The appliance shall also be designed so that the audible signal may be silenced while maintaining strobe activation

INSTALLATION:

Installation shall be in accordance with the local and state codes, as shown on the drawings, and as recommended by the equipment manufacturer.

All fire detection and alarm system devices, control panels and remote enunciators shall be flush mounted or surface mounted as per instructions of the Engineer-in-charge.

Manual call boxes shall be suitable for surface mounting or semi-flush mounting and shall be installed at a height of not less than 1,000mm, or more than 1200 mm above the finished floor level.

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

DEMONSTRATION:

The Contractor shall completely check out, calibrate and test all connected hardware and software to ensure that the system performs in accordance with the approved specifications and sequences of operations submitted.

This demonstration shall consist of the following:

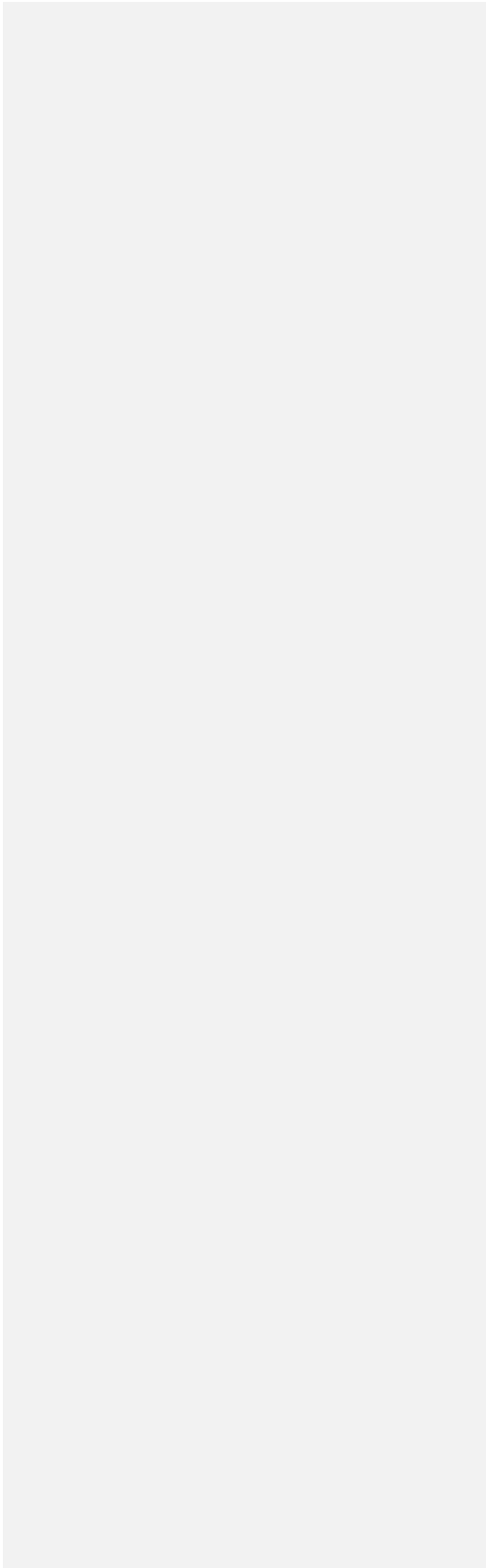
Display and demonstrate each type of data entry to show site specific customizing capability.

Demonstrate parameter changes.

Demonstrate scan, update and alarm responsiveness.

MANUALS

The following manuals shall be provided at the time of Handing over:



An Operator's Manual shall contain graphic explanations of keyboard use for all operator functions specified under Operator Training.

Computerized print outs of all data file layouts including all point processing programming details, flowcharts, etc.

On completion of works "**As Built**" drawings for completed installation shall be prepared by the Contractor and (5) Five copies of the same will be supplied to the Engineer-in-Charge. In addition, (5) Five sets of all Operation Manuals, Technical Literature for the various components of equipment, Controls and Accessories installed, Recommended Spares and Services Manuals will be supplied by the Contractor to the Engineer-in-charge.

TRAINING & HANDING-OVER

All training by the Contractor shall utilize manual and as-built documentation and the on-line help utility.

Operator training shall include:

- Sequence of Operation review

- Sign ON -Sign OFF

- Selection of all displays and reports

- Commanding of points, keyboard

- System initialization

- Trouble shooting of sensors (determining bad sensors)

- Password modification

Supervisor training shall include:

- Password assignment/modification

- Operator assignment/modification

- Operator authority assignment/modification

- Point disable/enable

Terminal and data segregation/modification

Guarantee

The guaranty shall cover the following: -

Quality, strength and performance of materials used.

Safe mechanical and electrical stress on all parts under all specified conditions of Operation.

Satisfactory operation during the guarantee period.

Performance figures and other particulars as specified by the tendered under

Labour to trouble shoot, repair, reprogram or replace system components shall be furnished by the contractor at no charge to the Engineer-in-charge during the guarantee period.

All corrective software modifications made during guarantee period shall be updated on all user documentation.

MISCELLANEOUS:

The onus of incorporating the **statutory requirements as per local rules** and obtaining necessary approval for the fire alarm systems shall rest fully with the Contractor.

The installation shall be carried out using new Equipment/ Materials complying with applicable standards in a workmanship like manner. Engineer-in-charge reserves the right to reject any part of installation having poor workmanship.

All minor Masonry, Carpentry and Civil works such as cutting / opening in Masonry Walls/ Internal Partitions, Chasing on Walls, etc. and making good the same to match existing surface shall be done by the Contractor, wherever asked for by the Engineer-in-charge or his authorized representative. Nothing extra shall be paid on this account.

END OF SECTION

Fire Suppuration System

TECHNICAL SPECIFICATION

GAS BASED SUPPRESSION SYSTEM

SCOPE OF WORK

The bidder shall supply, install, test and put in operation FK 5112 based fire suppression system. The fire suppression system shall include and not be limited to gas release control panel, CCOE approved seamless cylinders, discharge valve (with solenoid or pneumatic actuator), discharge pipe, non-return valve and all other accessories required to provide a complete operation system meeting applicable requirements of NFPA 2001 standards and installed in compliance with all applicable requirements of the local codes and standards.

The work under this system shall consist of design, supply, installation, testing, training & handing over of all materials, equipment, hardware, software appliances and necessary labor to commission the said system, complete with all the required components strictly as per the enclosed tender specifications, design details. The scope also includes the supply, installation & commissioning of any material or equipment including civil works that are not specifically mentioned in the specifications and design details but are required for successful commissioning of the project.

The system design should be based on the specifications contained herein, NFPA 2001 and in accordance with the requirements specified in the design manual of the agent. The bidder shall confirm compliance to the above along with their bid.

The system shall be properly filled and supplied by an authorized OEM (Original Equipment Manufacturer).

Key Component of the system along with calculation software of the system shall be approved by VdS/LPCB/UL-FM.

Generally, the key components of the FK 5112 system shall Comply with NFPA 2001 standards and Have the approval from US EPA (Environmental Protection Agency) for use as a total flooding fire extinguishant for the protection of occupied space:

Must have zero ozone depletion potential (ODP)

Be efficient, effective and does not require excessive space and high pressure for storage;

Be commercially available

Contain the required key components such as valves and its accessories, actuators, flexible discharge and connection hoses, check valves, pressure switch, and nozzles

DESIGN AND ENGINEERING

The system shall be designed taking the minimum design concentration as per NFPA 2001(Latest Edition) guidelines & as applicable to class 'A' & C risks. The FK 5112 agent shall be stored in seamless steel cylinders and dry nitrogen shall be added to provide additional energy to give the required rapid discharge. At the normal operating pressure of 42 bar at 21Deg C, the agent is a liquid in the container.

The system design must consider the limitations caused by the void height. The vendor should clearly indicate the

quantity of the gas in Kgs. to be used for the system. All voids within each hazard shall be discharged simultaneously. Each hazard shall have an independent system, unless otherwise specifically stated.

The system shall have a working pressure of 42 bars. A fill density between 0.40 Kg /Lit. To 0.85 Kg/Lit or as recommended by the manufacturer should be considered for the agent to be discharged within the specified time of 10 seconds.

The system engineering company should carry out the Piping Routing, Isometric design and validate the same with a hydraulic flow calculation generated by using the agent's design software. The appropriate fill density to be arrived based on the same. Software calculation for one room must be designed and corresponding result shall be generated in front of the customer.

The design & calculation shall be checked & certified by manufacturer/Consultant. You may note that the calculation is the only guarantee that the system will work, provided the system is installed exactly as per the design. The contractor has to take into consideration the routing available while designing the pipe network.

The Vendor shall enclose their design sheet along with the offer & the offer/BOQ should be in line with their design. The dimensions of rooms to be protected are given in the BOQ. The vendor shall also consider the following

The vendor shall consider simultaneous total flooding of all voids within the protected volume. The system shall be designed in accordance with the OEM's Design Manual.

In order to extinguish a fire using clean agent, the concentration of agent delivered to each void shall be above the minimum design concentration. The following shall be considered while designing the system. The minimum design concentration shall be 4.5%. Class A&C fire risks.

If the protected volume has a floor and / or ceiling void the spaces shall be included in the protected volume, employing a minimum design concentration not below that of the main room compartment.

The discharge nozzles shall be located within the protected volume in compliance to limitations and with regard to spacing, floor and ceiling coverage, etc.

The nozzles shall be positioned such that they would cover the entire area up to the extreme corners of the area under protection and the design concentration will be established in all parts of the protected volumes and it shall be ensured that the nozzles are NOT placed directly above the racks

The final numbers of discharge nozzles shall be according to the OEM's product manual.

The gas flow calculations shall be carried out on special software given by the OEM. The software should support usage of seamless cylinders which have a different design compared to the standard containers used worldwide.

The system acceptance report shall show the resulting concentration in each independent void to be above 4.5% and the average pressure at each nozzle to be not less than 6.4 Bar.

The agent discharge time shall not exceed 10 seconds.

The design concentration shall follow at minimum NFPA 2001 for under floor, room and ceiling space. Unless otherwise approved, room temperature for air-conditioned space shall be taken around 20 - 23 Deg C. For non-air conditioned space, the temperature shall be taken around ambient temperature. The system shall be designed with minimum design concentration of 4.5 % as applicable to Class A& C fire.

The system engineering company should carry out the piping Isometric design and validate the same with a hydraulic flow calculation generated by using the agent's design software. Appropriate fill density to be arrived at based on the same.

REFILLING AND MAINTENANCE

In case of any leakage or accidental discharge of the agent, it should be possible to refill the cylinders in India itself in the CCOE approved filling station. The contractor should indicate the source of refilling and time that will be taken for refilling and replacement.

DISCHARGE TIME

As gas has to be fully discharged within 10 seconds for effective quenching of fire as per the relevant standards, the contractor has to ensure that the design meets this requirement. Once the discharge takes place there should be warning signs restricting personal from entering the protected area until the gas has been cleared from the area.

MATERIALS AND EQUIPMENTS

All materials and equipment's shall be from approved manufacturers and shall be suitable for the performance of their respective functions. The cylinders should be complete with all accessories. The contractor shall indicate the dimensions of the cylinders required for each area while quoting.

CYLINDER

The cylinder shall be high pressure, seamless steel gas cylinder, flat type, concave bottom as per IS 7285 complete with neck ring. Welded and non-CCE approved cylinders will not be accepted.

Each cylinder shall be seamless steel type manufactured from billets and tested in accordance with IS 7285

As per the regulations of the Chief Controller of Explosives (CCE) Nagpur, any system which has a working pressure above 19 bar (280 psi) will require the use of seamless cylinders that have been duly approved by the CCE, Nagpur.

The maximum fill density of FK 5112 in a cylinder shall not exceed 0.85 Kg/Lit. of internal volume. Appropriate fill density shall be chosen based on the cylinder location and piping. The hydraulic calculations should prove that the fill density is appropriate and total discharge will take place within 10 seconds.

The cylinders shall be super-pressurized with dry nitrogen to 42 bar at 20°C. The cylinder shall be capable of withstanding any temperature between -30° C and 70°C. Cylinder shall be mounted according to manufacturer recommendations. The cylinder shall withstand Hydrostatic test pressure up to 250 bars and maximum working pressure at 15°C shall be 150 bars

The cylinder/valve assembly shall have suitable metallic protection for the valve enabling transportation of the filled cylinders safely.

All cylinders shall be distinctly and permanently marked with the quantity of agent contained, the empty cylinder weight, the pressurization pressure and the zones they are protecting.

CYLINDER VALVE

Each cylinder shall be provided with a valve of suitable size. Each cylinder valve shall have a provision for fixing a supervisory pressure switch and a safety burst disc to protect the cylinder from over pressure. The cylinder valve shall necessarily have a disabling plug (locking pin) to prevent accidental discharge of the valve during transportation and installation. The Valve assembly shall be mounted directly on the cylinder.

The Pressure Gauge must have in-built low supervisory switch and low-pressure supervisory switch must not be connected externally on the valve. The Cylinder Valve must have a provision of mounting the Electrical Actuator and the Pressure gauge on either any two sides of the Valve, it should not be limited to only one side.

Each valve is to be fitted with a pressure gauge for monitoring loss of pressure.

The master cylinder valve is to be released electrically which is performed by means of a solenoid valve arrangement.

CYLINDER VALVE ACTUATORS

In a single cylinder system the cylinder shall have a solenoid operated actuator and a manual actuator incorporating a strike knob mounted on top of the solenoid operated actuator. Multi cylinder systems shall have the same fitted on to the master cylinder and pressure operated actuators fitted on each slave cylinder. All actuators shall be original OEM

make and locally manufactured actuators shall not be used.

HOSES

Each cylinder valve shall be provided with a plug-in type flexible rubber discharge hose of minimum 40mm size and shall withstand a test pressure as at least 150 -200% of the cylinder stored pressure. Each hose shall be permanently marked with the test pressure and OEM's part number. Multi cylinder systems shall have an interconnect hose for each cylinder. The interconnect hose shall have a length not less than 700 mm and shall be labeled with the test pressure of 100 Bar and the OEM's part number. All hoses shall be original OEM make and locally manufactured hoses shall not be used.

MANIFOLD WITH CHECK VALVE

The manifold shall be fabricated from ASTM A106 Schedule 80 seamless pipe and shall have integral check valves provided for each cylinder.

OTHER ACCESSORIES

Electric Control Head, Pressure operated control head, Master Cylinder Adapter Kit, Flexible discharge hose, discharge Nozzles, and other required accessories shall be approved or listed for use with FK 5112 All the gaskets, O-ring, sealant and other components shall be constructed of materials compatible with the clean agent. The system should be engineered using hardware & accessories approved by the Engineering System Distributors of FK 5112 as mentioned in the list of approved makes. The Vendor shall submit the detailed data sheets & drawings of each accessories with the required part Nos. and also the common system data sheet containing these parts with part Nos.

PIPES & FITTINGS

All Pipes shall be of ASTM - A-106, Gr: B, schedule - 40 seamless Mild Steel Pipes and fittings shall be as per ASTM-A-105 standard. Distribution piping and fittings shall be installed in accordance with the manufacturer's requirements, NFPA 2001, and approved piping standards and guidelines. All distribution piping shall be installed by qualified individuals using accepted practices and quality procedures. All piping shall be adequately supported and anchored at all directional changes and nozzle locations.

All piping shall be reamed, blown clear and swabbed with suitable solvents to remove burrs, mill varnish and cutting oils before assembly.

All pipe threads shall be sealed with Teflon tape pipe sealant applied to the male thread only.

DISCHARGE NOZZLE

Engineered discharge nozzles shall be provided within the manufacturer's guidelines to distribute the FK 5112 agent throughout the protected spaces Nozzle shall control the flow of FK 5112 to ensure high velocity, proper mixing in the surrounding air and uniform distribution of the agent throughout the enclosure.

The number of nozzles and their positions must be chosen so that the design concentration is maintained everywhere in the enclosure. Nozzle shall be located where they can be adequately supported on walls, ceiling or structural members. Software generated calculation supporting the nozzle design shall be submitted by the successful bidder before signing of contract.

FIRE DETECTION & GAS RELEASE PANEL & OPERATION PROCESS

Fire detection shall be achieved using the microprocessor-based fire detection cum gas release panel specifically used for each protected area. The detectors shall be in cross zone and the trigger from the panel shall be for 2 stage action.

Some of the enhance features of the detection cum gas release panel shall be,

Easy on-site configuration
Upload / download of configuration data's

Event logging facilitates identifying origin of events
Display countdown timer before extinguishing release
Extinguishing automatic activation with various alarm combinations
72h battery backup time
Various system test modes
Automatic calibration facility for actuators control lines (solenoid or pyrotechnical actuators)
Manual Release button for manual activation of extinguishing
Emergency hold button to temporary stop the extinguishing or abort button to cancel the initiated extinguishing release as long as the pre-warning time is running
Remote transmission facility for transmitting alarms and faults

If in case the fire detection part is handled by a separate fire control panel, the panel shall have the capability to integrate with larger fire detection system. Also, the panel shall have the facility to connect repeater panel for remote status indication and remote control.

AUTO MODE OPERATION

The sequence of operation of the gas release system shall be as follows.

When the any one of the detectors connected to the building fire alarm panel goes into alarm, immediately the sounder cum strobe shall get activated.

The fire detection cum gas release panel shall ensure that the access control shall get deactivated.

The first stage activation in the gas release circuit shall happen only when any one of the detectors in the protected area goes into alarm.

When the first stage gets activated, the specific zone numbers and the detectors location shall be displayed, and the panel buzzer shall start operating. The stage 1 bells shall be identified by the fact that they pulsate at the rate defined by timer 1.

The panel shall also illuminate the "ALARM" lamp on the control panel face.

The sounder cum strobe shall remain on until the alarm is silenced in the panel. The panel shall return to normal only after the fire alarm condition is cleared and a reset is performed in the panel.

The second stage activation in the gas release panel shall happen when the second detector in the protected area goes into alarm in the second stage or vice versa.

The PAC units shall be deactivated. The panel shall also illuminate the "PRE-DISCHARGE" lamp on the control panel face

When the second stage is activated, the second zone number and the detectors location shall also be displayed on the panel and the sounder shall be activated which is identified by a continuous tone. The stage 2 bells indicate that area is to be evacuated.

The timer shall start to trigger the signal for gas release. The delay set time shall NOT exceed 60 seconds. It shall be possible to program the delay timing at site

During the delay time period, the Gas release can be aborted by activating the "Manual abort switch" mechanically. The countdown timer shall countdown till 10 second and stops. Once if the abort switch is released, the timer shall start count down from 10 seconds. Releasing and pressing again the manual abort switch shall reset the countdown time to 10 seconds. A buzzer shall be activated when the abort switch is operated.

After the expiry of the timer, the output from the actuator output terminal of the panel shall activate and operate the solenoid valve in the master cylinder. It is important to note that the actuator output on the panel shall be enabled only if the automatic gas release mode is selected

A Gas sign board with lamp (Located outside the protected area) shall also illuminate indicating that the gas discharge has taken place

The gas shall discharge into the protected area within 10 seconds as stipulated in the NFPA 2001 guidelines (2004 edition). The gas shall permeate into all the voids in the desired quantity so that the fire shall be quenched.

As long as both the stages remain in alarm, the output to solenoid shall be active. If at least one of the two stages returns to normal as explained above, the delay timer shall stop. The gas release shall not happen if the delay is set to zero.

MANUAL MODE OPERATION

The manual release shall happen in three ways. Manual Release through the panel, Manual release station & Manual Release directly from the cylinder

The electric manual release (activated through the panel) shall be a dual action switch device which provides a means of manually discharging the suppression system from the panel

The manual release station shall also be a dual action device requiring two distinct operations to initiate a system actuation.

Manual actuation shall be capable of bypass the time delay or shall have the time delay depending upon the client requirements. It shall be possible to program both at site and abort functions and shall cause all release and shutdown devices to operate in the same manner as if the system had operated automatically.

Manual release station shall be located at each entry from the protected hazard and the abort station shall be located at the exit side

If the "Manual release lever on the master cylinder shall be activated by operating the lever, the gas shall get released immediately. Abort function cannot be performed after activating the manual release lever.

CONNECTION DETAILS

The Addressable detectors shall be connected in loops which are independently addressed from the fire alarm panel. Or Conventional detectors shall be used and the same shall be connected to the conventional fire detection cum gas release panel.

The manual abort station and manual release stations shall be connected to fire alarm cum gas release panel. In addition, the gas release panel shall have the manual mode switch as explained above

The discharge pressure switch shall be connected to the gas release panel through addressable monitor modules.

The sounder cum strobes shall be connected to gas release panel.

The solenoid actuator shall be connected to gas release panel in the Gas release terminal.

The fire trip input for the PAC units are looped and connected through addressable control modules to the fire alarm cum gas release panel.

The Access controlled door release shall be connected to the fire alarm cum gas release panel through addressable control modules.

The monitor module shall be connected from the Building fire alarm panel to the gas release panel for alarm communication fault status of the gas release panel.

CONVENTIONAL MULTI SENSOR DETECTOR

It shall be Multi Sensor type Smoke Detector with UL and FM Approval. It should have Green LED Indication for Normal Operation, RED for Fire condition and Yellow for Fault. Detector should have 360° LED Indication.

MANUAL RELEASE UNITS / STATIONS

Manual release units - double action type shall be provided at each exit of the protected area and as indicated on the drawings. Manual release unit casings shall be colored YELLOW and shall be inscribed with the lettering "AGENT (NAME) MANUAL RELEASE POINT". Mounting heights for manual release units shall be agreed on site.

ABORT UNITS / STATIONS

Abort switches, where provided, shall be located within the protected area and shall be located near the means of egress for the area. The abort switch shall be of a type that requires constant manual pressure to cause abort. In all cases the normal and manual emergency control shall override the abort function. The abort switch shall be clearly recognizable for the purpose intended.

The abort units shall be momentary devices requiring constant pressure to maintain contact closure and shall be coloured RED and shall be inscribed with the lettering "AGENT (NAME) ABORT POINT". Mounting heights for abort units shall be agreed on site.

REMOTE LAMP UNIT

Remote lamp units shall be provided to give indication of an activated smoke detector within a ceiling or floor void.

DOCUMENTATION

The successful contractor should prepare & submit the piping Isometric drawing and support the same with a hydraulic flow calculation generated by using the agent's design software. The calculations shall validate the fill density assumed by the bidder.

The bidder shall submit copies of the datasheets of the hardware used in the system.

The bidder shall also submit calculations to evidence the qty of agent considered for the system.

The System Company should provide, as part of handing over, the as-built drawing, operation manual and maintenance manual. The as-built drawing shall exactly match the Isometric drawing submitted with the flow calculation prior to commencement of work.

The successful vendor must submit, along with the supply invoice, a certificate of authenticity, for the agent.

The design & the installation shall be certified by principal system supplier.

TESTING PROCEDURES FOR GAS BASED FIRE SUPPRESSION SYSTEM

GENERAL

Prior to placing the completed system in service, the installation should be inspected and tested by qualified personnel to confirm that the system has been properly installed and will function as specified below.

Conformance to System design.

Suitability of piping, its correctness to project design, and its supports.

Operating Sequences.

Suitable Hazard Environmental controls and Safety precautions and.

Compliance with the norms of NFPA STD. 2001 (2008 Edition) and other applicable standard.

PIPING

Verify that pipe sizes and layout are as indicated on the project working drawings.

Verify the piping supports and ensure the pipes are secured and restrained from the movement.

After the installation after system piping is completed, and prior to the connection of the cylinders, accessories, nozzles etc., the discharge piping should be blown out and then

Pressure tested for leakage. Plug or Cap all pipe outlets and apply 40 psi (3 bar) pressure with air for 10 minutes. At the end of 10 minutes, the pressure loss shall not exceed 20% of the test pressure. Under no conditions should water be used in testing.

CYLINDERS

Inspect cylinders and ensure bracketing and cylinders are secure.

Check pressure gauge and ensure pressure is correct for temperature at cylinder location.

Check cylinder discharge bends and check valves for proper orientation, connection and tightness.

Ensure that the cylinder operating components and auxiliary control devices are installed in accordance with the project drawing.

All the required labeling as done on the cylinders

NOZZLES

Ensure each nozzle has an orifice drilled to suit the specific location and discharge flow requirements.

Verify that nozzle locations and orifice sizes are as indicated in the project drawing.

ELECTRICAL

All testing of the extinguishing system electrical circuits, Interlocks, Fire detectors and other electrical devices like solenoid actuators shall be carried out in accordance with the systems control panel.

The control panel should indicate normal supervisory condition.

Check the smoke detectors are in cross zone.

ROOM INTEGRITY TEST

NFPA2001 states that the design concentration of a clean agent post discharge shall be maintained for a sufficient period of time to ensure there is no reignition of fire once suppressed. NFPA 2001 and 12A require an enclosure integrity test as part of the acceptance procedure for all clean agent systems. This includes halocarbon and inert agents. This comprehensive test and calculation predict the leakage area corresponding to the retention time of agent in the enclosure on discharge. Most specification state it must be ten minutes.

Transformer

DISTRIBUTION TRANSFORMER (DRY TYPE)

Scope

Three-phase 11KV/0.433 KV, 2 no's 2500 KVA Transformers of Cast Resin Type, class F insulation system with natural (AN) cooling for indoor installation, destined for use in three-phase LV distribution systems.

Standards

These transformers will be in compliance with the following standards:

- IEC 60076-11
- prEN 50541-1

Specific Standards according to country requests

These transformers will be manufactured in accordance with:
a quality system in conformity with ISO 9001
an environmental management system in conformity with ISO 14001, both certified by an official independent organization.

Description

Magnetic core

This should be made from laminations of insulated silicon steel, and should be protected against corrosion with a coat of varnish.

In order to reduce the power consumption due to transformer no-load losses, the magnetic core should be stacked using overlapping-interlocking technology.

In order to reduce the noise produced by the magnetic core, it should be equipped with noise-damping devices.

LV windings

The LV winding should be produced using copper foils in order to cancel out axial stress during short circuit; this foil should be insulated between each layer using a heat-reactivated class F pre-impregnated epoxy resin film

The ends of the winding are to be protected and insulated using a class F insulating material.

The whole winding assembly will be polymerized throughout by being autoclaved for 2 hours at 130°C, to ensure:

High level of resistance to industrial environments

Excellent dielectric with stand

Very good resistance to radial stress in the instance of a bolted short circuit.

HV windings

They should be separated from the LV windings to give an air gap between the MV and LV circuits in order to avoid depositing of dust on the spacers placed in the radical electrical field and to make maintenance easier.

These will be made of copper wire or foil (according to the manufacturer's preference) with class F insulation.

The HV windings will be vacuum cast in a class F fireproof epoxy resin casting system composed of:
an epoxy resins
an anhydride hardener with a flexibility additive
a flame-retardant filler.

The flame-retardant filler will be thoroughly mixed with the resin and hardener. It should be composed of trihydrate alumina powder (or aluminium hydroxide) or other flame-retardant products to be specified, either mixed with silica or not.

The casting system will be of class F. The interior and exterior of the windings will be reinforced with a combination of glass fiber to provide thermal shock withstand.

MV winding support spacers

These will provide sufficient support in transport, operation and during bolted short circuit conditions as well as in the case of an earthquake.

These spacers should be circular in shape for easy cleaning. They should give an extended tracking line to give better dielectric withstand under humid or high dust conditions.

These spacers should include an Elastomer cushion that will allow it to absorb expansion according to load conditions. This Elastomer cushion should be incorporated in the spacer to prevent it being deteriorated by air or UV.

HV connections

The HV connections will be made from above on the top of the connection bars. Each bar will be drilled with a 13 mm hole ready for connection of cable lugs on terminal plates.

The HV connection bars will be in rigid copper bars protected by heat shrinkable tubing. HV connections in cables are not allowed, in order to avoid all risk of contact, due to cables flapping.

The HV connections will be in copper.

LV connections

The LV connections will be made from above onto bars located at the top of the coils on the opposite side to the HV connections.

Connection of the LV neutral will be directly made to the LV terminals between the LV phase bars.

The LV connection bars will be in copper.

The output from each LV winding will comprise copper connection terminal, enabling all connections to be made without using a contact interface (grease, by-metallic strip: out of scope of supplying) able to connect to the Bus Duct.

HV tapping

The tapping which acts on the highest voltage adapting the transformer to the real supply voltage value, will be with ON Load Tap Changer (OLTC Type) as per manufacturer's standard/ 1.25% Step Up & Step-Down settings with remote panel.

Accessories and standard equipment

These transformers will be equipped with:

- 4 flat bi-directional rollers
- lifting lugs
- haulage holes on the undercarriage
- 1 earthing terminals
- 1 rating plate
- 1 "Danger Electricity" warning label (T 10 warning)
- 1 routine tests certificate
- 1 instruction manual for installation, commissioning and maintenance in English.

Thermal protection

These transformers will be equipped with a thermal protection device which will comprise:

3 thermal detection systems (1 by phase), installed in the active part of the transformer. The sensors will be

placed in a tube to enable them to be replaced if ever necessary.

An electronic converter with two independent monitoring circuits equipped with a changeover switch, one for "Alarm 1" the other for "Alarm 2". The position of the relays will be indicated by different coloured indicator lights. A third indicator light will indicate the presence of voltage.

These three indicator lights will be on the front of the converter. The electronic converter should be installed away from the transformer.

A plug-in terminal block for connection of the sensors to the electronic converter.

The sensors will be supplied assembled and wired to the terminal block fixed on the upper part of the transformer. The converter will be supplied loose with the transformer, packaged complete with its wiring diagram.

Metal enclosure

On request, these transformers will be equipped with a metal enclosure for indoor installation comprising an integral IP 31 (except the base which may be IP 21) metal enclosure, that can be dismantled on request, with:

On request specified in the annex, these transformers can be supplied mounted equipped with protective metal enclosure:

either for indoor installation, with degree of protection IP 31 (except the bottom which may be IP 21),

Electrical tests Routine tests

These tests shall be carried out on the transformers after the manufacturing, enabling an official test certificate to be produced for each one:

measurement of windings resistance

measurement of the transformation ratio and vector group

measurement of impedance voltage and load loss

measurement of no-load loss and no-load current

applied voltage dielectric test

induced voltage dielectric test

measurement of partial discharges. For this measurement, the acceptance criterion will be: partial discharges less than or equal to 10 pC at 1.30 Un, or

partial discharges less than or equal to 5 pC at 1.30 Un (Special test)

(All these tests are defined in the IEC 60076-11 and IEC 60076-1 to 60076-3 standards).

Type tests or special tests

The manufacturer should furnish following type tests certificates:

temperature rise test carried out in accordance with the simulated loading method as defined by the IEC 60076-11 standard

lightning impulse test in accordance with IEC 60076-3

short circuit test in accordance with IEC 60076-5

noise level measurements in accordance with IEC 60076-10.

(All these tests are defined by the IEC 60076-11 and IEC 60076-1 to 60076-5 standards).

Climatic and Environmental classifications

These transformers will be of environmental class E2 and of climatic class C2 as defined in IEC 60076. E2 and C2 classes will be indicated on the rating plate.

The manufacturer must produce a test report from an official laboratory for a transformer of the same design

as those produced.

The tests must have been performed in accordance with IEC 60076-11 for C2 climatic class and IEC 60076-16 for E2 environmental class.

Fire behaviour classification

These transformers will be of class F1 as defined in IEC 60076-11. F1 class will be indicated on the rating plate.

The manufacturer must produce a test report from an official laboratory on a transformer of the same design as those produced and on the same transformer which have initially passed the here above Climatic and Environmental tests.

This test must have been performed in accordance with IEC 60076-11.

3.11 Transformer Losses:

Transformer Losses should be as per ECBC PLUS.

END OF SECTION

PLC SYSTEM

CONTROL PHILOSOPHY

AUTOMATIC STARTING & STOPPING OF ENGINES

The system should come in operation after sensing of grid failure and or the voltage drops below preset value. The 'PLC' shall issue the command to 'Master' D.G. In case the D.G. set do not start in the 1st cranking; two more cranking attempts shall be made with proper intervals. Even then if engine fails to start, indication must appear on MMI/Monitor 'SET FAILS TO START' & alarm shall be generated. The PLC shall give the command to the next D.G. in selected sequence.

D.G. set has started and put on load. The system shall start monitoring voltage, Frequency and load, if the load exceeds a settable limit. The next D.G. shall be started to prevent D.G. over loading. The process shall continue till all the D.G.s have been started.

At any point of time, the engines are under loaded and the load is capable of being catered by less than the numbers of running D.G.'s. Stop command shall be given to the D.G. running for shortest duration at that moment.

On restoration of mains and sensing the healthiness of the same, the load shall be transferred to mains. The D.G.'s shall be given stop command after a settable time delay ensuring adequate cooling down of the engine.

AUTO SYNCHRONISATION

Synchronization facility shall be available for 'Auto & manual mode. In auto synchronizing mode, the synchronization will be achieved by 'PLC' (PLC will control voltage, frequency and phase angle and issue command to breaker), However if due to any reason auto synchronization fails repeatedly, the 'PLC' system should initiate start command to next DG for operation and as well as synchronises the system automatically. **In manual mode the system shall be manually operated backed by relays only.** In auto mode facility the closing of breaker shall be automatic, whereas in manual mode breaker will be closed by panel switch through synchronizing relay.

In any case if the auto synchronization is failed to achieve in a settable time an alarm shall be generated and displayed that the 'DG FAILED TO SYNCHRONISE' and the same shall be aborted.

AUTOMATIC LOAD SHARING

'PLC' shall monitor continuously the Active & Reactive Power Generated by the various sets and shall issue command to achieve proper load sharing.

BACKUP PROTECTION

The system shall have built in protection as listed below and shall continuously monitor the parameters and on sensing of any electrical fault P.L.C shall trigger 'Trip command Through Trip relay of the corresponding breaker similarly in case of semi auto mode and in case of manual mode it shall be through master trip relay.

Over voltage/Under voltage

Over frequency/under frequency

Over current

Reverse power active

Active Power reactive

Synchronizing check (MMI)

Earth fault relay unbalance

Differential protection through relay inter face with PLC/PC

Engine Protection as listed under DG sub-head shall also be interfaced with PC/PLC for generating trip command/alarm and generating report etc.

PROGRAMMABLE LOGIC CONTROLLER (PLC)

The entire operation of the captive power generation system and Grid supply shall be controlled automatically through PLC. These PLCs shall be a state- of-the-art equipment's using latest technology and shall be of most rugged and reliable design. Since system will be operating in the harsh and unfriendly environment of D.G. Room, they should be suitable to operate trouble free under the conditions. The selected equipments should be able to withstand high temperature, humidity and voltage fluctuations, thus making it suitable for the operating conditions described above.

Automatic PLC system basically shall consist of but not limited to:

Main processor unit

EEPROM for CPU

Power supply for unit (1 KVA UPS with maintenance free batteries for 15-minute capacity)

Mounting chassis 16/slot mounting rack

Power monitor module

Digital input module

Digital output module

Computer to PLC communication card with cable (MMI)

Operator interface graphics software package (window based)

Analog/P module 16/8 channels

Outgoing ckt (kwh) meter with pulse counter interface with PLC for generating report

20% spare incoming/outgoing shall be provided for future use.

Interfaced connectivity for engine safe ties and parameters with cabling etc.

System diagnostic card control for DG auxiliary (Pump, fans, oil, fuel cooler etc.)

Monitoring of HT voltage Transformers alarm and trip mimic of 11KV&LV system

Monitoring of electrical parameters including and outgoing Circuit Breaker of high and low voltage ckt and PC complete with CPU, coloured monitor, keyboard, inkjet printer, required software shall be installed and commissioned.

SEQUENCE OF OPERATION FOR AUTO START-STOP, AUTO SYNCHRONISING AND AUTO LOAD SHARING AND LOAD MANAGEMENT OF DG SETS

ON GRID Supply failure or on sensing of grid supply voltage (voltage drop than pre-set value), the master DG shall start automatically and closes its breaker/neutral contactor, bus breaker also closes to feed the loads.

On attainment of maximum permissible load on master DG set (i). The 2nd DG set shall start automatically.

Voltage & frequency of 2nd No. DG shall be monitored and compared with Bus Parameters and will be adjusted by giving commands to the incoming DG sets (2nd) if required.

Auto synchronizing system shall verify the phase angle and also compensates at closing time of incoming breaker by initiating closing command to breaker ahead of the actual on predictable synchronizing ensuring thereby a zero (0) degree phase difference, as well as the system shall monitor the slip frequency, beat

(hunting) voltage of the machine or system.

First DG neutral contactor shall remain in circuit even if the 1st DG set is shut-off. The neutral contactor of the other working set shall get closed first before tripping of the shutting off DG Set.

The process shall continue for incoming DG's such as 3rd, 4th..... soon.

The starting sequence of the DG sets can be altered through MMI/PLC

ON restoration of grid supply and sensing of healthiness of the same. The DG's & bus breaker shall be 'out' and grid breaker shall be 'in' to feed the power.

Active power on DG's is balanced automatically through Governor Control with the help of Active Load Balancing System.

Reactive load balancing system to achieve KVAR and regulation within preset bank value through the motorized potential meters.

In the event set fails to synchronised, the alarm generated through Annunciator shall invite the attention of the Operator for 'Manual' intervention. If the sets do not synchronise, the bus breakers shall be switched off and both the sets shall start feeding their respective loads.

In the event of a D.G. standing idle more than 8 hours lube oil priming pump shall be started for 3-5 minutes.

DG auxiliary feeders shall be controlled through 'PLC' for starting/stopping of respective DG auxiliary system.

The system shall have total manual over-side w/o (without) by-passing the safeties and protections.

The system shall facilitate program change ability/selling's/time delay etc. through MMI on PC.

Stand-alone Mode (No synchronizing)

In this case the system shall work independently with electrical inter-linking to prevent parallel operation of two supply sources.

FUNCTION/FEATURE OF PLC SYSTEM

In general terms the following will be the functions of PLC. During final freezing of the controls, logic & Dos, additions and deletions can be made through PLC (MMI)

The system shall directly accept CT & PT signals without the need of any transmitters for electrical parameter monitoring and control system or the same shall be met through energy monitoring/management relays with RS 232/485 communication port.

Depending upon the load requirement starting and stopping of DG sets automatically with by-pass arrangement in PLC.

Automatic selection of next DG as master after stopping/tripping of master DG & to close or open of neutral contactor respectively.

Automatic synchronizing of DG sets in auto mode.

In the event of PLC failure, the system shall run on manual mode with relay protection back up.

Key for selection of number of DG sets to start and synchronize at no load for kick (starting) load requirements.

Active & reactive power sharing of each DG sets.

Monitoring of electrical parameter per D.G., voltage, frequency, reactive load, active load, energy produced etc.

Status and control of outgoing breakers

Backup protection electrical by time delayed tripping of D.G. Sets

Alarm and trip for reverse power, reverse KVAR, under voltage, over voltage, under frequency, over frequency, over current, low lube oil pressure, high cooling water temperature and pressure, over speed and other safeties as called for in DG tender.

Data acquisition system will be incorporated with the system for the purpose of recording and display of all important and critical parameters of the engine, alternator and system as such in totality operation and maintenance of the system will also be through operator interface with graphic screen.

PLC system should be capable to take care of all the protection (relay features) in Auto mode. Relay base protection features of manual mode shall also be compatible with PC.

'B' checks alarm after each DG complete 500 hours or as recommended by DG supplier of running for proper maintenance.

Tripping of less priority loads in the building in case of under frequency of bus both in isolation as well as synchronised mode.

PLC input/output cards should be dedicated to individual DGs with out in terming ling of signals from different DGs.

PLC system shall have provision to test the DG in auto mode without closing the Breaker to do the routine electrical/mechanical testing of Set without interruption of power generation.

Monitoring of 6 points alternator winding, 2 points bearing temp drive and non-drive, ends for alarm & trip respectively. Provision for monitoring of 2 points exhaust gas temperature and smoke quality.

Also, the system supplier shall include of the cost of 1 spare card for each system to facilitate in case of maintenance.

The system supplier will supply 6 sets of as built drawings along with trouble shooting with suggested measurer operational and maintenance guidelines through consultants.

MANUAL MODE

In this case complete system operation will have to be done manually. Hence starting of the DG sets, stopping of the DG sets, Synchronization procedure, breaker closing, tripping etc. will be done through respective switches, push buttons provided on respective feeders.

In this mode load sensing units will be ineffective hence starting or stopping of D.G. sets will be done manually only.

Note:

Any hardware/software required to make the system operational in PLC/manual mode shall be included with any extra cost to project (employer).

NEUTRAL CLOSING SYSTEM FOR PARALLEL RUNNING OF D.G. SET

A suitably rating L.V. contactor shall be provided for each D.G. set for neutral isolation controlled through PLC (auto/manual) from remote. Neutral contactor of the D.G. set started first will be closed and then command for that ACB closing can be effective. Only one neutral contactor (of the first started D.G. set) will be closed during parallel operation. In the event of tripping of neutral contactor for master D.G. set the next selected D.G.'s N/C (Neutral Contactor) should close before the neutral contractor of the master D.G. trip. While switching 'off' the D.G. sets which has started first is selected then neutral contactor of either of remaining set will be switched on and then tripping signal to the first started D.G. set will be actuated. After voltage and frequency reached the set band. PLC shall Issu eclose command to neutral contactor 1st and then to ACB of selected set. This will prevent fault level current from flowing into the system. At any moment of time only neutral is the system to avoid any circulation current in other alternator.

The operational mimic shall also be provided on for complete function of mains & D.G.'s etc. on the boxed.

END OF SECTION

BUSBAR TRUNKING SYSTEM Suggested specifications

A. Range:

- Aluminium (Having contacts of Copper): 800A-6300A
- Copper (Silver plated throughout the length): 630A-6300A

B. Manufactured Units

1.General

a)The busbar trunking system (800A and above), both feeder and plug-in, shall be sandwich construction.

All busbar trunking products and fittings (straight length, elbow, tees, flanged ends, cable tap box and circuit breaker, etc.) shall be in accordance with IEC 61439 Part 6 (2012) or UL857 and from the same manufacturer as the busbar trunking system. The degree of protection of the busbar trunking system should be IP54/65 in accordance to IEC 60529.

b)Rated operation voltage of the busbar trunking is 1000V. 3 – Phase, 4 or 5 Wire with 50% capacity continual integral/internal earth busbar. The neutral conductor should have the same cross-sectional area as the phase conductor. The earth busbar must be one continuous piece without bolting on housing

c) The ampere ratings, approximate footage, fitting, plug-in units etc. are shown on the plan. The electrical contractor shall be responsible for routing the busbar trunking to coordinate with the other trades. Final field measurements shall be made by the contractor prior to release to the busbar trunking for fabrication by the manufacturer.

2.Certificate

a)The busbar, of full range and each rating, should pass full type tests specified in IEC 61439 Part 6 (2012).

The certificate shall be issued by an international independent testing authority (e.g. ASTA, KEMA, UL). b)

A product safety mark (e.g. KEMA-KEUR, ASTA DIAMOND, UL) should be on the product offering a visible assurance to all of full product safety testing, factory inspection and ongoing surveillance under independent authority to ensure the ongoing safety of product.

c)The busbar trunking system should pass seismic tests with actual physical product and being certified complying with UBC seismic Zone 4 condition by an international recognized earthquake research body, e.g. Asian Pacific Network of Centers for Earthquake Engineering Research (ANCER).

3.Short Circuit Ratings and Tests

a)The whole busbar trunking system shall be capable of withstanding the short circuit of the electrical installation without damaging the electrical, mechanical and thermal stress under fault condition at a service voltage of 1000V 50Hz. The minimum rated insulation voltage shall be 1000V.

b) The minimum certified short circuit ratings of the busbar trunking shall be as follows:

Ra	K	K	Ra	K	K
80	40	84	25	75	16
10	50	10	32	90	19
12	50	10	40	10	22
16	60	13	50	12	26
20	60	13	60	12	26

C. Basic Construction

1.Housing

- a)The busbar trunking housing shall be constructed of electro galvanized steel and aluminum to reduce hysteresis and eddy current losses and shall be provided with a suitable protective finish of ANSI 49 grey epoxy paint.
- b)The busbar trunking housing shall be totally enclosed non-ventilated for protection against mechanical damage and dust accumulation. And it shall pass at least 500 hours salt spray test to ensure the anticorrosion ability.
- c) The totally enclosed housing shall be manufactured by the busbar trunking manufacturer. Modifications of busbar trunking to make it totally enclosed by other than the busbar trunking manufacturer voids the manufacturer's warranty. Busbar trunking so modified is unacceptable without the written consent of the manufacturer.

2.Busbars

- a)Busbars shall be of hard drawn silver-plated high conductivity copper of 99.9% purity or aluminum with copper cladding utilized Molecular Fusion technology.
- b)There shall be no bolts passing through the busbars of the busway.
- c)Each busbar shall be insulated with Class B (130 °C DuPont Polyester). Epoxy insulation is not allowed.
- d)The temperature rise at any point of the busbar trunking enclosure shall not exceed 55 degree Centigrade rise above ambient temperature when operation at rated current.

3.Joint

- a)The busbar trunking joint shall be of the one-bolt type which utilizes a high strength steel bolt(s) and Belleville washers to maintain proper pressure over a large contact surface area. b)
The bolt shall be torque indicating and at earth potential.
- c) The bolt shall be two-headed design to indicate when proper torque has been applied and require only a standard long handle wrench to be properly activated.
- d)Access shall be required to only one side of the busbar trunking for tightening joint bolts.
- e)It shall be possible to remove any joint connection assembly to allow electrical isolation or physical removal of a busbar trunking length without disturbing adjacent busbar trunking lengths.

4.Plug-in Opening

- a)The connecting jaw of the plug-in unit shall plug directly onto the busbar and have full contact with busbar itself. Welded tab at plug-in busbar is not allowed.
- b)All contact on joint and plug-in opening should be silver plated copper.
- c)On plug-in busbar trunking there shall be three dead front, hinged cover type plug-in openings on each side.
- d)All openings shall be usable simultaneously.
- e) Busbar trunking shall be installed so that plugs are side mounted to permit practical use of all plug-in openings.
- f)It shall be possible to inspect the plug-in opening and busbars prior to the installation of the plug-in units.

D. Support of busbar Trunking

- 1.Hanger spacing shall be noted on layout drawings and shall not exceed manufacturer's recommendations.
- 2. Indoor feeder and plug-in busbar trunking shall be approved for hanger spacing of up to 3 meters for horizontally mounted run and 4.88 meters for vertically mounted runs. Outdoor feeder busbar trunking shall be approved for spacing of up to 1.5 meters for horizontally or vertically mounted runs.

E. Voltage drop

- 1.The voltage drop (input voltage minus output voltage) specified shall be based on the busway operating at full rated current and at stabilized operating temperature in 30 °C ambient.
- 2.The three-phase, line to line voltage drop shall not exceed 3.4 volts per hundred feet at 40% power factor concentrated load which may exist during motor starting.
- 3.The line-to line voltage drop shall not exceed 4.1 volts per ^{internal} hundred feet at the load power factor which produces

maximum voltage drop in the busway.

F. Plug-in Units

- 1.The plug-in jaw shall be spring design composed of different metal to ensure the firm and tight contact with the busbar
- 2.Plug-in Units should be type tested in accordance with IEC 61439-6 (Annex D: Part 1-5 and 9-13)
- 3.The earthing contact of the plug-in unit shall always be made before that of the live conductors and the last to break during removal. And it must connect to the earth bar of busway to ensure the safety.
- 4.Covers of all plug-in units must have interlocks to prevent the cover from being opened when the switch is in the ON position.
- 5.Plug-in units (circuit breaker type or fusible switch type) shall be operated with visible blade quick-make and quick-break mechanism
- 6.Presence of Transparent shield shall be inside to avoid direct contact of human
- 7.The plug-in units shall be equipped with internal barriers to prevent accidental contact of fish tape and conductors with live parts on the line side of the protective device during time of wire pulling.

END OF SECTION

16.0 EXTERNAL LIGHTING

a. GENERAL

16.1 Work Description

The scope of work includes design, erection, testing and commissioning of external lighting, façade and landscape lighting. The all fittings, the wiring details and cable routes shall be coordinated with other trades at site and submitted for the approval of the Engineer-in-charge. All time and cost required for adjusting the layout or complete installation to suit site requirement is included.

To determine the exact positioning of External lighting points due consideration shall be given, for selection of the most accessible routes for wiring, convenience of switching and operational requirement of the installation.

No extra cost will be paid should the final positions be re located.

For the purpose of specification and related drawing, each lighting circuit shall be coded with a prefix to indicate the corresponding distribution board number.

The electrical equipment/system may develop sudden changes due to low frequency/or direct electric current components such as fluorescent lamps, contactors, etc. shall be fitted with radio and television interference suppression components suitable to meet the levels specified in BS 800 "Limits of Radio Interference".

16.2 Standards

The complete wiring installation shall be engineered according to manufacturer data and constructed in accordance with the latest revision of the IS and the appropriate BS/IEC

In the adoption of standards and requirements, the Contractor shall take the following precedence:

- Engineer's decision
- Local codes of practice
- Drawings
- Specification
- International standard and requirements

16.3 Submission

All technical submissions shall be approved by the EPC contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of consultant for its review and approval.

The submission shall include the following as a minimum requirement,

- Equipment catalogues submission with manufacturer's data
- Sample submission include all wiring accessories
- Shop Drawings of the lighting, circuit numbers, cable routings, switching arrangement, mounting height, etc. The positions and mounting heights shall be coordinated with other services. Fixing details of all wiring accessories shall also be included.
- Drawings showing the installation details
- Labeling system
- Builder's works requirement.

Supply, Installation, Test & Commissioning of 60W LED Decorative double triangle Post Top type luminaire with System efficacy of 130 lm/W (7800lumens), . Luminaire shall be made up of Aluminum Extrusion/die cast housing duly Powder coated with gray pure polyester powder with polycarbonate Diffuser , capable of producing Symmetric optics. . LM 80-08 compliant LEDs of EMC/ceramic package from reputed makes such as Nichia/Cree/ Bridgelux/ Lumiled/ Osram/Seoul should be provided. LEDs used in the product shall comply with EN 62471 for Photo-biological safety and certificate for the same from manufacturer shall be provided. Luminaire shall be with IP66 and IK10 protection. The LED shall be compliant with LM80-08 standard with L70 life of 50000 Hrs tested at maximum current (Complete LM 80 test report for LED should be submitted for 10000 hrs of testing). The LEDs used should be with CCT of 57000 K, CRI of Minimum 70 and SDCM <5. LEDs must be driven at max 70% of the rated current. MCPCB with Aluminium core and copper thickness of 35 micron to be used for LED mounting. LED Driver shall be silicone potted, Integrated type, Isolated, Constant Current with range 140-290V AC. Driver Efficiency > 85% & 5 KV internal surge protection , Power factor greater than 0.95 and total harmonic distortion (THD) of less than 10% should be integral to the luminaire. Manufacturer shall have inhouse lab approved by NABL or ministry of science of govt of India. LM79 and LM80 reports need to be submitted from a NABL/UL accredited lab to verify above parameters. Compliance to Indian Standards of IS10322 Part 5 / Sect 5:1967; 16105 : 2012; IS 16106 : 2012; IS 15885 (Part2/Sec13) : 2012; IS 16108 : 2012 should be there.

Supply, Installation, Test & Commissioning of 11W LED Decorative pattern Bollard with System efficacy of 100 lm/W (880 lumens). Luminaire shall be made up of dark grey, pure polyester power coated extruded Aluminium housing with High efficiency Transmission PC diffuser, having dimension of length 151mm± 2mm, Width 151 mm with height of 800mm±2mm. All external hardware must be of SS304 grade. LM 80-08 compliant LEDs of EMC/ceramic package from reputed makes such as Nichia/Cree/ Bridgelux/ Lumiled/ Osram/Seoul should be provided. LEDs used in the product shall comply with EN 62471 for Photo-biological safety and certificate for the same from manufacturer shall be provided. Luminaire shall be with IP65 and IK10 protection. The LED shall be compliant with LM80-08 standard with L70 life of 50000 Hrs tested at maximum current (Complete LM 80 test report for LED should be submitted for 10000 hrs of testing). The LEDs used should be with CCT of 4000 K, CRI of Minimum 80 and SDCM <5. LEDs must be driven at max 70% of the rated current. MCPCB with Aluminium core and copper thickness of 35 microns to be used for LED mounting. IP66 rated LED Driver shall be silicone potted, Integrated type, Isolated, Constant Current with range 140-280V AC. Driver Efficiency > 80% & 2.5 KV internal surge protection, Power factor greater than 0.95 and total harmonic distortion (THD) of less than 10% should be integral to the luminaire. Manufacturer shall have inhouse lab approved by NABL or ministry of science of govt of India. LM79 and LM80 reports need to be submitted from a NABL/UL accredited lab to verify above parameters. Compliance to Indian Standards of IS10322 Part 5 / Sect 5:1967; 16105 : 2012; IS 16106 : 2012; IS 15885 (Part2/Sec13) : 2012; IS 16108 : 2012 should be there. similar to

Supply of 100W SMD LED Streetlight fixture with System efficacy of 100 lm/W (13000 lumens). Luminaire shall be made up of pure polyester powder coated die cast Aluminium housing with high purity IP66 of single module of same make. The housing should be made non-corrosive pressure die-cast aluminum, to withstand extreme environments. T. All external hardware must be of SS304 grade. The name of the brand should be embossed/engraved & should not be mentioned using sticker/screen printing. Luminaire shall be designed with street optic LENS for uniform light distribution. LM 80-08 compliant LEDs of EMC/ceramic package from reputed makes such as Nichia/Cree/ Bridgelux/ Lumiled/ Osram/Seoul should be provided. LEDs used in the product shall comply with EN 62471 for Photo-biological safety and certificate for the same from manufacturer shall be provided. Luminaire shall be with IP66 and IK10 protection. The LED shall be compliant with LM80-08 standard with L70 life of 100000 Hrs tested at maximum current (Complete LM 80 test report for LED should be submitted for 17000 hrs of testing). The LEDs used should be with CCT of 5700 K, CRI of Minimum 70 and SDCM of < 5. LEDs must be driven at max 70% of the rated current. , Integrated type, Isolated, Constant Current with range 120-300V AC. Driver Efficiency > 85% & 5 KV internal surge protection along with external SPD of 10 KV mounted on the streetlight , Power factor greater than 0.95 and total harmonic distortion (THD) of less than 10% should be integral to the luminaire. Driver must be of die cast / extruded Aluminium casing. Manufacturer shall have inhouse lab approved by NABL or ministry of science of govt of India. LM 79 and LM80 reports need to be submitted from a NABL/UL accredited lab to verify above parameters. Compliance to Indian Standards of IS10322 Part 5 / Sect 3:2013; 16105 : 2012; IS 16106 : 2012; IS 15885 (Part2/Sec13) : 2012; IS 16108 : 2012.

Supply, Installation, Testing & Commissioning of 495mm Length X 200 mm Width X 330mm Height Rectangular Flood light with Non-integral driver & completely made in India luminaire. Luminaire must use Single LED of RGBW Chip and not discrete individual LEDs of each colour for colour effect. The luminaire's shall be made of Extruded aluminum housing powder coated in grey. The complete luminaire has IP66 & IK08 protection and it comprises of high purity integrated poly carbonate Lens. The LEDs shall have minimum CRI ≥ 80 (White LED) & shall have SDCM ≤ 5 . The luminaire shall have wattage 192W and shall deliver 8640 lumens. Beam angle of the Luminaire shall be 60 deg. Fixture shall operating temperature range of 0°C to 45°C. Input Voltage Range of 24V DC, Integrated DMX Decoder, No need to additional external decoder. The luminaire shall have declared life of 50,000 burning hours at L70. The luminaire shall be compatible with DMX controller. The luminaire shall automatically addressable using hand-held addressing device. The luminaire shall be capable of 8-bit control of RED, Green, Blue & White (W=4000K) to produce 16.7million colours. Luminaire and Driver must be made in India with same brand. Luminaire manufacturer must have In-house NABL accredited lab to conduct LM79. The successful bidder must submit the NABL accreditation certificate for Luminaire manufacturer along with technical bid. LM80, RoHS compliance issued by LED luminaire manufacturer, BIS certificate for LED Luminaire. Brand name shall be embossed / engraved on each an every light fixtures. Luminaire and Driver should be Made in India. Luminaire, Driver and controller should be with same make.

Supply, Installation, Testing & Commissioning of 500 mm length X 80mm Width X 115mm Height RGBW Linear Wall Washer with Non-integral driver & completely made in India luminaire. Luminaire must use Single LED of RGBW Chip and not discrete individual LEDs of each colour for colour effect. The luminaire's shall be made of Extruded aluminum housing powder coated in grey. The complete luminaire has IP66 & IK07 protection and it comprises of high purity integrated poly carbonate Lens. The LEDs shall have minimum CRI ≥ 80 (White LED) & shall have SDCM ≤ 5 . The luminaire shall have wattage 12W and shall deliver 480 lumens. Beam angle of the Luminaire shall be Asym deg. Fixture shall operating temperature range of 0°C to 45°C. Input Voltage Range of 24V DC, Integrated DMX Decoder, No need to additional external decoder. The luminaire shall have declared life of 50,000 burning hours at L70. The luminaire shall be compatible with DMX controller. The luminaire shall automatically addressable using hand-held addressing device. The luminaire shall be capable of 8-bit control of RED, Green, Blue & White (W=4000K) to produce 16.7million colours. Luminaire and Driver must be made in India with same brand. Luminaire manufacturer must have In-house NABL accredited lab to conduct LM79. The successful bidder must submit the NABL accreditation certificate for Luminaire manufacturer along with technical bid. LM80, RoHS compliance issued by LED luminaire manufacturer, BIS certificate for LED Luminaire. Brand name shall be embossed / engraved on each an every light fixtures. Luminaire and Driver should be Made in India. Luminaire, Driver and controller should be with same make.

Supply, Installation, Testing & Commissioning of 1000 mm length X 80mm Width X 115mm Height RGBW Linear Wall Washer with Non-integral driver & completely made in India luminaire. Luminaire must use Double LED Array of RGBW Chip Double Array and not discrete individual LEDs of each colour for colour effect. The luminaire's shall be made of Extruded aluminum housing powder coated in grey. The complete luminaire has IP66 & IK07 protection and it comprises of high purity integrated poly carbonate Lens. The LEDs shall have minimum CRI ≥ 80 (White LED) & shall have SDCM ≤ 5 . The luminaire shall have wattage 96W and shall deliver 3840 lumens. Beam angle of the Luminaire shall be Asym deg. Fixture shall operating temperature range of 0°C to 45°C. Input Voltage Range of 24V DC, Integrated DMX Decoder, No need to additional external decoder. The luminaire shall have declared life of 50,000 burning hours at L70. The luminaire shall be compatible with DMX controller. The luminaire shall automatically addressable using hand-held addressing device. The luminaire shall be capable of 8-bit control of RED, Green, Blue & White (W=4000K) to produce 16.7million colours. Luminaire and Driver must be made in India with same brand. Luminaire manufacturer must have In-house NABL accredited lab to conduct LM79. The successful bidder must submit the NABL accreditation certificate for Luminaire manufacturer along with technical bid. LM80, RoHS compliance issued by LED luminaire manufacturer, BIS certificate for LED Luminaire. Brand name shall be embossed / engraved on each an every light fixtures. Luminaire and Driver should be Made in India. Luminaire, Driver and controller should be with same make.

Supply, Installation, Testing & Commissioning of 196mm Dia X 158mm Height RGBW Circular Flood light with Non-integral driver & completely made in India luminaire. Luminaire must use Single LED of RGBW Chip and not discrete individual LEDs of each colour for colour effect. The luminaire's shall be made of Extruded aluminum housing powder coated in grey. The complete luminaire has IP66 & IK08 protection and it comprises of high purity integrated poly carbonate Lens. The LEDs shall have minimum CRI ≥ 80 (White LED) & shall have SDCM ≤ 5 . The luminaire shall have wattage 60W and shall deliver 3300 lumens. Beam angle of the Luminaire shall be 15 deg. Fixture shall operating temperature range of 0°C to 45°C. Input Voltage Range of 24V DC, Integrated DMX Decoder, No need to additional external decoder. The luminaire shall have declared life of 50,000 burning hours at L70. The luminaire shall be compatible with DMX controller. The luminaire shall automatically addressable using hand-held addressing device. The luminaire shall be capable of 8-bit control of RED, Green, Blue & White (W=4000K) to produce 16.7million colours. Luminaire and Driver must be made in India with same brand. Luminaire manufacturer must have In-house NABL accredited lab to conduct LM79. The successful bidder must submit the NABL accreditation certificate for Luminaire manufacturer along with technical bid. LM80, RoHS compliance issued by LED luminaire manufacturer, BIS certificate for LED Luminaire. Brand name shall be embossed / engraved on each an every light fixtures. Luminaire and Driver should be Made in India. Luminaire, Driver and controller should be with same make.

Supply, Installation, Testing & Commissioning of 16mm X 16mm of 5 meters length RGBW Neon Flexible strip LED light with Non- Integral driver embedded inside. The luminaire's shall be made of Silicon extrusion with high-efficiency, high grade appearance, soft bend flexibility & Option of Top bend, the same shall be so designed with completely made in India luminaire. The luminaire shall have silicon glue between optical cover & LED chamber to ensure proper IP67 protection. Required external decoder. The LEDs shall have minimum CRI ≥ 80 (White Light). The luminaire shall have system wattage of 14 Watt/ meter. Fixture shall operating temperature range of 0°C to 45°C. The fixture shall have a Non integral driver with input voltage for 220-240 VAC, 50/60Hz. The luminaire shall have declared life of 50,000 burning hours. The luminaire shall be compatible with DMX512 controller. The luminaire shall automatically addressable using hand-held addressing device. The luminaire shall be capable of 6-bit control of RED, Green, Blue & White (W=4000K) to produce 16.7 million colours. Luminaire manufacturer must have In-house NABL accredited lab to conduct LM79. The successful bidder must submit the NABL accreditation certificate for Luminaire manufacturer along with technical bid. Bidder shall submit the following reports along with technical bid LM79 report of the family of luminaire issued by NABL accredited lab, LM80 issued by LED manufacturer BIS certificate for LED Luminaire.. Brand name shall be embossed / printed on each and every light fixtures.

Supply of Isolated, constant Voltage type 240 W LED Driver enclosure in Extruded Aluminium metal enclosure. Driver shall be made in India compatible for RGBW luminaires with silicone potted and IP66 Protected of same make as luminaire. Output voltage of the driver 24Vdc. Driver efficiency should be greater than 85% at full load, THD < 10%, PF > 0.95 with Under and Over Voltage Cutoff Protection and 440V withstand for 8 hours minimum & should have large operating input voltage range of 140V to 300V AC (nominal rated voltage – 240V) with 5KV internal surge protection. LED driver shall have inbuilt output short circuit, over voltage protection, Thermal Shutdown protection.

Supply of Isolated, constant Voltage type 120 W LED Driver enclosure in Extruded Aluminium metal enclosure. Driver shall be made in India compatible for RGBW luminaires with silicone potted and IP66 Protected of same make as luminaire. Output voltage of the driver 24Vdc. Driver efficiency should be greater than 85% at full load, THD < 10%, PF > 0.95 with Under and Over Voltage Cutoff Protection and 440V withstand for 8 hours minimum & should have large operating input voltage range of 150V to 300V AC (nominal rated voltage – 240V) with 5KV internal surge protection. LED driver shall have inbuilt output short circuit, over voltage protection, Thermal Shutdown protection.

Supply of Isolated, constant Voltage type 150 W LED Driver enclosure in Extruded Aluminium metal enclosure . Driver shall be made in India compatible for RGBW luminaires with silicone potted and IP66 Protected of same make as luminaire. Output voltage of the driver 24Vdc. Driver efficiency should be greater than 85% at full load, THD < 10%, PF > 0.95 with Under and Over Voltage Cutoff Protection and 440V withstand for 8 hours minimum & should have large operating input voltage range of 150V to 300V AC(nominal rated voltage – 240V) with 5KV internal surge protection. LED driver shall have inbuilt output short circuit, over voltage protection, Thermal Shutdown protection.
Supply, installation, testing and Commissioning of 5Core 5C DMX cable/Patch cord Patch Endcap 1m
Supply, installation, testing and Commissioning of 5Core T Type 5C DMX cable Supply, Installation, Testing and commissioning of DMX Decoder completely made in India product .Input Power DC 12V -24V input which Outputs 6A/Channels. 100-240V, 24VDC plug-in power adaptor .The number of devices controlled from 001-512 via DIPSwitch. Connection of DMX (3 pin, 3.5mm pitch screw terminal). Channel bondin capable up to 10A. 8 pin terminal connector current LED connection. Compact PCB or chassis mounted.All six output ports should have an independent output driver and ELV transformer to boost the DMX signal. 1: 6 Way DMX Splitter/Booster ,Optically isolated DMX Input/Outputs, Individual coil transformer for each output , Surface/Rack/Floor/Celling mountable with provide mounting accessories ,Refined and filtered data , Cable 3 core 0.75sq.mm .Five Year Warrantyof DMX Signal Splitter+Amplifier - One DMX512 signal Input to six DMX512 outputs, Designed to amplify, distribute and isolate DMX signals in short-runs and localised splitting scenarios. Protection of short circuit, Reverse Polarity, Over Temprature, Over Voltage and Over Current. Photo-electric isolation between Input and Output terminals as well as between output terminals among channels. Compensates for any intereference from external sources like AC lines, Electrical equipment operating close to DMX transmission lines.Compact DIN rail enclosure enables easy installation inside most enclosures.

Supply, Installation, Testing and commissioning of DMX Master Controller, with completely made in India product. A stand alone interface for installation in electrical DIN Cabinets with Din rails, which can control from 512 to 1024 and can go up to 2048 channels on 1, 2 or 4 DMX universes. A robust Stand Alone mode and a wide range of trigger possibilities (RS232, Contacts, Clock, NODE x4 ports, Master/slave), USB-C Networks Ethernet, Internet, WIFI compatible when connected to a router Multiple Zone 10 Zone, play 10 scene/sequence per time in Stand Alone ,Memory of Micro SD Card (max. 256 GB) and 8Mb Internal memory . Art-Net and sACN from SD card, including triggers (2x512). A master / Slave Sychro (32 max wired / 128 max Ethernet) that Commands from the Contacts (speed, scene, dimmer, zone). Default start scene, Scene priority, Cross Fade time between scenes , Automatic Scene Recovery if the power is cut off and 16-bit and fine channel management. Triggers options of RS232 In/Out (16 characters max for RS232 triggers, commands or orders) and UDP / Ethernet triggers and commands (from SDK). Software Requirements with System Compatibility of Windows, Mac, iOS. Flexible, adaptable mounting options ,Should be provided with light show authoring software, Direct line voltage power supports 100—240VAC,Minimum five configurable effects, Using light show authoring software to select from standard five effects, adjust effect settings such as color, speed, and brightness. IP20. Addressing & Programming inclusive and with Five Year Warranty. Brand name shall be embossed on each and every lighting fixtures.

Supply, Installation, Testing and commissioning of DMX Splitter, Booster 343 mm Height X 123mm Width X 46 mm Depth with completely made in India product .Input Power DC 12-24V input, 100-240V, 24VDC plug-in power adaptor included Power Consumption 4.5W max and of MS/ Aluminium Housing. Power Consumption of 4.5 Approx and Weight of 1.5Kg .The output terminals should be optically isolated from the input and share a common ground reference. All six output ports should have an independent output driver and ELV transformer to boost the DMX signal. 1: 6 Way DMX Splitter/Booster ,Optically isolated DMX Input/Outputs, Individual coil transformer for each output , Surface/Rack/Floor/Celling mountable with provide mounting accessories ,Refined and filtered data , Cable 3 core 0.75sq.mm .Five Year Warrantyof DMX Signal Splitter+Amplifier - One DMX512 signal Input to six DMX512 outputs, Designed to amplify, distribute and isolate DMX signals in short-runs and localised splitting scenarios. Photo-electric isolation between Input and Output terminals as well as between output terminals among channels. Compensates for any interference from external sources like AC lines, Electrical equipment operating close to DMX transmission lines.Compact DIN rail enclosure enables easy installation inside most enclosures.

Supply, Installation, Testing and commissioning of 6 push button keypad/panel made of aluminium brushed CNC style modular with 6 individual push buttons that can trigger the Dry Port contacts.Output Voltage 12 V DC. A completely made in India product.

Supply, Installation, Testing and commissioning of Moving Head Gobo Projector having light source of 700 W with illumination level 14174 lux @15M With IP66 protection and operating temperature -30to +45°C and 20000 Hrs LED Source , with adjustableZoom range 4 to 36 °, light output aperture 138 mm with color temperature 6500K , having color wheel 1 (7 color +CMY+CTO) static GOBO wheel 1 (6 Interchanable GOBOs) , Rotating Gobo wheel 1 (& interchangeable Of Gobo)with prism 2 (8 face & 6 face) no of channle 38/41 ch , dimming 0-100 % linear with horizontal 540° Scan , vertical 270°Cscan and control with DMX 512 / RDM

Programming & Intergartion of all the Façade & Gobo as per Client Requirement will all the required accessories

b. **PRODUCT**

EXTERNAL LIGHTING:

A. **STEEL TUBULAR SWAGED TYPE POLE**

Steel tubular swaged type street lighting poles of the following standard shall be used on work

1. The steel tubular swaged type welded poles in stepped from shall be with single/double curved bracket arm suitable for mounting luminaries as per bill of quantities.
2. The poles shall be manufactured from electric resistance welded tubes as per IS: 2713-1980 with latest amendment.
3. The pole shall be erected in plumb, buried 1/6th of the pole size underground in cement concrete foundation as per details given in the schedule of quantities and the drawing.
4. The excavation shall be made in hard and dense soil as per site. A MS plate of size450x450x10mm thick shall be welded at the bottom of the pole and 300x300x6mm thick MS plate for G I pipes poles.
5. The base plates of pole shall be grouted over a 150mmthick 1:2:4 cement concrete bed. The pole shall have a brick / concrete collar as per drawing duly plastered around it at the ground level.
6. AMS junction box of size250x200x115mmdepthfor looping incoming and outgoing cables asper drawings. MS whether proof junction box shall be fabricated out of 16SWG sheet steel having hinged cover on the front with neoprene gasket and locking arrangement. The box shall incorporate glands and one 63A, 10way ELMAX connector for looping incoming and outgoing 2Nos. cables and 10/20A DP, MCB, 40mm GI pipe for incoming and outgoing cables shall be fixed to the pole so that PVCA aluminium cable shall be protected from mechanical damages.
7. An earthing stud with copper lugs for connecting 8SWG GI wires for earthing shall be provided on the pole at the position outside the MS box. The incoming and outgoing cables shall be marked with ferrules as required.
8. The poles shall be given a coat of rust preventive bituminous^{Internal} paint on the inside and red oxide primer on the outside at the factory premises. After the erection of the pole, two coats of enamel/aluminium paint of

approved colour shall be applied.

9. Touch up paint shall be given at the time of handing over the work. Marking of circuit and pole number shall also undergo same painting treatment as given above for the pole. GI pole shall be supplied in 3M length as per B.O.Q., no jointed /welded pole shall be accepted.

B. DECORATIVES TREE TLIGHTING POLES:

Decorative street lighting pole of the following standard shall be used on work

Design & Construction:

Ornamental cast aluminum pole BCIP- 01 made out of cast aluminum as per requirements of IS: 202- 1993 or equivalent. Casting of all pole sections should be accurately done from permanent mould sand cores of the design submitted to achieve uniformity in all design aspects in internal and external shape of the unit. All sections should be free from defects like blow holes, porosity, hard spots, cracks, hot tears, cold shuts, distortion, sand and slag inclusion and other harmful defects. All the casted sections used in the pole should be free from welding of any kind used to repair it. The casted sections should be machined from all the locations used to insert the pieces into one another using either threading or socket method accuracy of all machined parts should be maintained throughout a lot for random replacements of sections if and when required. All the threaded joints should be mechanically tightened and sealed using industrial tools to make the entire unit vandal resistant

Aesthetic Appearance:

All the groove sand carvings of the pole unit should be free from any kind of distortion for a pleasing aesthetic appearance

Material:

Cast aluminum material used for casting pole unit should be of gradeFG-220type, as described in IS: 202 and should have minimum tensile strength of the order of 200 N/sq. mm.

Pretreatment:

Each and every casted piece should be subject to sand blasting at a pressure of 10-15 Kg f to remove all external dirt and sand remains etc.

Painting & Finishing:

Entire unit should be given an extensive three stage treatment with PU based two pack Zn-Ph primer and paint prescribed for CI surfaces to make it absolutely rust and corrosion proof, as well as giving it a pleasing appearance. PU based paint.

Thickness of the coating:

A minimum of 80 microns of coating thickness should be achieved on the final piece.

Installation:

Pole unit should be grouted using 4nos. anchor bolts of size M-16x450mm confirming to 6.8 Gr. As per IS: 2062. Pole unit should be grouted in a Foundation made out of 1:3:6 cement concrete after excavating the earth with proper cable sleeves etc. laid in the foundation itself.

Manufacturer standard installation drawing shall be follower for installation of poles.

C. OCTAGONAL STREET LIGHTING POLES:

Internal

Octagonal G.I. streetlighting poles of the following specification shall be used for work.

1. The Octagonal Poles shall be designed to withstand the maximum wind speed as per IS 875. The top loading i.e. area and the weight of fixtures are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BS: 5649 Part VI1982.
2. The pole shaft shall have octagonal cross section and shall be continuously tapered with single longitudinal welding. There shall not be any circumferential welding. The welding of pole shaft shall be done by Submerged Arc Welding (SAW) process.
3. All octagonal pole shafts shall be provided with the rigid flange plate of suitable thickness with provision for fixing 4 foundation bolts. This base plate shall be fillet welded to the pole shaft at two locations i.e. from inside and outside. The welding shall be done as per qualified MVAW process approved by third party inspection agency.
4. The octagonal Poles shall have door of approximate 500 mm length at the elevation of 500 mm from the Base plate. The door shall be vandal resistance and shall be weather proof to ensure safety of inside connections. The door shall be flush with the exterior surface and shall have suitable locking arrangement. There shall also be suitable arrangement for the purpose of earthing.
5. The pole shall be adequately strengthened at the location of the door to compensate for the loss In section.
6. Hie welding shall be carried out confirming to approved procedures duly qualified by third party Inspection agency. The welders shall also be qualified for welding the octagonal shafts.
7. The Octagonal Poles shall be in single section (up to 11mtr). There shall not be any circumferential weld joint
8. The poles shall be hot dip galvanized as per IS-2629/IS-2633/IS-4759 standards with average coating thickness of 70 micron. The galvanizing shall be done in single dipping.
9. The Octagonal Poles shall be bolted on a pre-cast foundation with a set of four foundation bolts for greater rigidity.
10. Top Mounting; the galvanized mounting bracket shall be part of supply along with the Octagonal Poles for Installation of the luminaries.
11. Installation of poles shall be carried out as per manufacturer's standards.

D. The Lux level for lighting shall be considered as per IS standards and on the following area requirement.

Public Parking	Public Parking
Internal Roads(10mtrs)	Internal Roads(10mtrs)
Main Approach Roads(12mtrs)	Main Approach Roads(12mtrs)
Piazza Lights	Piazza Lights
Security lights	Security lights

END OF SECTION

18.0 SOLAR PV SYSTEM

a GENERAL

18.1 Work Description

This specification covers the 'General Requirements' for the design, manufacture, supply performance, inspection, testing and commissioning of required rating of KW p as per Girah requirement of star-3.

It is proposed that power for lights, raw power etc. shall be supplied through solar PV. These loads shall get two supplies. One from normal panel and other from solar PV. The total capacity of solar power has been considered at required rating of KW p as per Girah requirement of star-4. The solar panels shall be installed in the terrace area

18.2 System Description (Grid Connected System)

The Photovoltaic (PV)Grid connects system consists is having mainly of 3components: The Mono Crystalline Silicon PV array, Module Mounting Structure and the Power conditioning Unit (PCU). The C-Si module will generate the DC voltage and to increase the voltage to make it suitable for the PCU rating.

The Solar Photovoltaic (PV) modules convert solar radiation from the sun into electrical energy in the form of direct current (DC). The Solar Charge Controller (SCC) part of PCU then maximizes the use of this electrical energy to charge the battery bank and at the same time it prevents over charging of the battery bank.

The PCU is nothing but converting the DC Power into AC power and feeding into the grid. It is design with a high efficiency >98% with IGBT technology, it is delivering the max. Power generated through solar modules in to grid due to its inbuilt feature of MPPT operations. The PCU is having internal self-protection in case of any fault in the grid. Also, the PCU has in built contactors/breakers with fuses for self-protections.

The PCU is having inbuilt microprocessor-based controls before starting it's monitored the grid voltage, frequency of the grid if it is within set value then it senses the array voltage and current then it's start feeding the power in the grid if all parameters are within range. In case of power gets fail the PCU will stop working automatically. During the morning the PCU starts on its own when the power generation start from the solar module and stops automatically when the sunset and array is not generating any power.

Each PCU is having a remote and local data monitoring system with which one can monitor all the parameters and current energy generation & past generation for the given period. Outputs of PCU's are connected to Distribution boards and grid supply will be brought to distribution boards for synchronization with the PCU.

The power generated from the PV Modules will be supplied to the load through solar inverter unit (part of PCU), which converts DC power to pure 440V/230 VAC sine wave power. The inverter unit will power the dedicated loads either from the solar array or battery bank in that order of preference. The inverter is designed for catering the power needs of the load.

18.3 Submission

All technical submissions shall be approved by the EPC contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of consultant for its review and approval.
Such drawings shall show the proposed method of construction of the Solar PV systems

The drawings shall also incorporate a full list of proposed materials. The construction shall not commence until the drawings are approved for consultant.

Pre delivery inspection of materials at manufacturer's works, pre commissioning test at site and preparation of report in formats are included.

Submission of test certificate and testing procedure details prior to pre delivery inspection at works. Providing

procedures detail for pre commissioning of equipment's installed and testing at site.
Preparation of as built drawings for the services rendered by the contractor.
Any other work/activity which is not listed and is necessary for complete ness of electrical system

c. PRODUCTS

18.4 Electrical Features of Crystalline silicon solar photovoltaic module

Modules array consists of high efficiency Solar Modules utilizing crystalline high-power silicon Solar Photovoltaic cells.

- Solar module has laminated using lamination technology using established mono crystalline.
- 250Wp solar module consists of 72crystalline silicon photovoltaic cells.
- Solar Modules has made with High Quality, High Transmission 3.2mmtemperedSolar Glass.
- The efficiency of Solar Photovoltaic module is greater than 13%. It has made of high transmissivity glass front surface giving high encapsulation gain and hot butyl rubber edge sealant for module protection and mechanical support.
- All materials used in manufacturing of module have a proven history of reliable and stable operation in external outdoor applications

Solar module has designed to operate and perform in relative humidity up to 100% with temperatures between-10DegC and+85Deg C and with stand gustupto200km/h from back side of the panel.

- Sturdy New screw type anodized Aluminum frame design using double sided tape for framing.
- Solar Modules have IEC and UL approved, IP65rated junction box assembly using USE cable and UL approved connectors. Three Schottky bypass diodes used for preventing any damage due to shading
- Degradation of power generated will not exceeding 20% of the min. Rated power over the 25-year period. Efficiency of solar PV system is to 90% for above 12 years & 80% for above 25 years.
- The solar modules have suitable encapsulation and sealing arrangements to protect the silicon cells from the environment. The arrangement and the material of encapsulation are compatible with the thermal expansion proper ties of the Silicon cells and the module framing arrangement/material.
- Multilayered Back sheet giving weather-able barrier for modules and high performance in rugged environments around the world, high dielectric performance, superior partial discharge and electrical insulation properties.
- Solar modules have Ted lar/Polyester trilaminate back surface

18.5 SYSTEMC ONFIGURATION

a) PVMODULES

A Photovoltaic module is a packaged interconnected assembly of Photovoltaic cells, which converts sunlight into Electrical Power. The Solar Modules are mono/multi crystalline type, made of High Transmissivity front glass giving high encapsulation gain and silicon rubber edge sealant for module protection, mechanical support and moisture proofing.

b) MOUNTING STRUCTURE

The Solar Module Mounting Structure (MMS) is designed for holding suitable number of modules. Modules will be mounted on Mild Steel, support structures suitable for site conditions, which are tilted according to the Site Locations to maximize annual energy output. Support Structure design and foundation or fixation mounting arrangements shall with stand minimum horizontal wind speed relevant to site conditions.

TECHNICAL SPECIFICATION OF PVMODULE MOUNTING STRUCTURE

Parameters	Specifications
Type	Roof Mounted

Configuration	Designed to suit site requirements
Material	Mild Steel
Tilt angle	Suitable to site
Fasteners	SS304
Design Wind Speed	120ph

c) **PVCCU.CABLES**

Sizes of cables between array interconnections, array to junction boxes, junction boxes to Inverter etc. shall be so selected to keep the voltage drop (power loss) of the entire power plant to the minimum. Cables are flexible and are used with annealed electrolytic grade copper conductors. They are suitable for outdoor and for 1000VDC application

TECHNICAL SPECIFICATION OF PV CABLES

Parameters	Specifications
Type	PVC insulated and sheathed
Material	Copper
Working voltage	Upto1100V
Test voltage	650V/1.1Kv
Color	To suit Red, Black, Blue
Temperature	-15DegCto+70DegC

d) **SOLARON-GRIDINVERTER**

The PCU consists of in-built charge controller and bi-directional inverter to supply continuous power to the dedicated load with support to the load coming either from the solar array, battery bank, Grid Power in order of preference. The Grid-Tie of required rating of KW p as per Griha requirement of star-4 is considered for this project. The sinewave inverter generates a sinusoidal AC voltage with an exceptionally precise voltage and stabilized frequency. The inverter is protected against overload and short circuit.

e) **JUNCTION BOX**

In the Junction boxes, individual module strings are bundled and safely routed to the inverter. It is a combination of an exact, well-organized string monitoring system and a safety concept adapted to the PV technology.

These junction boxes are weather proof outdoor suitable and areIP65 rated, making it ideal for long-term use in PV systems. In addition, the direct connection between the string sand the spring clamp connectors ensures a durable and safe installation.

f) **EARTHING PROTECTION**

Earthing: The array structure of the PV yard will be grounded properly using adequate number of earthing kits. All metal casing / shielding of the plant shall be thoroughly grounded to ensure safety of the power plant.

Lightning: The SPV Power Plant shall be provided with lightning & over voltage protection. The main aim in this protection shall be to reduce the over voltage to a tolerable value before it reaches the PV or other subsystem components. The source of over voltage can be lightning, atmosphere disturbances etc. Metal

Oxide visitors shall be provided inside the Array Junction Boxes. In addition, suitable MOVs also shall be provided in the Inverter to protect the inverter from over voltage.

END OF SECTION^{Internal}

19.0 Energy Meter

1. OBJECTIVE &SCOPE

This specification shall cover design, engineering, manufacture, assembly, inspection, testing at manufacturers works before dispatch, supply and delivery at destination anywhere in "state", Class 1.0accuracyclassstatic3 phase–4 wire tri-vector energy meter. The meter shall be suitable for measurement of energy and power, demand requirement in an AC balanced/unbalanced system over a power factor range of zero lag to unity. These meters should have communication port to interface for remote meter reading.

2. SERVICE CONDITION

The meter shall be suitable for satisfactory continuous operation under the following tropical conditions: -

Maximum ambient temperature	:	50°C
Maximum ambient temperature in shade	:	45°C
Relative Humidity	:	10to95%
Maximum wind pressure	:	150Kg/m. sq.
Maximum altitude above mean seal level	:	1000meter s
Isoceraunic level	:	50 days/year
Seismic level (Horizontal acceleration)	:	0.3g
Moderately hot and humid tropical climate		

3. APPLICABLE STANDARDS

The whole current energy meter shall be of accuracy Class1.0 and conform to relevant clauses of following standards or report: -

1 .	IS13779	AC Static Transformer Operated Watt-hour and VAR-Hour Meters, class 1.0.
2 .	CBITechnicalreportno.111	Specification for common Meter Reading Instrument
3 .	IS:9000	Basic Environmental Testing Procedures for Electronic & Electrical Items.
4 .	ETD13(6211)	DLMS Indian Companion Standard– ^{internal} Category ‘C’ for consumer metering

Unless otherwise specified elsewhere in this specification the static meters shall conform to the latest version available of the standard as specified above.

4. GENERAL TECHNICAL REQUIREMENT

- 4.1 Application : 3 phase 4 wire
- 4.2 Rated Secondary Voltage : 240 volts (Phase to Neutral)
- 4.3 Current Rating : 05-30A, 10-60A, 20-100A
- 4.4 Rated Frequency : 50Hz.
- 4.5 Accuracy class : 1.0
- 4.6 Power Factor : Unity to Zero (all power factor lag/or lead)
- 4.7 The meter shall start and continue to register on application of 0.2% of basic current at Unity P.F., as per relevant standards and shall work satisfactorily with the following supply system variation:
Voltage: $V_{ref} \pm 30\%$ to -30%
Frequency: $50\text{Hz} \pm 5\%$
- 4.8 Temperature: The standard reference temperature for performance shall be 27°C . The mean temperature coefficient shall not exceed 0.03%.
- 4.9 The reactive accuracy class of the meter shall be same as the active accuracy class
- 4.10 The meter shall be able to continuously with stand phase to phase voltage of 500V

5. INFLUENCE QUANTITIES:

The meter should be designed and protected such that all external effects and influences shall not change its performance & shall work satisfactorily within guaranteed accuracy limits, as specified in IS 13779, under the presence of influence quantities.

6. CONSTRUCTION

The case, winding, voltage circuit, sealing arrangements, registers, terminal block, terminal cover & name plate etc., shall be in accordance with the relevant standards. The meter should be compact & reliable in design, easy to transport & immune to vibration & shock involved in the transportation & handling. The construction of the meter should ensure consistence performance under all conditions especially during storms/heavy rains/very hot weathers. The insulating materials used in the meter should be non-hygroscopic, non-ageing & have tested quality. The meter should be sealed in such a way that the internal parts of the meter become inaccessible.

The meter should employ latest technology such as Application Specific Integrated Circuit (ASIC) to ensure reliable performance. The mounting of the components on the PCB should be Surface Mounted Technology (SMT) type except some power supply related component. The electronic components used in the meter should be of high quality.

6.1 GENERAL MECHANICAL REQUIREMENTS

The construction of the meter shall be rigid & suitable to withstand shock & vibration involved in transportation & handling, as specified in IS 13779. Meter shall be designed and constructed in such a way as to avoid introducing any danger in normal use and under normal conditions, so as to ensure especially personal safety against electric shock, safety against effect of excessive temperature, protection against spread of fire, protection against penetration of solid objects, dust and water. The design of meter shall conform to IP51 class degree of protection against dust and moisture as per relevant standards.

Internal

6.2 TROPICAL TREATMENT

All parts, which are subject to corrosion under normal working conditions, shall be protected effectively. Any protective coating shall not be liable to damage by ordinary handling or damage due to exposure to air, under normal working conditions. Meters shall withstand solar radiation. The meters shall be suitably designed and treated for normal life & satisfactory operation under the hot and hazardous tropical climatic conditions as specified in clause no. 2. The meter shall work from -10°C to +55°C and RH 95% non-condensing type.

6.3 METER CASE

The housing of the meter shall be safe high-grade Engineering plastic or any other high quality insulating material and shall be very compact in design. All the insulation materials used in the construction of meter shall be non-hygroscopic, non-ageing & of tested quality, capable of withstanding resistant to heat & fire. The construction of the meter offered shall be such that it can be sealed independently and the cover cannot be removed with the use of a tool, without breaking the seal. The case of offered meters shall be so constructed that any non-permanent deformation shall not prevent the satisfactory operation of the meter. The meter shall have a transparent cover and opaque base with seamless ultrasonic welding.

6.4 TERMINALS-TERMINAL BLOCK

The base of the meter shall have a terminal block at the bottom made out of high-grade engineering plastic so as to facilitate bottom connection and having capability to carry maximum value of current.

The material of the terminal block shall be capable of passing the tests given in IS13779.

The terminal holes in the insulating material shall be of sufficient size to accommodate the insulation of the conductors. The diameter of the terminal hole for current terminals shall not be less than 9 mm & shall be of adequate length in order to have proper grip of conductors / crimping pins with the help of two screws.

The terminal block shall satisfy all the conditions such as clearance & creepage distance between terminals & surrounding part of the meter as specified in relevant clause of IS 13779. The material of terminal and connection screws should be brass.

The manner of fixing the conductors to the terminals shall ensure adequate and durable contact such that there shall have no risk of loosening or undue heating. Screw connections transmitting contact force and screw fixing which may be loosened and tightened several times during the life of the meter shall be such that the risk of corrosion resulting from contact with any other metal part is minimised. Electrical connections shall be so designed that contact pressure shall not be transmitted through insulating material.

6.5 TERMINAL BLOCK COVER

The terminals block cover for the energy meters shall be extended transparent type, which can be sealed independently of the meter cover. The ETBC shall have a clear space of 45 ± 5 mm, thus allowing sufficient clearance space for inserting cables. ETBC shall have a top side hinge arrangement for easy access of terminal for wire termination. The terminals, their fixing screws and the insulated compartment^(terminal) housing them shall be enclosed by extended terminal cover in such a way that no part of meter or accessories at terminal block shall be accessible from the front of the

meter. There shall be provision of fixing of seals so that screws cannot be loosened without breaking the seals.

The terminals shall not be accessible without removing the seal(s) of terminal cover when energy meter is mounted on the meter board.

6.6 WINDOW

The energy meter cover shall be made of high-grade engineering plastic with a clear window. The window shall be of transparent material shall be such that it cannot be removed undamaged without breaking the meter cover seals.

6.7 QUALITY

Over all the quality of the meter should be good and the service life of the meter shall be more than the guarantee period. The material, components used for manufacturing the meter shall be of premium quality. The LCD display shall not fade with time and the display annunciators should be visible. Functionality of the meter shall not be affected by the harsh environmental conditions. Quality meters shall be given preference and the performance of previous installed meters shall be analysed before awarding the tender. Aesthetically, the meter shall be of premium quality.

7. COMMUNICATION PORT

a) LOCAL COMMUNICATION PORT

The energy meter shall have a galvanically isolated IEC 1107 optical communication port located in front of the meter for data transfer to or from a hand-held Data Collection Device. The sealing provision should be available for optical port.

b) REMOTE COMMUNICATION PORT

Meter shall have an additional communication port (RS 232) in the form of RJ11 port to interface external modem for remote data collection. RS 232 (RJ11) port shall be located under the terminal cover.

Both the ports will support communication on DLMS and should be accessible through a DLMS compliant HHU.

8. DATA DOWNLOADING CAPABILITY

Meter shall support a minimum baud rate of 9600 on optical port as well as RS 232 remote communication port. It shall be possible to read selective data set from the meter from the meter. as specified in ETD 13(6211).

9. DISPLAY OF MEASURED VALUE:

The measured value(s) shall be displayed on seven segments^{9a)} seven digit Liquid Crystal Display (LCD) display unit/register, having minimum character height of 10 mm.

The data should be stored in non-volatile memory. The non-volatile memory should retain data for a period of not less than 10 years under unpowered condition. Battery back-up memory will not be considered as NVM.

It should be possible to easily identify the single or multiple displayed parameters through symbols/legend on the meter display itself or through display annunciators.

The register shall be able to record and display starting from zero, for a minimum of 1500 hours, the energy corresponding to rated maximum current at reference voltage and unity power factor. The register should not roll over in between this duration.

The principle unit for the measured values shall be kWh for active energy, kVA r h for reactive energy & k VA h for apparent energy. Bidder shall mention the scale in which the meter displays the energy values.

Required display list will be given at the time of order. How ever it will be in line with companion standard such as:

- Real Time
- Date
- Line currents
- Phase to Neutral Voltages
- Phase wise Power Factor
- Frequency
- Active, Reactive and Apparent Power
- Cumulative tam per count
- Cumulative M Dre set Count
- Cumulative active for warded energy
- Cumulative re active lag forwarded energy
- Cumulative re active lead forwarded energy
- Cumulative apparent forwarded energy
- Universal active maximum demand with date and time
- Universal apparent maximum demand with date and time
- Present PT status
- Present CT status
- Other status
- Last occurred and restored tamper with date and time
- High resolution active for warded energy (up to 4 decimal point)
- High resolutioner active lag forwarded energy(upto4decimalpoint)
- High resolution re active lead forwarded energy(upto4decimalpoint)
- High resolution app aren't forwarded energy (up to 4 decimal point)

Above listed displays shall be configurable in three different pages in push mode for easy access in mains on condition. First page should contain the instantaneous parameters, second page, for energy and demand values, and third page for tamper related displays.

The meter should have visual quadrant representation on the LCD for energy measurement. Relevant quadrant in which metering is taking place should be in on state for ease of understanding.

Parameter value with relevant OBIS code should also be simultaneously available along with the respective values on the display.

10. ELECTROMAGNETIC COMPATIBILITY

The static energy meters shall conform to requirements listed in relevant standards and shall also be protected against radiated interference from either magnetic or radio-frequency source.

10.1 IMMUNITY TO ELECTROMAGNETIC DISTURBANCE

The meter shall be designed in such a way that conducted or radiated electromagnetic disturbance as well as electrostatic discharge do not damage or substantially influence the meter and meter shall work satisfactorily under these conditions as per relevant standards

NOTE: the disturbances to be considered are: -

- (a) Harmonics
- (b) Voltage dip and short interruptions
- (c) Conducted transients
- (d) D.C. and A.C. magnetic fields
- (e) Electromagnetic fields
- (f) Electrostatic discharges

10.2 RADIOINTER FERENCE SUPPRESSIONS

The meter shall not generate noise, which could interfere with other equipment, and meter shall work satisfactorily as per relevant standards

10.3 INFLUENCE OF HIGH MAGNETICFIELD

The meters shall be provided appropriate magnetic shielding so that any external magnetic field (AC/DC electromagnet) as per IS 13779 applied on meter would not affect the proper functioning of the meter and meter shall work satisfactorily as per relevant standards.

11. STARTING CURRENT

The meter shall start and continue to register at the current0.2% of Ib.

12. RUNNING WITH NO LOAD

When the 115% of rated voltage is applied with no current flowing in the current circuit, the meters shall not register any energy and test output of the meter shall not be more than one pulse/count on "no load".

13. POWER CONSUMPTION

- 13.1 The active and apparent power consumption in each voltage circuit at reference voltage; temperature and frequency shall not exceed 1.0 W and 4 VA per phase respectively.

Internal

13.2 The apparent power consumption in each current circuit at basic current, reference frequency and reference temperature shall not exceed 1.0 VA per phase.

14. CALIBRATION & TEST OUT PUT

All the meters shall be tested, calibrated and sealed at works before des patch. Further, no modification of calibration shall be possible at site by any means.

However, it shall be possible to check the accuracy of energy measurement of the meter in the field by means of LED output on meter. Meter should have two calibration LEDs for accuracy measurement for different energies. Out of these, one should be kept fixed on kWh and other one shall be configurable for rest two (kVA r h, kVA h). Resolution of the test output shall be sufficient to enable the starting current test in less than 10 minutes.

15. CONNECTION DIAGRAM

The connection diagram of the meter shall be clearly shown for 3 phase 4 wire system, on the terminal cover. The meter terminals shall also be marked and this marking should appear in the above diagram.

16. QUANTITIES TO BEME ASURED:

The meter shall be able to provide the following data in line with Category 'C'typeasperETD13(6211).

- a) Instantaneous Parameters
- b) Block Profile/Load Survey data for 30minute capture time block.
- c) Parameters for billing.
- d) Abstract quantities
 - Name Plate Details
 - Programmable parameters
- e) Event Conditions.

The meter shall be able to measure and provide the parameters listed in the guideline document. The OBIS code for each parameter shall be as identified in Indian companion standard.

17. ABNORMAL EVENTS:

The meter should have features to detect the occurrence and restoration of, at least, the following common abnormal events:

- a) **Missing Potential:** The meter shall be capable of detecting and recording occurrence and restoration with date and time the cases of Potential failure (one phase or two phases). All potential missing cases shall be considered as power failure.
- b) **Current imbalance:** The meter shall be capable of detecting and recording occurrence and restoration with date and

Internal

time of Current unbalance (for more than a defined persistence time).

- c) **Current Reversal:** The meter shall be capable of detecting and recording occurrence and restoration with date and time if the current is flowing in reverse direction in one or more phases. The meter shall continue to record in forwarded direction even in case of CT reversal.
- d) **Power on/off:** The meter shall be capable to record power on/off events in the meter memory. All potential failure should record as power off event.
- e) **Magnetic Influence** - The Meter shall be capable of detecting and recording of presence of abnormal magnetic influence near the meter, if the magnetic influence affects the meter functionality. The meter should record at I_{max} on account of magnetic influence. Separate legend for magnet event shall be made available on LCD. This legend shall remain in on state till meter reading so that it will come in to notice of meter reader.
- f) **Voltage unbalance**–Meter shall detect voltage unbalance if the reis unbalance in voltages.
- g) **Over Current** – When load condition at any phase i.e. Line current at any phase goes more than defined limit, this will be detected as Over current condition.
- h) **CT Open** – The meter should detect phase wise current circuit open when the circuit is opened from meter side.
- i) **CT Bypass**–The condition should be detected whenever the current terminal is bypassed in the meter
- j) **Neutral Disturbance** – The meter should detect neutral disturbance if any spurious signal is applied at the meter's neutral.
- k) **High and Low Voltage:** The meter should detect under and over voltage events respectively if voltage falls /Rise from defined limits.
- l) **Cover Open:** The meter shall be able to detect cover open occurrence event if cover is opened in mains on or off condition. Separate legend for cover open event shall be made available on LCD. This legend shall remain in on state till meter reading so that it will come in to notice of meter reader
- m) In absence of one phase and neutral, meter should record the event with date and time and maintain the accuracy with in $\pm 3\%$.

A separate register is additionally required for defraud energy registration.

The above shall be selectable and will be in line with ETD 13 (6211): Data Exchange for Electricity Meter Reading, Tariff and Load Control – Companion Specification

The meter shall keep records for the minimum last 300 events (occurrence + restoration) for above abnormal conditions. Each event shall be logged with date and time of occurrence/restoration with snaps hot of voltage, current power factor and active energy (except cover open, power on-off). It shall be possible to retrieve the abnormal event data locally using a hand-held unit (HHU) through the meter's optical port & same can be viewed / analysed at base computer end in simple and easily understandable format.

Internal

18. ABNORMAL VOLTAGE/FREQUENCY DEVICE TEST:

The accuracy of the meter would not be affected with the application of abnormal voltage/ frequency generating device having spark discharge of approximately 35KV. The meter will be tested by feeding the output of this device to meter in any of the following manner for 10 minutes:

- i) On any of the phase or neutral terminals.
- ii) On any connecting wires of the meter.
- iii) Voltage discharge with 0-10mm spark gap.
- iv) Spark on meter body.
- v) At any place in load circuit.

The accuracy of the meter will be checked before and after the application of above device.

19. BILLINGHISTORY&LOAD SURVEY: -

The meter shall have sufficient non-volatile memory for recording history of energy parameters for minimum last twelve billing cycles (Bill date shall be 00 hrs. of the 1st date of the calendar month by default– programmable)

Following parameters shall be made available for last 60 days with integration period of 30min:

- Active forwarded energy
- Re active lag energy
- Reactive lead energy
- Apparent for warded energy
- Phase wise voltage
- Phase wise current
- Avg power factor

These load survey and history data can be retrieved with the help of Meter Reading Instrument on local interrogation or remotely using the remote communication interface.

20. Daily Energy snaps hot

The meter shall record the daily mid night energy snap for 60 days for active forwarded energy (kWh) and apparent forwarded energy.

21. MD REGISTRATION

The meter shall continuously monitor and calculate maximum demand for each interval of time, which may be programmable as a block of 30 minutes. At the end of every demand integration period the new calculated MD shall be compared with the previous MD and meter shall store whichever value is higher.

22. MD RESET

The meter shall have any of the following MD resetting options: -

- (a) Automatic reset at the end of a certain predefined period (say, end of the month)
- (b) Manual re setting arrangement (MD reset button) with sealing facility.
- (c) MD re set through authenticated transaction

23. SELF DIAGNOSTIC FEATURE

The meter shall be capable of performing complete self-diagnostic check to monitor the circuits for any malfunctioning to ensure integrity of data memory location at all time. The meter shall have indication for unsatisfactory/non-functioning/malfunctioning of the following:

- a) Time and date on meter display
- a) All display segments on meter display

Internal

b) Self-diagnostic (RTC, NVM information) on display

24. OTHER SALIENT FEATURES OF METERS

- a) It should be possible to check the healthiness of phase voltages by phase indicator available on meter display.
- b) The meter shall have provision of reading in the absence of power through an internal battery. It shall be possible to access the display in power off condition. It shall also be possible to do meter data download through MRI under power off condition.
- c) The meter should work accurately irrespective of phase sequence of the supply.

25. TEST AND TEST CONDITIONS

- Acceptance test: All acceptance tests as per relevant standards shall be carried out in the presence of utility representatives.
- Routine Test: All the routine tests as per –IS 13779 shall be carried out and routine tests certificates shall be submitted for approval of purchaser.

ARTICULARS FOR 3 PHASE 4 WIRE WHOLE CURRENTT RIVECTOR ENERGY METER

S . N o.	Item	Bidder's data
1.	Type	
2.	Application	
3.	Rated Voltage	
4.	Rated Current	
5.	Frequency	
6.	Minimum starting current in % of base current	
7.	Power loss in potential circuit	
8.	Power loss in current circuit	
9.	Change inerrordue to	
	i. Variation in frequency	
	ii. Variation in voltage	
10.	Accuracy Class Internal	

1 1.	Total Weight of meter	
1 2.	Details of case	
1 3.	Standard to which the meter confirms	
1 4.	Type of Energy Registration Mechanism.	
1 5.	MD Reset Mechanism	
1 6.	MD reset button with sealing provision	
1 7.	Two LED s for accuracy measurement	
	Working range	
1 8.	Voltage	
1 9.	Current	
2 0.	Displaydetails	
	i. Display Cycle (page mode display)	
	ii. Period of display of each parameter	
	Display scroll-lock facility	
	Back lit LCD	
	v. Relevant OB IS codes for parameter	
	Legend for Cover open detection	
	Legend for Magnet event	
2 1.	Power on in absence of mains	
	i. Internal/External Battery	
	ii. Display access	
	Reading (Data downloading)	
2 2.	Total Events (300nos)	
2 3.	Load Survey	
2 4.	Parameter Logged	
2 5.	Logging interval	
2 6.	No. of days of Load Survey	
2 7.	Daily Energy Snap Parameters No. of Days	
2 8.	Time of the day Zone	
2 9.	Capability for fraud Prevention & detection Internal	
3	Sealing and Locking Arrangement	

0.		
3 1.	Type of communication Local-OpticalportIEC1107 RS 232 port for remote comms	
3 2.	Event Logging Current Related events: CT reversal (phase wise) Current I m balance Over Current CT open (phase wise) CT Bypass	
	Voltage related events PT missing (phase wise) Voltage unbalance High and low voltage Others: Magnet Neutral Disturbance Low Power factor Non-Rollover events Front Cover open Power on-off events	

- TECHNICAL SPECIFICATION FOR STATIC 3 PHASE 4 WIRE CT OPERATED STATIC TRIVECTOR ENERGY METER

26.OBJECTIVE & SCOPE

This specification shall cover design, engineering, manufacture, assembly, inspection, testing at manufacturers works before dispatch, supply and delivery at destination anywhere in "state", Class 0.5s accuracy class static 3 phase–4 wire CT operated three-vector energy meter. The meter shall be suitable for measurement of energy and power, demand requirement in an AC balanced/unbalanced system over a power factor range of zero lag to unity. These meters should have communication port to interface for remote meter reading.

27. SERVICE CONDITION

Internal

The meter shall be suitable for satisfactory continuous operation under the following tropical conditions: -

- a) Maximum ambient temperature :50°C
- b) Maximum ambient temperature in shade :45°C
- c) Relative Humidity : 10to95%
- d) Maximum annual rainfall : 1450mm'
- e) Maximum wind pressure :150Kg/m. sq.
- f) Maximum altitude above mean seal level :1000 meters
- g) Isoceraunic level :50days/year
- h) Seismic level (Horizontal acceleration) :0.3g
- i) Moderately hot and humid tropical climate

28. APPLICABLE STANDARDS

The CT operated energy meter shall be of accuracy Class 0.5 for active/ reactive / apparent energy and conform to relevant clauses of following standards or report: -

IS14697: 1999	Specification for A.C Static Transformer operated Watt Hour & VAR – Hour meters, class 0.5s
CBIP Technical Report No. 304	Specification for A.C. Static Electrical Energy Meters.
IS15959(Companion specification)	DLMS Indian Companion Standard– Category 'C' for consumer metering

Unless otherwise specified elsewhere in this specification the static meters shall conform to the latest version available of the standard as specified above.

29. GENERAL TECHNICAL REQUIREMENT

- 4.11 Application : 3phase3wire
- 4.12 Rated Secondary Voltage : 240 volts (Phase to neutral)
- 4.13 Rated secondary Current (I Basic) :5 Amps
- 4.14 Rated Frequency : 50Hz.
- Accuracy class : 0.5s (the meter should meet the same class of accuracy for reactive energy also)
- Internal
- 4.16 Power Factor : Unity to Zero (all power factor lag/or

lead)

- 4.17** The meter shall start and continue to register on application of 0.1% of basic current at Unity P.F., as per relevant standards and shall work satisfactorily up to maximum continuous current of 2 times rated basic current with the following supply system variation:
Voltage: $V_{ref} \pm 30\%$ Frequency: $50\text{Hz} \pm 5\%$

- 4.18** Temperature: The standard reference temperature for performance shall be 27°C . The mean temperature coefficient shall not exceed 0.03%.

- 4.19** The reactive accuracy class of the meter shall be same as the active accuracy class

- 4.20** The meter shall be able to continuously with stand phase to phase voltage of 500V

30. INFLUENCE QUANTITIES: The meter should be designed and protected such that all external effects and influences shall not change its performance & shall work satisfactorily within guaranteed accuracy limits, as specified in IS 14697: 1999 / CBIP technical report – 304, under the presence of influence quantities.

31. CONSTRUCTION

The case, winding, voltage circuit, sealing arrangements, registers, terminal block, terminal cover & name plate etc., shall be in accordance with the relevant standards. The meter should be compact & reliable in design, easy to transport & immune to vibration & shock involved in the transportation & handling. The construction of the meter should ensure consistence performance under all conditions especially during storms/heavy rains/very hot weathers. The insulating materials used in the meter should be non-hygroscopic, non-ageing & have tested quality. The meter should be sealed in such a way that the internal parts of the meter become inaccessible.

The meter should employ latest technology such as Application Specific Integrated Circuit (ASIC) to ensure reliable performance. The mounting of the components on the PCB should be Surface Mounted Technology (SMT) type except some power supply related component. The electronic components used in the meter should be of high quality.

6.8 GENERAL MECHANICAL REQUIREMENTS

The construction of the meter shall be rigid & suitable to withstand shock & vibration involved in transportation & handling, as specified in IS 14697. Meter shall be designed and constructed in such a way as to avoid introducing any danger in normal use and under normal conditions, so as to ensure especially personal safety against electric shock, safety against effect of excessive temperature, protection against spread of fire, protection against penetration of solid objects, dust and water. The design of meter shall conform to IP51 class degree of protection against dust and moisture as per relevant standards.

6.9 TROPICAL TREATMENT

Internal

All parts, which are subject to corrosion under normal working conditions, shall be protected effectively. Any protective coating shall not be liable to damage by ordinary handling or damage due to exposure to air, under normal working conditions. Meters shall withstand solar radiation. The meters shall be suitably designed and treated for normal life & satisfactory operation under the hot and hazardous tropical climatic conditions as specified in clause no. 2. The meter shall work from - 10°C to +55°C and RH 95% non-condensing type.

6.10 METER CASE

The housing of the meter shall be safe high-grade Engineering plastic or any other high quality insulating material and shall be very compact in design. All the insulation materials used in the construction of meter shall be non-hygroscopic, non-ageing & of tested quality, capable of withstanding resistant to heat & fire. The construction of the meter offered shall be such that it can be sealed independently and the cover cannot be removed with the use of a tool, without breaking the seal. The case of offered meters shall be so constructed that any non-permanent deformation shall

not prevent the satisfactory operation of the meter. The meter shall have a transparent cover and opaque base with seamless ultrasonic welding.

6.11 TERMINALS-TERMINAL BLOCK

The base of the meter shall have a terminal block at the bottom made out of high-grade engineering plastic so as to facilitate bottom connection and houses solid nickel-plated brass terminals having capability to carry maximum value of current.

The material of the terminal block shall be capable of passing the tests given in IS14697:1999.

The terminal holes in the insulating material shall be of sufficient size to accommodate the insulation of the conductors. The diameter of the terminal hole for current terminals shall not be less than 5.0 mm & shall be of adequate length in order to have proper grip of conductors / crimping pins with the help of two screws.

The terminal block shall satisfy all the conditions such as clearance & creepage distance between terminals & surrounding part of the meter as specified in relevant clause of IS 14697: 1999.

The manner of fixing the conductors to the terminals shall ensure adequate and durable contact such that there shall have no risk of loosening or undue heating. Screw connections transmitting contact force and screw fixing which may be loosened and tightened several times during the life of the meter shall be such that the risk of corrosion resulting from contact with any other metal part is minimised. Electrical connections shall be so designed that contact pressure shall not be transmitted through insulating material.

6.12 TERMINAL BLOCK COVER

Internal

The terminals block cover for the energy meters shall be extended transparent type, which can be sealed independently of the meter cover. The ETBC shall have a clear space of min 40±5mm, thus allowing sufficient clearance space for inserting cables. ETBC shall have a top side hinge arrangement for easy access of terminal for wire termination. The terminals, their fixing screws and the insulated compartment housing them shall be closed by extended terminal cover in such a way that no part of meter or accessories at terminal block shall be accessible from the front of the meter. There shall be provision of fixing of seals so that screws cannot be loosened without breaking the seals.

The terminals shall not be accessible without removing the seal(s) of terminal cover when energy meter is mounted on the meter board.

6.13 WINDOW

The energy meter cover shall be made of high-grade engineering plastic with one window. The window shall be of transparent material ultrasonically welded with the meter cover such that it cannot be removed undamaged without breaking the meter cover seals.

6.14 QUALITY

Over all the quality of the meter should be good and the service life of the meter shall be more than the guarantee period. The material, components used for manufacturing the meter shall be of premium quality. The LCD display shall not fade with time and the display annunciators should be visible. Functionality of the meter shall not be affected by the harsh environmental conditions. Quality meters shall be given preference and the performance of previous installed meters shall be analysed before awarding the tender. Aesthetically, the meter shall be of premium quality.

32.COMMUNICATION PORT

a) LOCALCOMMUNICATIONPORT

The energy meter shall have a galvanically isolated IEC 1107 optical communication port located in front of the meter for data transfer to or from a hand-held Data Collection Device. The sealing provision should be available for optical port.

b) REMOTE COMMUNICATION PORT

Meter shall have an additional communication port (RS 232) in the form of RJ11 port to interface external modem for remote data collection. RS 232 (RJ11) port shall be located under the terminal cover.

Both the ports will support communication on DLMS and should be accessible through a DLMS compliant HHU

33.DATA DOWNLOADING CAPABILITY Internal

Meter shall support a minimum baud rate of 9600 on optical port as well as RS 232 remote communication port. It shall be possible to read selective data from the meter as specified in the companion standard.

34.DISPLAY OF MEASURED VALUE:

The measured value(s) shall be displayed on seven segments, seven-digit Liquid Crystal Display (LCD) display unit/register, having minimum character height of 10 mm.

The data should be stored in non-volatile memory. The non-volatile memory should retain data for a period of not less than 10 years under unpowered condition. Battery back-up memory will not be considered as NVM.

It should be possible to easily identify the single or multiple displayed parameters through symbols/legend on the meter display itself or through display annunciators.

Meter shall have Scroll Lock facility to display any one desired parameter continuously from display parameters.

The register shall be able to record and display starting from zero, for a minimum of 1500 hours, the energy corresponding to rated maximum current at reference voltage and unity power factor. The register should not roll over in between this duration.

The principle unit for the measured values shall be Wh/kWh/MWh for active energy, VARh/kVARh/MVARh for reactive energy & VAh/kVAh/MVAh for apparent energy based on secondary current. Bidder shall mention the scale in which the meter displays the energy values.

Required display list will be given at the time of order. However it will be in line with companion standard such as:

- Real Time
- Date
- Line currents
- Phase to Neutral Voltages
- Phase wise Power Factor
- Frequency
- Active, Reactive and Apparent Power
- Cumulative tam per count
- Cumulative MD reset Count
- Cumulative active forwarded energy
- Cumulative reactive lag forwarded energy
- Cumulative reactive lead forwarded energy
- Cumulative apparent forwarded energy
- Universal active maximum demand with date and time
- Universal apparent maximum demand with date and time
- Present PT status
- Present CT status
- Other status
- Last occurred and restored tamper with date and time
- High resolution active forwarded energy (upto 4 decimal point)
- High resolution reactive lag forwarded energy (upto 4 decimal point)
- High resolution reactive lead forwarded energy (upto 4 decimal point)
- High resolution apparent forwarded energy (upto 4 decimal point)

Above listed displays shall be configurable in three different pages in push mode for easy access in mains on condition. First page should contain the instantaneous parameters, second page, for energy and demand values, and third page for tamper related displays.

The meter should have visual quadrant representation on the LCD for energy measurement. Relevant quadrant in which metering is taking place should be in on state for ease of understanding.

Parameter value with relevant OBIS code should also be simultaneously available along with the respective values on the display.

35.ELECTRO MAGNETIC COMPATIBILITY

The static energy meters shall conform to requirements listed in relevant standards and shall also be protected against radiated interference from either magnetic or radio-frequency source.

9.1 IMMUNITY TO ELECTROMAGNETIC DISTURBANCE

The meter shall be designed in such a way that conducted or radiated electromagnetic disturbance as well as electrostatic discharge do not damage or substantially influence the meter and meter shall work satisfactorily under these conditions as per relevant standards

NOTE: the disturbances to be considered are: -

- (g) Harmonics
- (h) Voltage dip sand short interruptions
- (i) Conducted transients
- (j) D.C. and A.C. magnetic fields
- (k) Electromagnetic fields
- (l) Electro static discharges

9.2 RADIO INTER FERENCE SUPPRESSIONS

The meter shall not generate noise, which could interfere with other equipment, and meter shall work satisfactorily as per relevant standards

9.3 INFLUENCE OF HIGH MAGNETIC FIELD

The meters shall be provided appropriate magnetic shielding so that any external magnetic field (AC/DC electromagnet) as per CBIP Technical Report no. 304 applied on meter would not affect the proper functioning of the meter and meter shall work satisfactorily as per relevant standards.

36.STARTING CURRENT

The meter shall start and continue to register at the current 0.1% of Ib.

37.RUNNING WITHNO LOAD

When the 115% of rated voltage is applied with no current flowing in the current circuit, the meters shall not register any energy and test output of the meter shall not be more than one pulse/count on "no load".

38.POWER CONSUMPTION

- 13.1 The active and apparent power consumption in each voltage circuit of the CT Operated meters at reference voltage; temperature and frequency shall not exceed 1.0 W and 4 VA per phase respectively.
- 13.2 The apparent power consumption in each current circuit for the CT Operated meters at basic current, reference frequency and reference temperature shall not exceed 1.0 VA per phase.

39.CALIBRATION & TEST OUT PUT

All the meters shall be tested, calibrated and sealed at works before des patch. Further, no modification of calibration shall be possible at site by any means.

However, it shall be possible to check the accuracy of energy measurement of the meter in the field by means of LED output on meter. Meter should have two calibration LEDs for accuracy measurement for different energies. Out of these, one should be kept fixed on kWh and other one shall be configurable for rest two (kVArh, kVAh). Resolution of the test output shall be sufficient to enable the starting current test in less than 10 minutes

40.CONNECTION DIAGRAM

The connection diagram of the meter shall be clearly shown for 3 phase 4 wire system, on the terminal cover. The meter terminals shall also be marked and this marking should appear in the above diagram.

41.QUANTITIES TO BE MEASURED:

The meter shall be able to provide the following data in line with Category ‘C’ type as per IS 15959 -Indian Companion Specification.

- f) Instant aneous Parameters
- g) Block Profile/Load Survey data
- h) Parameters for billing.
- i) Abstract quantities
 - Name Plate Details
 - Programmable parameters
- j) Event Conditions.
- k) Billing profile parameters.
- l) Time of day registers.

The meter shall be able to measure and provide the parameters listed in the guideline document. The OB IS code for each parameter shall be as identified as per DLMS/COSEM proto colin line with Indian companion standard.

42.AB NORMALITY EVENTS DETECTION:

The meter should have features to detect the occurrence and restoration of, at least, the following common abnormal events:

Internal

- n) **Missing Potential:** The meter shall be capable of detecting and recording occurrence and restoration with

date and time the cases of Potential failure (one phase or two phases). All potential missing cases shall be considered as power failure.

- o) **Current imbalance:** The meter shall be capable of detecting and recording occurrence and restoration with date and time of Current unbalance (for more than a defined persistence time).
- p) **Current Reversal:** The meter shall be capable of detecting and recording occurrence and restoration with date and time if the current is flowing in reverse direction in one or more phases. The meter shall continue to record in forwarded direction even in case of CT reversal.
- q) **Power on/off:** The meter shall be capable to record power on /off events in the meter memory. All potential failure should record as power off event.
- r) **Magnetic Influence** - The Meter shall be capable of detecting and recording of presence of abnormal magnetic influence near the meter, if the magnetic influence affects the meter functionality. The meter should record at I_{max} on account of magnetic influence. Separate legend for magnet event shall be made available on LCD. This legend shall remain in on state till meter reading so that it will come in to notice of meter reader.
- s) **Voltage unbalance**—Meter shall detect voltage unbalance if the reis un balance in voltages.
- t) **Over Current** – When load condition at any phase i.e. Line current at any phase goes more than defined limit, this will be detected as Over current condition.
- u) **Neutral Disturbance** – The meter should detect neutral disturbance if any spurious signal is applied at the meter's neutral.
- v) **High and Low Voltage:** The meter should detect under and over voltage events respectively if voltage falls / rise from defined limits.
- w) **Cover Open:** The meter shall be able to detect cover open occurrence event if cover is opened in mains on or off condition. Separate legend for cover open event shall be made available on LCD. This legend shall remain in on state till meter reading so that it will come in to notice of meter reader

The above shall be selectable and will be in line with IS 15959: Data Exchange for Electricity Meter Reading, Tariff and Load Control – Companion Specification

The meter shall keep records for the minimum last 300 events (occurrence + restoration) for above abnormal conditions. Each event shall be logged with date and time of occurrence/restoration with snapshot of voltage, current power factor and active energy (except cover open, power on-off). It shall be possible to retrieve the abnormal event data locally using a hand-held unit (HHU) through the meter's optical port & same can be viewed / analysed at base computer end in simple and easily understandable format.

43.AB NORMAL VOLTAGE/FREQUENCY DEVICE TEST:

The accuracy of the meter would not be affected with the application of abnormal voltage/ frequency generating device having spark discharge of approximately 35KV.The meter will be tested by feeding the output of this device to meter in any of the following manner for 10 minutes:

- vi) On any of the phase or neutral terminals.
- vii) On any connecting wires of the meter.
- viii) Voltage discharge with 0-10 mm spark gap.

Internal

- ix) Spark on meter body.
- x) Spark on the optical and RS232 port.
- xi) At any place in load circuit.

The accuracy of the meter will be checked before and after the application of above device.

44.LOAD SURVEY:-

Meter should support parameters as mentioned in IS-15959for Category “C”.

Following parameters shall be made available for last 60 days with integration period of 15 min. Out of which the utility should be able to select any five parameters

- Real timeclock, date and time.
- Current, Ir
- Current, Iy
- Current, Ib
- Voltage, VRn
- Voltage, VYn
- Voltage, VBn
- Active for warded Energy
- Reactive lag forwarded energy
- Reactive lead forwarded energy
- Apparent Energy

These load survey can be retrieved with the help of Meter Reading Instrument on local interrogation or remotely using the remote communication interface.

45.TIME OF DAY REGISTERS

The meter shall have support of eight TOD registers and rate registers for demand and energy monitoring in peak and off-peak time zones. TOD rate and MD registers are required for active and apparent energy channels.

46.MD REGISTRATION

The meter shall continuously monitor and calculate maximum demand for each interval of time, which may be programmable as a block of 15 minutes or 30 minutes (30 minutes by default). At the end of every demand integration period the new calculated MD shall be compared with the previous MD and meter shall store whichever value is higher.

47.MD RESET

The meter shall have any of the following MD resetting options: -

Internal

- (d) Automatic reset at the end of a certain pre-defined period (say, end of the month)
 - (e) Manual resetting arrangement (MD reset button) with sealing facility.
48. MD reset through authenticated transaction SELF
- DIAGNOSTIC FEATURE
- The meter shall be capable of performing complete self-diagnostic check to monitor the circuits for any malfunctioning to ensure integrity of data memory location at all time. The meter shall have indication for unsatisfactory/non-functioning/malfunctioning of the following:

- a) Time and date on meter display
- c) All display segments on meter display
- d) Self diagnostic (RTC, NVM information) on display

49.OTHER SALIENT FEATURES OF METERS

- It should be possible to check the healthiness of phase voltages by phase indicator available on meter display.
- The meter shall have provision of reading in the absence of power through h an internal battery. It shall be possible to access the display in power off condition. It shall also be possible to do meter data download through MRI under power off condition.
- The meter should work accurately irrespective of phase sequence of the supply.

50.TEST AND TEST CONDITIONS

- Acceptance test: All acceptance tests as per relevant standards shall be carried out in the presence of utility representatives.
- Routine Test: All the routine tests as per – IS 14697 shall be carried out and routine tests certificates shall be submitted for approval of purchaser.

GUARANTEED TECHNICAL PARTICULARS FOR 3 PHASE 3 WIRE CT OPERATED TRIVECTOR ENERGY METER FOR CONSUMER METERING

S . N o .	Item	Bidder's data
1	Type	
2	Application	
3	Rated Voltage	
4	Rated Current	

.		
5	Frequency	
.		
6	Minimum starting current in% of base current	
.		
7	Power loss in potential circuit	
.		
8	Power loss in current circuit	
.		
9	Change in error due to	
.		
	Variation in frequency	
	Variation in voltage	
1	Accuracy Class	
0		
.		
1	Total Weight of meter	
1		
.		
1	Details of case	
2		
.		
1	Standard to which the meter confirms	
3		
.		
1	Type of Energy Registration Mechanism.	
4		
.		
1	MD Reset Mechanism	
5		
.		
1	MD reset button with sealing provision	
6		
.		
1	Two LEDs for accuracy measurement	
7		
.		
	Work in grange	
1	Voltage	
8		
.		
1	Current	
9		
.		
2	Display details	
0		
.		
	Display Cycle (page mode d	
	Period of display of each p	
	Internal	

	.Display scroll-lock facility	
	i. ack lit LCD	
	event OBIS codes for p	
	Legend for Cover open detection	
	Legend for Magnet event	
2 1 .	Power on in absence of mains	
	Internal/External Battery	
	Display access	
	Reading (Data downloading)	
2 2 .	Total Events (300nos)	
3 .	Load Survey	

2 4 .	Parameter Logged	
2 5 .	Logging interval	
2 6 .	No. of days of Load Survey	
2 7 .	Time of the day Zone	
2 8 .	Capability for fraud Prevention & detection	
2 9 .	Sealing and Locking Arrangement	
3 0 .	Type of communication Local-Optical port IEC 1107 RS 232 port for remote comms	
3 1 .	Event Logging Current Related events: CT reversal (phase wise) Current imbalance Over Current Voltage related events PT missing (phase wise) Voltage unbalance High and low voltage Others: Magnet Neutral Disturbance Low Power factor Non-Rollover events Front Cover open Power on-off events	

20.0 LIFTSYSTEM

GENERAL

To provide complete electric operated Passengers Lifts including design, manufacture, installation at site, testing and commissioning of the same to the Engineer-in-charges at is faction. No consideration will be given to extra payment based upon difference in interpretation of the specification and drawings.

1 SCOPE

Safety to personnel and equipment during both operation and maintenance Reliability of service

Minimal fire risk

Ease of maintenance and convenience of operation

Automatic protection of all electrical equipment throughs elective relaying system Maximum

interchangeability of equipment

Fail safe feature.

Suitability of applicable environmental factors

These specifications define the basic guidelines of the system as necessary for lifts. All data required in this regard shall be taken into consideration to develop a detailed engineering of the system. Site conditions as applicable are mentioned elsewhere. Compliance with these specifications and or approval of any of Contractor's documents shall in no case relieve the Contractors of his contractual obligations.

All works to be performed and supplies shall be affected as a part of contract requirement, specific approvals/reviewofEngineer-in-Charge.Majoractivitiesrequiringapprovals/reviewshallincludebut not be limited to the following: -

- General Arrangement drawings for the lifts including section through lift pit and lift shaft,
 - Quality assurance procedures,
 - Field testing and commissioning procedures
- Engineering activities to be performed by Contractor shall include but not be limited to the following as relevant to the scope of work included in the project specification.
- a) Control and protection scheme.
 - b) Making of shop drawings with bill of materials.
 - c) Factory in section and testing procedures.
 - d) Field testing and testing procedure.
 - e) Preparation of as-built drawings
 - f) Any other work/activity, which is not listed above, however is necessary for the completion of lift/system.

2. TESTS

Charging

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Owner/ Engineer-in-Charge and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The pre commissioning tests are to be performed as per relevant I.S. codes given and shall be included in the Contractor's quality assurance program me.

Commissioning Tests

The available instruments and control equipment will be used during such testes and the Contractor will calibrate all such measuring equipment and devices as far as practicable. However, un- measurable parameters shall be taken into account in a reasonable manner by the Contractor for the requirement of these tests. The tests will be conducted with specified load capacity for the respective lifts.

All instruments, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.

Pre-commissioning test shall be carried out as per relevant IS Codes and / or as specified elsewhere in the tender.

The Contractor shall be responsible for obtaining clearances from the concerned authorities for commissioning of the equipment. However necessary fee for these clearances, if any shall be reimbursed by Owner on production of requisite documents in original.

3. PACKAGING

All the equipment's shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of availability of Railway wagon/truck/trailersizesinIndiashouldbetakenintoaccountbytheContractor.TheContractorshall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, warfare and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Owner takes no responsibility of the availability of the wagons etc.

4. PROTECTION

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic protecting device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner.

5. CODE SANDSTANDARDS

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

Electric Traction Lifts – Guide line for outline dimension IS 14665 (Part-1)–2000 Electric Traction Lifts –
Code of practice for installation IS 14665 (Part-2)–2000 Electric Traction Lifts–Safety Rules

	IS14665(Part-3)–2000	
Electric Traction Lifts – Components	IS14665(Part-4)–2000	Electric
Traction Lifts – Inspection manual	IS14665(Part-5)–2000	Glossary of
terms relating to wire ropes	IS 2363 – 1981	
Steel wire suspension ropes for lifts and hoists	IS2365–1977	Flexible Trailing
Cables for lifts	IS4289–1984	1100-volt grade
XLPE insulated Armored cables	IS 7098	
1100-volt grade PVC insulated Armored cables	IS1554–1988	1100-volt grade
FRLS PVC insulated copper conductor wires	IS 694	Rigid steel conduits
IS9537–1981		
Flexible steel conduits	IS 3480 – 1966	Safety procedure
and practices in electrical works	IS 5216 – 1982	Electrical
installation fire safety of buildings	IS 1646 – 1997	Electric Traction
Lifts Part–4Components	IS14665(Part-4/	
Sec1&9):2001		
Electric Traction Lifts Part–5 Inspection Manual	IS14665(Part-5):1999	Specifications for hoist way door-
locks	IS 7754-1975	Rules for design,
installation, testing and		
Operation of lifts, escalators and moving parts	IS1735-1975	

In addition, the relevant clauses of the following, as amended up to date shall apply. The Indian Electricity
Rules 1956

The Indian Electricity Act 1910 State Lift Rules

Fire safety regulations pertaining to lifts

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

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

6. ELECTRIC SUPPLY

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

7. SITE CONDITIONS

Lift shall be designed considering the following:

Ambient Temperature	-	45DegreeC.
Relative Humidity	-	100%
Mean Seal Level	-	300m

8. DRAWINGS

Before the commencement of work, the lift contractor on receipt of building drawings, shall prepare and submit all drawings necessary shop drawings showing the general arrangement of the lift equipment's for the approval of the Engineer-in-Charge and these drawings will become part of the contract. Contractor shall also check the exact dimensions of the lift shaft at site, before taking up the manufacturing the equipment at site.

9. PAINTING

All exposed metal work furnished under these specifications, except as otherwise specified shall be properly spray painted over an anti-corrosive primer coat.

10. CIVIL WORK TO BE DONE BY LIFT CONTRACTOR:(INCLUDED IN CONTRACT)

- a) To provide scaffolding in the hoist way required for erection of lift.
- b) To carry out minor civil work, such as modification and making good the pocket/cutout in wall/ceiling for car, counter weight, rail bracket, hall buttons, indicators and laying of sills in positions or any other work required for smooth operation commissioning of lifts.
- c) To provide and fix the steel items such as machine beams, bearing plate in the machine room, lift shaft for installation of machinery. Separators wherever required and buffer support channels and vertical iron ladder in lift.
- d) Providing of hoisting beam, lifting hook in the lift shaft for hoisting of equipment during erection and to facilitate maintenance in future including their fixing etc.^{Internal}

- e) Providing and fixing of necessary sill supporting projections, sheet steel facia plates on all landings as per requirements.

11. WORK NOT IN CLUDED

The employer shall provide the following:

- a) A hoist way properly framed and finished including pit of required depth with drain including water proofing, as per approved lift supplier drawing. The hoist way walls shall be neatly plastered to avoid dust accumulation.
- b) Properly lighted and ventilated machine room (in case of lifts with Machine Rooms) and hoist way shall also have lights including power plugs point at landing as per requirement including access doors, ladder and guards as required. Walls & ceiling shall be properly finished to avoid accumulation of dust.

12. MAINTENANCE CONTRACT-2YEAR

Bidders are to quote their rates for annual maintenance contract for maintenance of all the lifts. The maintenance shall start after expiry of sales service guarantee period for all the lifts.

13.WARRANTY

The bidder shall provide for one year warranty after commissioning against all manufacturing defects and shall provide for free replacement of all materials having manufacturing defects.

14. PERMISSION TO INSTALL THE LIFT SAND LICENSE TO RUN THE LIFTS FROMR ELEVANT AUTHORITIES

It shall be the responsibility of the successful tenderer for obtaining the necessary permission, if required, to install the lifts from the relevant local authorities and subsequently to have the installation inspected by the relevant local authorities and arrange to obtain the license to run the lifts. All relevant papers connected for obtaining the permission and final inspection will be signed by the Owner / Engineer-in-Charge. The requisite fee for this purpose shall be payable on the production of original receipts on this account.

15.ERECTION

The lift Contractor shall commence the erection of the lift equipment's immediately after receipt of the complete equipment's from their work sand complete the work to the satisfaction of the Engineer- in-charge with in the stipulated time. The lift installation shall be handed over in perfect working order on completion of the work.

Internal

16. TESTS

The following tests shall be carried out as per relevant IS requirement.

- a) Insulation and earth test for all electrical apparatus.
- b) Continuous operation of the lift full load conditions for one hour. This shall be as per I.S. specifications.

17. TESTING

Testing at manufacturers works of the various equipment's and components as required by I.S Codes/Standards & other applicable/European Standards shall be done by the successful tenderer before dispatching the materials to site. The tenderer shall furnish a certificate for the same.

If the authorized representative of Owners, wishes to participate/witness these tests the scheduled dates for the same will be informed well in advance before carrying out such tests.

Various tests required to be done as per I.S. Codes / European Standards at site of the installation shall be carried out in the presence of the Engineer-in-Charge.

18. HOIST MOTOR

- (a) Each elevator shall be provided with individual A.C. Motor. Motor shall be 415 Volt AC 3 phase, 50 cycles. The motor shall be designed for lift duty i.e., for repeated starts and shall be of high-capacity integral motor with class F insulation and equipped with thermal protection. It shall be AC reversible type for elevator service with high starting torque and low starting current. It shall be with minimum sound during operation and shall comply with latest relevant IS specifications for lifts.
- (b) Protection for motor - Provision shall be made for over load protection of motor. Protective relay shall be provided on the controller to protect the lift equipment's against low voltage and phase failure. The slow speed winding of this motor shall function automatically when the car is approaching a floor so as to provide a greater stopping accuracy.
- (c) Reverse phase relay - A reverse phase relay shall be provided on the individual controller to protect the lift equipment against phase reversal, low voltage and phase failure switches. Relays shall have suitable contact to with stand warning due to frequent make/break operation of the floor controlled in the machine room and in the contact hoist way.

19. BRAKING SYSTEM

The brakes shall be used only to hold the counter weight and car in position. The brakes should not be used for stopping the lift. The electromechanical brakes mounted on the motor and gear shall work on rectified D.C. supply. The brakes shall be fitted with self-aligning shoes and operated on power release principal to ensure safety if the power supply fails. The brake should be capable of operation automatically by various safety devices, current failure and by normal stopping of car. It should be possible to release the brake manually, such releases requiring the permanent application of manual force so as to move the lift car in short stops. For this purpose, one set of brake release equipment shall be supplied. The tenderer shall specify the make of rectifiers for DC supply. Provisions made in IS – 10923:1984 shall be complied with. Stopping of the lifts shall not be achieved electrically but by electromechanical system.

20. CONTROL

The control shall be by microprocessor controlled electronically regulated A.C. Variable Voltage & Variable Frequency drive using pulse width modulation (PWM) with phase reverse relay.

21. CONTROLLER WITH DRIVE SYSTEM

Controller with Simplex / duplex full collective control and selective, drive control with digital technology having Thyristor controlled acceleration and deceleration and digital tachometer on warm shaft.

22.HOISTWAY

- a) Car Frame: A suitable car frame shall be provided with adequate bracing to support the platform and car enclosure. The buffer striking plate on the underside of the car-frame platform assembly must fully compress the buffer mounted spring in the pit before the plunger reaches its lower limit of travel.
- b) Platform, Heavy Loading Type: The car platform shall be arranged to accommodate one piece load weighing up to 25% of the rated capacity, such as wheeled food carts, passenger's baggage, etc. The platform shall be recessed 25mm for flooring Granite / Marble stone flooring as per approved samples pattern.
- c) Car Guide Rails: Tee section steel rails with brackets and fasteners. (as applicable).
- d) Spring Buffer: Helical coil spring type. (as applicable).
- e) Wiring: Wiring for hoist way electrical devices included in scope of the elevator system, hall panel, pit emergency stops switch, and the travelling cable for the elevator car.

23. CAR FRAME SAFETY GEAR AND GOVERNOR

The car frame which supports the car platform and enclosure shall be made of structural steel and equipped with suitable guides and car safety device mounted under car platform. The safety gear shall be of instantaneous type. Car safety, to stop the car whenever excessive descending speed is attained, shall be operated by as peed governor through a continuous steel rope. Suitable device shall be provided to cut off power from the motor and apply the brake on application of safety.

24. THERMAL OVER LOAD PROTECTION

Auto thermal overload protection is to be provided to protect the driving motor against overloads. If the car is overloaded, it will not start. The overload indicator and the sounding buzzer shall signal the overload condition.

25. PRIORITY CONTROL

Internal

Switching on the key contact and at the same time pressing the required floor buttons will allow a direct

travel to the selected floor while the already registered car commands will be cancelled.

26. FULLLOAD CONTROL

Full loaded cars should respond only to car commands. Floor calls remain registered and are served by the next available not fully loaded cars.

27. COUNTER WEIGHT

All counter weights shall be cast iron and shall travel between rigid guides of steel frame capable of withstanding buffer impacts. Suitable metallic counter weights guard of required length shall be provided at the bottom of the hoist way.

28. CAR SAFETY AND GOVERNOR

The car safety is to be provided to stop the car whenever excessive descending speed is attained and runs more than 10 seconds in the same directions. The safety shall be operated by a centrifugal speed governor located at the top of the machine or hoist way and connected to the governor through a continuous steel rope. Suitable means shall be applied to cut off power from the motor and apply brake to stop the elevator immediately & after that the elevator shall restart automatically in normal speed.

29. SOUND REDUCTION

The lift contractor shall provide necessary sound reduction materials, preferably anti-vibration pads of proper density to effectively isolate the machine from the machine beams or flooring.

30. TERMINAL AND FINAL LIMITS

Terminal switches shall be provided to slow down / stop the car at the terminal landings. These terminal switches shall act independently of the operating device or final limits switches. Ultimate or final limit switches shall also be provided to automatically cut off the power and apply brake in case the car travel beyond terminal landings.

TERMINAL BUFFER

Suitable spring buffers shall be installed to stop the car and counter weight at the extreme limits of travels. Buffer must be suitable for installation in the space available.

31. GUIDES

Car and counter weight guides shall be of rigid steel guides shall be of machined 'T' section only. The size being in accordance with relevant European EN 81 standards, it shall be capable of withstanding the forces resulting from the application of car or counter weight safety devices.

32. ROPES

The hoist ropes shall be of traction steel of suitable size, construction and number to ensure the proper operation of elevator and shall give satisfactory wearing qualities. The Governor rope shall be of steel. The factor of safety should be as given in IS-4666. No car or counter weight ropes shall be repaired or lengthened by splicing. Fixing arrangements shall conform to IS – 2365-1977 shall be complied with.”

33. CARPLAT FORM

The car platform shall be framed construction and designed on the basis of rated load evenly distributed. The flooring shall be sound isolated platform having 6mm chequered plate with tough wearing floor cover and fire-resistant material and final finish with approved granite stone.

Car's stop page accuracy at floors shall be within ± 3 mm.

34. CAR ENCLOSURE OR BODY

The car body shall be approved finish stainless steel material. The car shall have suspended ceiling with arrangement for air through pressure fan mounted on the roof of car and in direct/ indirect lighting shall be with LED lamp fixtures evenly distributed in the cabin. Ceiling / wall interior material finishes to be submitted with offer.

35. CABIN FINISHES

- a) **For Passenger Lifts:** The car body shall be in approved finish stainless steel panels, the car floor will be of approved stone materials. The car shall have a suspended ceiling with arrangement for air through a pressure fan mounted on the roof of the car & indirect lighting shall be done with LED lamps fitting evenly distributed on the cabin finishes for the service lifts.
- b) **Other Cabin Features**
 - a. Telephone cabinet with phone and lead up to the control room or as directed by engineer in charge. Microphone with switch along with communication cable between cabin car and Centralized Security Room shall also be provided.
 - b. Full height infrared light-ray with photo-electric cells across the car entrance.
 - c. Door reversal feature in case of obstruction of doors.
 - d. Handrail only on rear side.
 - e. Braille signage on door and operation Panel.
 - f. Voice announcement system in the car & at landings, to announce the position of the elevator car in the hoist way as the car passes through or stops at any floor issued by the elevator.

36. CAR DOOR

Internal

Stainless steel hairline finishes as per brief technical sheet. The door panels to be of center opening type with horizontal sliding doors & shall be of minimum 2 Hrs. Fire Rating.

37. LANDING DOOR

As per car door specifications

38. CAR AND LANDING DOOR OPERATORS

An electric door operator for opening and closing the car door and the landing door shall be provided. It shall consist of a machine on the elevator car for each stopping at a landing. The car door and the landing door shall be mechanically connected and shall move simultaneously while opening and closing. Every landing door shall be provided with a locking device which shall comply with the following requirements: -

- a) It shall not be possible to open the landing door from the landing side until the lift car is within that particular relevant zone.

However, provision shall be made for opening the door by means of special key for use in case of an emergency.

- b) It shall not be possible for the car to be started or kept in motion unless all the landing doors and car door are closed and locked except when the car is coming to a stop at that landing within the levelling zone.
- c) The electrical and mechanical parts of all locking devices shall be of suitable design and construction.
- d) An electric contact for each car door shall be provided which shall prevent car movement away from the landing unless the door is in closed position.

The car doors and landing doors shall open automatically as the car is stopping at a landing. The closing of car door and landing door must occur before the car is set in motion. An electronic device shall be provided to stop and reverse the doors during their closing motion.

39. DOOR HANGERS AND TRACKS

The car and the landing door shall be provided with two-point suspension sheave type hangers complete with tracks. Sheaves and rollers shall be of steel with moulded nylon collar and shall include shielded ball bearing. Tracks shall be suitable steel section with smooth surface. The landing doors shall also consist of headers, sills, frames etc. as required.

41. CAR DOOR SAFETY SHOE

Full height car operating panel shall be installed on the car door panel. In the event of a person interrupting the beam, the closing operation of the doors (the car and landing doors) shall return to the open position. The closing operation of the doors shall also be reversible by pressing a button (Door Open button) in the lift car operating panel.

42. CAR AND CAR FRAME

Internal

- I. The passenger cars shall be isolated from frames to prevent vibration being transmitted from the ropes and guide shoes. Lateral and upward motion of the car shall be restrained by locking blocks but there should not be metal contact between the car and the frame. The top of the car shall be held firmly by rubber braced clamps welded to each side of the car's canopy. In addition, the side panels shall be coated with a layer of bituminous sound deadening compound. The car frames shall be of suitable steel section properly and securely braced and shall be sufficiently rigid to withstand the operation of the safety gear without permanent deformation of car frame.
- II. All passenger lifts shall be of metal construction with center opening sliding steel doors, side panels in stainless steel finish. The car enclosure will be provided with fan with grill for ventilation. The floor of the lift car shall be granite stone over suitable structural steel frame. (Sample is to be approved by Engineer-in-charge). Following shall also be provided in the passenger lifts: -
 - a) False ceilings – As per Para 36, Stainless Steel (Stainless steel finish and panels as per manufacturer) fitted with LED light fittings through two rows of translucent fixture & Pressure fan with grills. The fan shall be connected on electric mains independent of mains supplying power to lift machine. Ventilation opening shall be provided inside the enclosure as per standard practice of lift manufacturers. To permit switching off the power supply to the lift without switching off the fan and the light, a separate circuit with control in machine room shall be provided in machine room.
 - b) One number full car operating panel with buttons in stainless steel finish integral full height. Operating panel to be with Braille signage for PWD's.
 - c) Digital car position indicator in car and car position indicators at ground floor & landings of all upper floors.
 - d) Car direction indicator showing up/down directional movement of car is to be fitted on the ground floor and on each landing (at all upper floors).
 - e) Battery operated alarm bell and emergency light with recharge equipment (charger) including invertors and batteries. The lighting shall automatically come on in case of failure of normal lighting supply.
 - f) Over load warning indicator in car.
 - g) One specification plate showing rated load, passenger capacity and other installation details/ rating.
 - h) DO's and DON'Ts notice for lift operation duly framed.
 - i) Fireman's switch at main lobby.
 - j) Call Registration indicator for the purpose of registering the requirement of car at a particular landing.
 - k) Digital Floor position indicator.
 - l) A three-pin plug socket with switch for a hand lamp shall be fitted on top of the lift car for use by person working thereon.
 - m) Hands free intercom system.
 - n) Voice synthesizer.
 - o) Voice Announcement system in each & landings for People with Disabilities (PWD's).

43. CAR DIRECTION INDICATOR

Digital signal indicator in the car shall be provided by the appropriate arrow being
 illuminated to indicate the car travel direction.

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44. EMERGENCY LIGHTIN CAR

Internal

A trickle charged battery operated emergency light lamp shall be provided in the car which shall operate automatically in case of power failure for minimum 90 minutes.

45. ALARM BELL

An emergency alarm bell shall be provided. The alarm bell shall be located at the ground floor landing and push for the same shall be at the car operating panel. The system shall be operated by batteries with trickle charger and the bell/siren should work the moment the alarm button in the car is pressed.

46. COMMUNICATION SYSTEM

Telephone system with cables shall be provided between cabin car and machine room for each lift. In addition to this, microphone with switch shall be provided in each lift cabin so that operator/passenger can talk to main security personnel sitting at centralized room in case of emergency.

47. CALL BUTTON INLANDINGS

An 'up' push button and a 'down' push button at each intermediate landing and a single push button at each terminal landing shall be provided to call the lift car in a particular landing for travelling in a desired direction. The push buttons shall have call registration lights and shall illuminate when a button is momentarily pressed to indicate that the call is registered and the direction of the call is registered. The button shall remain illuminated until the call is answered. The top covers of the push button boards at the landings shall be of stainless steel.

48. FLOOR POSITION INDICATOR & DIRECTIONAL ROWS

Digital signal indications at all landings shall be provided by the appropriate numeral and direction arrows being indicated when the car is passing the corresponding floor. The indicator shall remain illuminated when the car is stopped at a floor. The top cover of the floor position and direction arrow indicator units shall be stainless steel.

49. ELECTRONIC DOOR DETECTOR

On each side of the lift entrance door and car door panel's, infrared light sensor unit shall be mounted in such a way to continuously monitor the light beam. (no. of beams shall be more than 100). When any beam is disturbed, an electronic circuit shall be interrupted and the doors operating mechanism shall return the door to open position. When the entrance is clear the lift door shall close automatically. Opening of the doors may also be accomplished by pressing the "Door Open Button" in the car operating panel.

Internal

50. EMERGENCY KEY

Emergency key or equivalent device shall be provided as required by the elevator supplier.

51. DETAILED INSTRUCTIONS

Inside the lift car suitable instruction for passengers on car operating panel will be displayed. Such instructions in lift car shall indicate capacity, Nos. of persons; 'No Smoking' and such other instructions as are suitable for proper and safe operation of the lifts.

52. FIRE MANS WITCH

Each lift will have fireman switch for access of fireman. The operation of this switch shall cancel all calls to this lift and lift will stop at the next nearest landing if travelling upward. The doors will not open at this landing and the lift will start travelling to ground floor. In case of its travel in the downward direction when the fireman's switch is operated, it will go straight to ground floor direct without stopping enroute. The emergency stop button inside the car will become inoperative during the journey. Once the car has reached the ground floor, it shall be safely under the command of

fireman by car buttons, landing calls being isolated. The lift can be put in normal use by putting the fireman switch in its original position.

53. OPERATION

The operation shall be Simplex/Duplex, full collective-selective with or without attendant. It shall generally function in the manner described below: -

On every intermediate landing is a Up/Down button with 'Call Registered' lights. The extreme positions have one call button with a "Call Registered" lights. Inside the car is the complete set of buttons and a key operated change over switch to facilitate operation with or without attendant. However, in this case the car attends to all calls registered inside the car and also at the landings, in the ascending or the descending order. If it is landing, the last stop is the top-most registered call. After this, it automatically reverses the direction of travel and attends to all calls registered "Down" on this downward trip, irrespective of the sequence in which the calls are registered. The car will answer all calls in a sequenced order depending upon the direction in which it is travelling. If the key is turned to 'Attendant' operation, and also lift operation can select the direction of travel by pushing the right buttons in the car.

54. EMERGENCY STOP SWITCH

Internal

On top of the lift car an emergency stop switch shall be provided for use by maintenance personnel. Similar switches shall also be provided in the car. Operation of these switches shall render the car and landing buttons inoperative and cancel all registered calls.

55. EMERGENCY BATTERY DEVICE

The emergency battery unit shall consist of suitable capacity of SMF (Sealed Maintenance Free) batteries with battery charger having auto trickle boost rate of charge. The unit shall be of such a capacity that in case of power failure, the lift shall come to the nearest landing automatically. The Bidder will submit calculations for batteries and battery charger before procurement.

56. AUTOMATIC TERMINALS STOP (RESCUE DEVICE)

The elevator hall be equipped with an automatic stopping device arranged to bring the car to a stop at the terminal landings, independent of the regular operating device in the car. This safety device is required so that in case of controller failure or power failure, the lift should not get stuck in the shaft. With this device, the lift will come to the nearest landing and its doors will open and the person can come out of the lift. All power-operated doors shall have a full length infra-red light curtain safety to retract the door in the event of coming across any obstacle during closing of door.

57. ELECTRICAL WIRING

Power wiring between the controller and main board and controller to various landings shall be done in heavy gauge M.S. conduits conforming to Indian Electricity Rules and Specifications for electrical works. All cables shall be PVC insulated of appropriate size and voltage grading. Complete copper wiring for the entire lift installation will be used.

All multi-core trailing cables employed for the car shall satisfy the requirement of relevant IS and / or European Standard. There shall be separate trailing cables for the controls, for the lighting and fan and for signal circuits. The length of the cable shall be adequate to prevent any strain due to movement of the car. All cables shall be so tagged for easy identification. Trailing cables shall be so suspended, anchored and run that the strain on individual cable conductor shall be reduced to a minimum and the cables are free from contact with the car counter weight, shaft sides etc. No intermediate jointing shall be permissible in the trailing cable.

58. MACHINE

The machine shall be, of gear less traction type for variable speed equipment for all passenger lift and shall include electric motors, electromechanical brakes, chromium molybdenum steel shaft and a sheave all completely mounted on a single base or bed plate. The worm shaft will be provided with taper roller bearings to take the end thrust and self-aligning spherical roller bearing will be furnished for the sheave shaft to ensure alignment and long bearing life. The driving sheave will be grooved to ensure sufficient traction and minimum rope wear. Adequate means of lubrication will be provided for all bearings and the

worm gear. The machines shall be equipped with an arrangement for manual winding of machine for testing purpose or for operation when the power supply fails.

59. DUAL OPERATION WITH ATTENDANT

Provision shall be made for automatic operation as given below:

- (a) Without attendant
- (b) With attendant: For the use of attendant, the following additional equipment shall be added to car operating panel:
 - (i) Key operated switch for cutting in/out additional requirements for “WITH ATTENDANT” operations
 - (ii) Emergency buttons
 - (iii) Car Call indicators

60. AUTOMATIC SELF LEVELLING DEVICES

This device shall be operated in slow speed to bring the car door in level with landing door; the tenderer should specify the leveling errors that can be achieved by them.

61. LIGHT FIXTURES

Suitable composite LED light fittings as specified, recessed in the false ceiling and operated by switch in the car operation panel shall be provided. A light point along with bulb shall be provided about 5 cm above ground level for the purpose of providing proper light in the pit. Properly earthed lighting arrangement shall be provided in the hoist way in the form of Bulk-head fitting at each floor level.

62. CAR OPERATING PANEL

The car operating panel shall be flush mounted to full height in car enclosure and shall contain the following:

- (a) Bank of buttons to correspond to various floors/landings served.
- (b) Emergency switch for stopping the car independent of regular operating device.
- (c) Emergency alarm bell button connected to the alarm bell located at the main floor landing or adjacent to hoist way. The alarm should be operated through DC battery.
- (d) Light/Fan control switches.
- (e) A key operated switch to operate lift “Automatic without attendant” and “With attendant”.
- (f) All call buttons, signals, control switches and car operating panel shall be numbered/mounted on stainless steel finish panel to full height and flush mounted.
- (g) Over load warning indicator in car.
- (h) Battery operated emergency light.

63. TRAILING CABLE

The trailing cable shall have flame retarding and moisture resistant outer cover. They shall be flexible and shall be suitably suspended to relieve strain in the individual conductors.

Internal

- A. The works listed as under shall be arranged by Lift contractor and deemed to be included in the quoted rates.
- a) All cutting of walls, floors or partitions together with any repairs made necessary thereby, including grouting in position like bolts, cills, steel members, indicator, button boxes etc., after they are fitted in position.
 - b) Scaffolding including temporary barricade required for lift works in elevator hoist way during the erection period and to remove the same thereafter.
 - c) Facia Plates are to be provided and installed by the Lift contractor.
 - d) All painting works of elevator material.
- B. The Employer shall ensure the provisioning of the following: -
- (a) Provisioning of continuous cill bearing area for each hoist way entrance of such construction as to assure secure anchorage and support for each cill.
 - (b) Painting works of hoist way except of Elevator materials.
 - (c) Lighting/PowerPoints of hoist way and pit.
 - (d) Hoisting hook in the ceiling of the hoist way.
- C. Tenderer's lumpsum price in Schedule 'A' shall be deemed to include for full and entire completion of all works in accordance with good engineering practice and recognized principles. If any additional

civil works required other than mentioned in above to suit the lift well as constructed at site shall also be got executed by the lift contractor under his own arrangement, and the cost of same shall be deemed to have been included by them. The details of construction that may not have been inadvertently specified but are apparently and obviously required for making the lifts functional shall be deemed to be included in the lump sum rate quoted by the contractor. Decision of Engineer-in- Charge in such matter shall be final and binding.

- D. The lift tenderer has to work in close liaison with the building contractors.
- E. Braille signage shall be provided in each Lift in each Block.

Escalators

Passenger Escalators of below listed passenger capacity

Type External, Value of Rise (mm) 5800- 6300. Step Width (mm) 1000, Capacity, 9000 persons /hour, Speed 0.5m/s, Angle of Inclination 35°, Operation System VVVF Drive, Handrail Black Synthetic Rubber. Handrail support Stainless Steel Hairline, Balustrade interior paneling, 10mm transparent tempered safety glass, Inter & outer decking Hairline Stainless Steel, Skirting Hairline Stainless Steel, Comb plate Aluminum alloy, Step Integrated Aluminum Alloy with black painting, Step Cleat Yellow Molding Resin at the flank & on the front wall, Step of horizontally moving distance Two steps, Floor plate Stainless Steel Plate with Antiskid Patterns, Power voltage 415V, 3 Phase, 50 Hz, Lighting voltage 240V, 1 Phase, 50 Hz all Complete.

END OF SECTION

Technical Specifications

S r . N o .		
1	Usable Platform	Standard
a	Length	3755 mm
b	Width	2000~2500mm
c	Height (Car which could be accommodated)	Upper – Minimum 1500 mm for all stack
d	Equipment Weight	Lower 1500~2000 mm – Based Upon actual Clear Heights available at Site 696 Kgs (approx.)
2	Required Dimensions	Standard
a	Length	5000/4500/4250 (Car length Vary)
b	Width	2300~2800mm

.		
c	Clear Height for the system	3200~3700mm
.		
3	Lifting arrangement	Standard
a	Capacity of the motor	Electrical Motor for power pack 3KW only for Lifting
b	Mode of transmission	Hydraulic Cylinder
c	Speed of operation	Up Operation – 2.7 mtr./min
.		Down Operation – 2.5mtr. /min (Depends on Vehicle Weight)
d	Lifting Capacity	2000Kgs
4	Mode of Operation	Manual
5	Power supply	3 ph., 415V, 50hz
6	Hydraulic Piping Location	Cable tray from Ground
7	Number of Equipment for single Power pack (in a row)	Maximum 7 – As per the Site Layout
8	Color of the Structures	Basalt Gray RAL (7040)-Plain/Structure
9	Type of Powder Coating on Structures	Epoxy Powder Coating/hot dip galvanizing
10	Galvanization Details	Pre-Galvanized Sheet of 120 GSM (Corrugated Platform Profiles only)
11	Safety devices	Hydraulic valve with Solenoid Coils Electromagnet Operated Mechanical Stopper to preventunintentional lowering of platform, Leaf Chain Synchronization of platform lifting and lowering Wheel Stopper

Structural Part

1 .	Type of MS Steel	IS 2062
2 .	Thickness of C channel	ISMC 200
3 .	Platform Profile	Pre-Galvanized 1.5mm thick, 120GSM

Hydraulic Part

1	Type of Cylinder	Single Acting Hydraulic Cylinder
2	Stroke length	2100 /1800mm
3	Power Pack / Oil reservoir	Submerged type with 60-liter capacity
4	Valves	Electrically operated solenoid Valves
5	Piping	12 mm OD seamless hydraulic piping

□ **General description of Two Level Dependent Car parking system**

- 2 steel pillars with base that is mounted on the floor
- Two slides (mounted to the steel pillar with sliding Nylon bearing)
- 1 platform
- 1 Leaf Chain (for Synchronization of platform)
- 1 Hydraulic cylinder
- Hydraulic system with power pack & piping
- Operating panel for platform lifting and lowering.
- Bracketing for site fixings.
- Mechanical & Electrical safety systems.

□ **Platforms consisting of:**

- Platform Side Members
- Platform Connection Strips
- Adjustable wheel stops
- Access strip
- Platform profiles made out of pre-galvanized
- Screws, nuts, washers, distance tubes, etc.

□ **Hydraulic System consisting of:**

- Hydraulic cylinder
- Solenoid valve
- Hydraulic piping's
- Hydraulic power pack
- Fixing supports (wall stands)

□ **Electrical system consists of:**

- Operating panel (Emergency Stop, Deadman control switch with key)
- Terminal box on valve Column
- 2 Electromagnets for mechanical locking
- Electrical wiring

22.0 CCTV System

1	Specification for IP Indoor Dome Dual Sensor Camera:			
	Technical Specification		Compliance (Yes/No)	
	Image Sensor (CMOS)	2 TO 4MP		
	Optical Format	1/2.5" or better		
	Minimum Illumination	Colour (Day Mode)-0.3Lux		

	Illumination	B/W (Night Mode)-0.15Lux	
	Wide Dynamic Range	TrueSensorBased70dBorhigher	
	Full Field of View Resolution	Total:5120HX1920V PerSensor:2560HX1920V	
	Video Compression	H.264(MPEG-4, Part10)/Motion JPEG	
	Frame Rate	Atfullresolution:7fps(5120X1920) Scaled down 1 (X 9 resolution: 0 2 6 maintaining full field f 5 0 of view p 6) s 0	
	Lenses	2X8.0mmMPlenswithremotefocuscapability F1.6, H- FoV=43°;2.1/2.8/4.0/6.0/8.0/12.0/16.0mm M Plens with remote focus capability	
	Back light Compensation	Required. Reference windows for auto exposure and white balance	
	Privacy Masking	Required. Unlimited	
	Shutter speed	Userprogrammable1ms-500ms	
	Motion Detection	RealTime.1024detectionzones	
	Image Rotation	Corridor View(90°,180°and270°imagerotation)	
	Network Interface	100Base-TEthernet	
	Network Protocols	RTSP, RTP/TCP, RTP/UDP, HTTP, DHCP, TFTP	
	Industry compliance	Standard ONVIF Profile S	
	Compliance and certifications	UL (CB), 47 CFR 15 Class A FCC, RoHS, REACH, WEEE, (CE)EN55022ClassA, EN55024, EN61000-3-2, EN61000-3-3, EN60950-1	
	Mechanical rating	IP66(EN60529), IK-10	
	OperatingTemperature	-40°C(-40°F) to+50°C(122°F) upto90%non-Condensing humidity	
	Alarm Input/Output	Generalpurposeupto-coupled,1input/1output	
	Power Over Ethernet	PoE802.3af, Class3	
	Power Consumption	7.9Watts DC Power max	
	Flicker Control	50/60Hz selectable	
	Casing	Tamper-resistant Dome housing, IK-10 Impact- resistant, IP66 weather proof standard	

2	Specification for IP Indoor/Outdoor Fixed/Varifocal Dome Camera:	
	Technical Specification	Internal Complian

			ce (Yes/ No)	
	Image Sensor (CMOS)	1080p(2.1MP)		
	Optical Format	1/3.2"		
	Minimum Illumination	Colour (Day Mode)-0.2Lux		

		B/W (Night Mode)-0.02 Lux, IR Sensitive	
	Wide Dynamic Range	True Sensor Based upto100dB	
	Full Field of View Resolution	Total:1920Hx1080V	
	Video Compression	H.264(MPEG-4, Part10)/Motion JPEG	
	Frame Rate	Atfullresolution:30fps(1920X1080)	
	Lenses	2.1/2.8/4.0/6.0/8.0/12.0/16.0mm MP lens with r	
	Backlight Compensation	Required. Custom white balance	
	Privacy Masking	Required. Unlimited	
	Shutter speed	User programmable1ms-500ms	
	Motion Detection	RealTime.1024detectionzones	
	Image Rotation	Corridor View(90°,180°and270°imagerotation)	
	Network Interface	100Base-TEthernet	
	Network Protocols	RTSP, RTP/TCP, RTP/UDP, HTTP, DHCP, TFTP, QoS, IPv4, IPv6, 802.1x	
	Industry Standard compliance	ON VIF Profile S	
	Compliance and c	UL (CB), 47 CFR 15 Class A FCC, RoHS, REACH, WEEE, (CE) EN55022 Class A, EN55024, EN61000-3-2, EN61000-3-3, EN60950-1	
	Mechanical rating	IP66(EN60529), IK-10	
	Operating Temperature	-40°C(-40°F) to+50°C(122°F) upto90%non-Condensing humidity	
	Alarm Input/Output	Generalpurposeopto-coupled,1input/1output	
	Power Over Ethernet	PoE802.3af, Class3	
	Power Consumption	5.59Watts DC Power max	
	Flicker Control	5Hz~255Hzadjustable	
	IR Illuminator LED	Builtin3pcs850nmLEDs/50ft(15m) IR distance (max) / 80° IR angle	
	Casing	Tamper-resistant Dome housing, IK-10 Impact- resistant, IP66 weather proof standard	

3	Specification for IP Indoor/Outdoor360°Omni Directional Quad sensor Dome Camera:	
	Technical Specification Internal	Compliance (Yes/No)

	Image Sensor (CMOS)	4x3MPCMOS		
	Optical Format	1/3.2"		
	Minimum Illumination	Color (Day Mode)-0.5Lux B/W (Night Mode)-0.0Lux, IR sensitive		
	Wide Dynamic Range	True Sensor Based upto100d Bat full resolution		
	Full Field of View Resolution	Total:8192Hx1536V PerSensor:2048Hx1536V		
	Video Compression	H.264(MPEG-4,Part10)/Motion JPEG		
	Frame Rate	Atfullresolution:5fps(8192X1536) Scaled down resolution: 16fps (4096 X 768) r		
	Lenses	2.1/2.8/4.0/6.0/8.0/12.0/16.0mmMPfixedlens		
	Backlight Compensation	Required. Auto multi-matrix white balance		
	Privacy Masking	Required. Unlimited		
	Shutter speed	Userprogrammable1ms-500ms		
	Motion Detection	RealTime.1024detectionzones		
	Network Interface	100Base-TEthernet		
	Network Protocols	RTSP, RTP/TCP, RTP/UDP, HTTP, DHCP, TFTP		
	Compliance and c	UL (CB), 47 CFR 15 Class A FCC, RoHS, REACH, WEEE, (CE) EN 55022:2010 Class A, EN 55024:2010, EN 61000-3-2:2006+A1:2009+A2:2009, EN61000-3-3:2008, E N60950 1:2006+A11:2009+A1:2010+A12:2011, (UL)IEC 60950-1(ed.2) and IEC60950-22(ed.1)		
	Industry Compliance	ONVIF Profile S conformant		
	Mechanical rating	IP66, IK-10		
	Operating Temperature	-40°C(-40°F) to+50°C(122°F) upto90%non-Condensing humidity		
	Alarm Input/Output	1input/1 output		
	Power Over Ethernet	PoE802.3af, Class3		
	Auxiliary Power	12-48VDC,24VAC		
	Power Consumption	14Watts max (Aux)		
	Flicker Control	50/60Hzselectable		
	Casing	Die-cast aluminium chassis with polycarbonate dome bubble, IK-10 Impact-resistant, IP66 weather proof standard. Easily adjustable,2-axisw/360°panand90° tilt.		
	Mounting Options	Surface/Wall/Pole mounting option should be available		

	Specification Video Management System:			
			Com plian ce (Yes/ No)	
	GENERAL	The system shall be a highly scalable and modular enterprise level software solution.		
		The system shall have an open architecture, supporting seamless integration with third party applications.		
		The system shall have an object-oriented architecture /Design.		
		The system shall have the capability to integrate an unlimited number of video servers into one unified network – each server must be able to communicate with other servers, and video and events from any server must be viewable from other servers.		
		The system shall support PostgreSQL database.		
		The system shall allow an unlimited number of sites and cameras to appear as a single Site to the end- user.		
		The system shall allow for an unlimited number of servers, workstations, cameras, and user accounts to be configured into one logical enterprise implementation with a single Graphical User Interface (GUI).		
		The system shall have the capability of directly viewing and recording analogue and IP cameras.		
		The system shall have the capability to support simultaneous streams from the same IP camera (if camera supports multi-streams); each stream can be assigned for recording, play back and network transmission.		
		The system shall allow for a distributed architecture of the system configuration database. Each Video Server and Administrator Workstation can store a local copy of the system configuration database to add a level of built-in redundancy.		

		The system shall support a solution for native failover of the video servers. The system shall have the ability to be configured such that if one of the video servers fail, the failover server will automatically take over the recording of the cameras from the sever that failed.		
	System Setup / C	The system shall provide the following software installation types on a single computer: Video Server (VS), Operator Workstation (OW), and Administrator Workstation (AW).		
		All software installation types Should be available From the same installation package.		
		Video Server installation will include all functionality of the Operator Workstation and Administrator Workstation.		
		The system shall not require a dedicated configuration server. The system shall allow making changes to the configuration rom any Video Server or Administrator Work station on the security network.		
		The system shall provide a configuration wizard to help configure the system during the initial install process.		
		The system shall have an IP-Device Manager tool with an “IP auto-discovery” feature to search the network for connected IP devices and easily add them to the System configuration.		
		The system shall have the capability of individually configuring each object in the system (video capture devices, cameras, sensors, relays, desktops, monitors, etc....).		
		The system shall allow an option to make a backup of the entire system configuration to a single file (XML or SQL).		
	Built-In Feature	The system shall provide a tool to extract logs,		
		Databased at a and other information necessary for support without shutting down the application.		
		ThesystemshallsupportnIPcamera/device vendors Quoted by the SI		
		The system shall support all major video compression formats: H.264, MJPEG, MPEG4, Mx PEG, Delta Wavelet.		
		The system shall support Generic RTSP drivers to be able to get video from any IP device supporting the RTSP protocol.		

		The system shall support Generic HTTP drivers to be able to get video from any IP device supporting the HTTP protocol.		
		The system shall have an RTSP Server module that will provide the ability to send out live and archived video streams through the RTSP protocol to Requesting clients.		
	Video Recording			
		The system shall support video streams directly from analog cameras, IP cameras, and analog cameras connected to IP encoders.		
		The system shall have the capability to be configured to record continuously, on motion, on a schedule, or on event.		
		The system shall support all video resolutions, frame rates, and bitrates that the IP camera manufacturer supports.		
		Each camera's resolution, frame rate, and bitrate will be set independently from other cameras in the system, and changing these settings will not affect the Recording and display settings of the other cameras.		
		The system shall have the capability of recording video from analog and IP cameras on the same server.		
		The system shall have the capability to protect the recording of each camera with a password.		
		The system shall have the capability of recording at least 400 Mbps of video per server (depending on server specifications).		
		The system shall have the capability to record using another camera stream than the one being used for viewing (if camera being used supports multiple streams).		
		The system shall have a button on the camera view to easily start/stop recording of a single camera.		
		The system shall support the FIFO (First-In-First-Out) recording mode, to continue recording over the Previously recorded video.		
		The system shall have the option to configure the minimum days of video retention per camera.		
		The system shall have the option to configure the Maximum days of video retention per camera.		
		The system shall have the capability of pre- and post- motion recording.		

		The system shall have the capability to keep free Space on the hard drive.		
		There cording should be for at least 60 days		
		The system shall have the capability to display a recorded video file as a virtual camera (format of video files must be Native / AVI).		
		The system shall have the capability of recording video at a lower frame than is received from the Camera (frame rate reduction).		
		The system shall allow for use of non-proprietary PC storage hardware that shall not limit the storage capacity and shall allow for future upgrades of recording capacity.		
	Video Playback / Archive Search	Video Should be available immediately for playback (as soon as current video sequence/file is finished recording).		
		The system shall have a one step process (single button click) to toggle between live and archive mode.		
		The system shall support a Timeline view for playing Back archive video.		
		The Timeline shall support playback of up to 32 simultaneous cameras without any performance degradation.		
		The Timeline shall be easily dragged with the mouse In either direction		
		The system shall provide a calendar to easily search for recorded video.		
		Dates of recordings shall be designated in the calendar.		
		The system shall have simple to use VCR type digital controls to control playback.		
		The system shall have an option to speed up and slow Downplay back speeds up to x32.		
		The system shall support backward playback of video, where video frames will be played in reverse order.		
		The system shall have the capability of saving/searching for book marks with unique met a- Text (based on video start time, or full-time interval).		
		The system shall have the capability of multiple search methods by motion, event, or timespan.		
		The system shall have the capability of masking out non-essential are as of recorded video and only ^{Internal} Searching with in areas of interest ("Smart		

		Search”).		
		The system shall support digital PTZ on archived video.		
		The system shall support warping and PTZ control for archive video recorded from 3600 and 1800 cameras.		
		The system shall provide an option to search by camera name to easily find video for a camera (without having to manually search through a list of All cameras).		
		The system shall provide an Archive Player to play back native video in the case the VMS client Software is not installed on the client PC.		

	Camera		
	Motion Detection / Motion Zones		
		The system shall have the capability to support Multiple Motion Detection Zones from each camera.	
		Each Zone Should be uniquely addressable and be able to have specific reactions programmed based on alarm of a zone.	
		Each Zone can be created from a grid of 4,800 motion Detection blocks.	
		Each Zone shall have individual sensitivity settings for Contrast and Size of the moving object(s).	
		Each Zone shall have the option to be individually armed/disarmed.	
		For each Zone, video frame rate, quality of frames, and memory frames can be adjusted for motion detection.	
		The system shall have the capability to display/hide The Motion Zones in the camera live view.	
		The system shall display the Motion Zone in a different colour if motion was detected in that Zone.	
	User Interface (GUI)	Virtual Desktop scan be created on Operator Work stations, Administrator Work stations, and Video Servers.	
		Virtual Desk top scan contain:	
		Virtual Matrix	
		Event Viewer	
		Task Specific Dialog Forms	
		Graphical User Interfaces (GUIs) for VMS built-in analytics modules.	
		The system shall provide buttons to easily toggle Between different virtual Desktops.	
		The system shall provide a single button to minimize/hide any virtual Desktop being displayed and show the Windows Desktop.	
		The system shall have a very customizable User Interface where multiple UI components can be stitched together to create a single Use Inter face and User experience.	
		GUI objects on a single virtual Desktop can be configured to display across multiple physical monitors connected to a computer.	
		Internal	
	System		

	Automation		
		The system shall have the capability to send notifications to a specified client system.	
		The system shall have the capability to send Notifications by Email, SMS, or phone call.	
		The system shall have the capability for audible notification of alarm.	
		The system shall have macro programming capability.	
		The system shall have a built-in script programming capability based on VB/JScript programming languages.	
		The system shall provide an option to create Times Zones for the purpose of scheduling system events/reactions.	
		The system shall have the capability to call external Applications from within its interface.	
		The system shall be able to notify the administrator if a camera fails, blinding occurs, or if a server connectivity issue occurs.	
	Logging / Health Monitoring	The system shall have an event logging capability with filtering options.	
		The system shall have the capability to store login formation in log / txt files in a designated folder.	
		The system shall have an option to control the size of The logfiles.	
		The system shall have a Health Monitoring feature that will generate real-time alerts if certain problems arise in the system.	

	Control Room Equipment's: Server		
			Compliance (Yes/No)
	Memory	16.0GB or better expandable upto32 Gb	
	Network Interface	2on-boardIntelGbE NICs	
	Network Management Interface	110/100/1000MbENIC	

Internal

	USB Communicati on Ports	4USB2.0ports		
Expansion bus				
	Remote Management	Standard IPMI2.0-compliant service processor with ILOM		
	Supported Protocols	IPMI2.0, SNMP v1, v2c, v3, Secure remote access using Web interface over SSL, or CLI over SSH		
	Storage	1TB of SATAII hard disk		
		Hardware RAID; RAID 0,1		
	Power Supply	Redundant, hot-swappable PSU and fan modules		
	Included OS	Microsoft®WindowsServer®2012OS		

	Control Room Equipment's: Storage Server			
			Compliance (Yes/No)	
	Processor	DualIntel®Xeon®E5OctaCore,2.66GHzorfaster Processor		
	Memory	16.0Gb or better expandable upto32Gb		
	Network Interface	2on-board Intel Gb E NICs		
	Network Management Interface	110/100/1000MbENIC		
	Serial Communicati on Ports	RJ-45		
	USB Communicati on Ports	4USB2.0ports		
	Expansion bus	1PCIExpressslots		
	Remote Management	StandardIPMI2.0-compliant service processor with ILOM		
	Supported Protocols	IPMI 2.0, SNMP v1, v2c, v3, Secure remote access using Web interface over SSL, or CLI over SSH		
	RAID	Hardware RAID; RAID0,1,5		
	Power Supply	Redundant, hot-swappable PSU and fan modules		
	Included OS	Microsoft ®Windows Server®2012OS		

Application	Outdoor
IP Rating	IP-56
Housing	Barrier Housing Unit: Powder Coated
Housing Dimension	Modular
Housing Material of Construction	All Aluminium Housing with Base frame in SS-304 for high protection against corrosion.
Protection	All Housing and internal parts will be rust & corrosion free metals or alloys of high strength with suitable Epoxy coating as applicable.
Housing Dimension (W x Dx H)	469x279x1100mm
Boom Specification	Boom should be round or elliptical with led lights & rubber bumper
Intelligence	The barrier shall use a Hydraulic Drive in combination with microprocessor based control card communication standard interfaced Controller.
Loop Detector	Inbuilt Dual Loop Channel Detector
Compliance & Safety	Compliance to CE.
	Adherence to Safety Requirements of the
	EMC Directive 2004/108/EC,
	Low Voltage Directive 2006/95/EC and
	The basic requirements of the Machinery
	Directive2006/42/EC
Power Supply	230+/-10%VAC,50Hz.
Electric Motor	36vdc Brushless
Maximum Power Consumption	Not More than 240 watts
Reverse on Contact feature	In built in barrier, reverses when hits any obstacle
Opening & Closing Time	2.3 Mtrs in less than1.5sec & 8.3mtr s in less than 6secs.
Operating Temp	- 20 Degree Celsius to+55 Degree Celsius
Safety	Detection of Presence of Vehicle in Loop or in the path of Infrared Safety Sensors available. Loops or Sensors to be used to prevent barriers from closing on the vehicle.
Duty Cycle	100%
Integration	Shall function in integration with Smart cards, proximity reader based access control systems etc.
Requirement	MCBF-2MillionCycles
Certificates Required	CE/UL Certification for the product

23.0 Active Components System

Core Distribution Switch

S r N o	Minimum Specification Requirement	Compliance (Yes/No)
1	Switch should have minimum 32 no. of 40G QSFP+ ports which should Also support minimum 16 nos of 100G QSFP28 ports	
2	Switch should be provided with required number of QSFP + under Separate line item in the B o Q	
3	Switching system shall have minimum 3.2 Tbps of switching fabric and minimum 1 Bpps of forwarding rate.	
4	Should have 8GB RAM and 8GB Flash and uplink should support 100 Gbps For future scalability without fork lift up gradation	
5	Switch should have hot swappable 1:1 redundant internal power supply And redundant fan.	
6	Switching system shall have minimum 60K MAC Addresses and 4K VLANs IDs.	
7	Switch should support minimum 18K ACLs, 16K Multicast and 32K IPv4, 16K IPv6 Routes.	
8	Should support IEEE Standards of Ethernet: IEEE 802.1D, 802.1s, 802.1w, 802.1x, 802.3ad, 802.1ae (256-bit and 128-bit AES), 802.3x, 802.1p, 802.1Q.	
9	Must support BGP, MPLS, IS-IS, VRF, VXLAN, OSPF Routed Access, Policy- Based Routing (PBR), PIMSM, and Virtual Router Redundancy Protocol (VRRP) from Day 1	
10	Shall have 802.1p classes of service, marking, classification, policing and shaping. Should support strict priority queuing.	
11	Switch should support management features like SSHv2, SNMPv2c, SNMPv3, IGMP, Netconf/YANG.	
12	Switch should support port security, DHCP snooping, Spanning tree root Guard and First Hop Security.	
13	IPv6 support in hardware, providing wire rate forwarding for IPv6 Network	
14	Should support 802.1x authentication and accounting, IPv4 and IPv6 ACLs And Dynamic VLAN assignment.	
15	Eight egress queues per port for different types.	

Internal

16	During system boots, the system's software signatures should be checked for integrity. System should be capable to understand that system OS are authentic and unmodified, it should have cryptographically signed images to provide assurance that the firmware & BIOS are authentic.	
17	Switch shall support application visibility and traffic monitoring with minimum 60Ks flow/net Flow entries.	
	Certification:	
18	Switch shall conform to UL60950, IEC60950, CSA60950, EN60950 Standards	

Distribution Switch

S r N o	Minimum Specification Requirement	Compliance (Yes/No)
1	Switch should have minimum 16 no. of 10G SFP+ ports with 2 no. of 40Gbps QSFP+ ports	
2	Switch should be provided with required number of SFP+ and QSFP + transceivers under Separate line item in the B o Q	
3	Switching system shall have minimum 480Gbps of switching fabric and minimum 360 Mpps of forwarding rate.	
4	Should have 8GB RAM and 8GB Flash and uplink should support 100Gbps for future Scalability without fork lift upgradation	
5	Switch should have hot swappable 1:1 redundant internal power supply and redundant fan.	
6	Switching system shall have minimum 50K MAC addresses and 4K VLAN IDs.	
7	Switch should support minimum 18K ACLs, 16K Multicast and 32K IPv4, 16K IPv6 Routes.	
8	Should support IEEE Standards of Ethernet: IEEE 802.1D, 802.1s, 802.1w, 802.1x, 802.3ad, 802.1ae (256-bit and 128-bit AES), 802.3x, 802.1p, 802.1Q.	
9	Must support BGP, MPLS, IS-IS, VRF, VXLAN, OSPF Routed Access, Policy-Based Routing (PBR), PIMSM, and Virtual Router Redundancy Protocol (VRRP) from Day 1	
10	Should have 802.1p class of service, marking, classification, policing and shaping. Should support strict priority queuing.	
11	Switch should support management features like SSHv2, SNMPv2c, SNMPv3, IGMP, Netconf/YANG.	
12	Switch should support port security, DHCP snooping, Spanning tree root guard and First Hop Security.	
13	IPv6 support in hardware, providing wire rate forwarding for IPv6 network	

Internal

1 4	Should support 802.1x authentication and accounting, IPv4 and IPv6 ACL and Dynamic VLAN assignment.	
1 5	Egress queues per port for different types.	
1 6	During system boots, the system's software signatures should be checked for integrity. System should be capable to understand that system OS are authentic and unmodified, it should have cryptographically signed images to provide assurance that the firmware & BIOS are authentic.	
1 7	Switch shall support application visibility and traffic monitoring with minimum 60K S flow/j flow/net Flow entries.	
	Certification:	
1 8	Switch shall conform to UL60950, IEC60950, CSA60950, EN60950 Standards	

Access Switches-Non-POE-48x1G;4x10GPorts		
P a r a m e t e r s	Description	C o m p l i a n c e (Y e s/ N o)
T y p e	Switch should have minimum 48 no. of 1G ports with 4no. of 10Gbps SFP+ up link ports	
P e r f o r m a n c e C e F e a t u r e s	The switch should support switching capacity of 175Gbp sand forwarding rate of 261Mpps.	
	Switch should have 2GBRAM and 4GB Flash.	
	Shall have minimum 16 KMAC Addresses and 1024 active Lans.	
	Switch should have slot/ports (excluding up links) for minimum 80Gbps of stacking band width with Dedicated stacking ports and cables with minimum 8switch in stack	
	Switch should be able to support 3000 IPV4 & 1500 IPV6 routing entries.	
	Switch should support minimum 512 Switched Virtual Interfaces.	
	The switch should support Jumbo frames of 9216 bytes	
G e n e r a l F e a t u r e s	Proposed switch should be enterprise grade switch with x86 based CPU architecture	
	Layer2, Routed Access (RIP, EIGRPS tub, OSPF-1000 routes), PBR, PIMS tub Multicast (1000 routes), PVLAN, VRRP, PBR, CDP, QoS, FHS, 802.1X, MAC sec-128, CoPP, SXP, IPSLA Responder	
	The proposed switch should be software defined networking capable and be able to at least Integrate easily with the SDN controller from the same OEM.	

	Switch should have slot/ports (excluding up links) for minimum 80 Gbps of stacking band width with Dedicated stacking ports and cables with minimum 8 switch in stack	
	The Switch stack should be based on Distributed forwarding Architecture, where in each stack Member forwards its own information on network.	
	Switch should have unique secure identity so that it's authenticity and origin can be confirmed With OEM. Switch BIOS, software image should be cryptographically signed to ensure integrity and Switch should not boot with modified software regard less of user's privilege level.	
	Switch shall support application visibility and traffic monitoring with minimum 16K Net Flow/ s flow/ j flow entries.	
	Switches should support both front and back be ac on LEDs for easy identification of the switch being accessed.	
	Switches should have hardware support to connect a Bluetooth dongle to your switch, enabling you to use this wireless interface as an IP management port interface.	
H i g h a v a i l a b i t y	Switch should support redundant field repla cable platinum rated power supplies.	
	Switch should support redundant fans.	
	Switch should support cross-stacke the r channel.	
	Switch should support embedded event manager scripts	
	After are boot when power is restored to a switch, switch should start delivering power to End points without waiting for the operating system to fully load.	
L 2 F e a t u r e s	The switch should support Automatic Negotiation of Trunking Protocol, to help minimize the Configuration & errors	
	The switch should support IEEE 802.1QV LAN encapsulation	
	The switch should support Spanning-tree Port Fast and Port Fast guard for fast convergence	
	The switch should support Uplink Fast & Backbone Fast technologies to help ensure quick fail over recovery, enhancing over all network stability and reliability	
	The switch should support Spanning-tree root guard to prevent other edge switches becoming the root bridge.	
	The switch should support Voice VLAN to simplify IP telephony installations by keeping voice traffic on a separate VLAN	

	The switch should support Auto-negotiation on all ports to automatically select half - orfull-Duplex transmission mode to optimize bandwidth	
	The switch should support Automatic media-dependent interface cross over (MDIX) to Automatically adjusts transmit and receive pairs if an incorrect cable type (cross over or straight-	
	The switch should support Uni directional Link Detection Protocol (UDLD) and Aggressive UDLD to allow for unidirectional links caused by incorrect fiber-optic wiring or port faults to be detected and disabled on fiber-optic interfaces.	
	The switch should support IGMPv1, v2 Snooping	
	Switch should support IPv4 and IPv6 The Switch should be able to discover (on both IPv4 & IPv6 Network) the neighboring device giving the details about the platform, IP Address, Link connected through etc., thus helping in trouble shooting connectivity problems.	
Net work Sec urit y feat ure s	The switch should support IEEE802.1x providing user authentication, authorization and CoA.	
	The switch should support SSH v2 and SNMPv3 to provide network security by encrypting Administrator traffic during Telnet and SNMP sessions.	
	The switch should support TACACS+ and RADIUS authentication enable centralized control of the Switch and restrict unauthorized users from altering the configuration.	
	The switch should support MAC address notification to allow administrators to be notified of users Added to or removed from the network.	
	The switch should support MACSec-128	
Qu alit y of Ser vic e	Switch should support 802.1p Class of Service (CoS) and Differentiated Services Code Point (DSCP) field classification, Shaped Round Robin (SRR) scheduling, Committed Information Rate (CIR), and eight egress queues per port.	
La yer - 3F eat ure s sho uld Ob e sup port ed Po sta lice nse up gra de fro m L2	The Switch should support routing protocols such OSPF, BSR, IS-ISv4, LISP, VXLAN, VRF. The Switch should support IPv6 Routing capable protocols such as OSPFv3 in hardware. The Switch should support IP Multi cast and PIM, PIM Sparse Mode, & Source-Specific Multicast For Wired and Wireless Clients. The Switch should support basic IP Unicast routing protocols (static, RIPv1 & RIPv2). The Switch should support IPv6 & IPv4 Policy Based Routing (PBR) The Switch should support Inter-VLAN routing. The Switch should support HSRP for IPv4 & IPv6. The Switch should support VRRPv3. The Switch should support uRPF for IPv4 and IPv6.	
	Internal	

to L3		
Native Support of following L3 features from data-plane	The Switch should support routing protocols such OSPF, BSR, IS-ISv4, LISP, VXLAN, VRF.	
	The Switch should support IPv6 Routing capable protocols such as OSPFv3 in hardware.	
	The Switch should support IP Multicast and PIM, PIM Sparse Mode, & Source-Specific Multicast For Wired and Wireless Clients.	
	The Switch should support basic IP Unicast routing protocols (static, RIPv1 & RIPv2).	
	The Switch should support IPv6 & IPv4 Policy Based Routing (PBR)	
	The Switch should support Inter-VLAN routing.	
	The Switch should support HSRP for IPv4 & IPv6.	
	The Switch should support VRRPv3.	
	The Switch should support uRPF for IPv4 and IPv6.	
Certifications	Safety certifications-IEC60950-1, UL60950-1, CAN/CSAC22.2No.60950-1, EN60950-1,AS/NZS 60950.1, Class I Equipment.	
	Electromagnetic missions certifications-47CFRPart15, CISPR22 Class A, CISPR32 Class A, CNS 13438, EN300386*, EN55022 Class A, EN55032 Class A, EN61000-3-2, EN61000-3-3,ICES-003 Class A, KN32, TCVN7189 Class A, V-3 Class A,CISPR24,EN300 386*, EN55024, KN35, TCVN7317	

	Environmental-Reduction of Hazardous Substances (ROHS) 5	
O p e r a t i n g T e m p e r a t u r e	Normal operating temperature* and altitudes:	
	-5°Cto+45°C, up to 5000 feet (1500m)	
G a r t n e r	Switch should be of an OEM who is a Gartner leader in campus switching.	
S m a r t M o n i t o r i n g	The switch should support from Day-1 the following basis SDN principles	
	Full network visibility and monitoring	
	End-to-end Quality of Experience (QoE)	
	Fast issue resolution and network remediation	
S m a r t o p e r a t i o n	· Web UI:	
	Web UI to be used as an embedded GUI-based device-management tool that provides the ability to provision the device, to simplify device deployment and manageability We should be able to use Web UI to build configurations, and to monitor and troubleshoot the device without having CLI	
	· RFID tags:	
	Switches should have an embedded RFID tag that facilitates easy as set and inventory management using commercial RFID readers.	
	· Blue beacon:	
	Switches should support both front and back blue beacon LEDs for easy identification of the switch being accessed.	
	· Bluetooth ready:	
	Switches should have hardware support to connect a Bluetooth dongle to the switch, enabling us to use this wireless interface as an IP management port interface. The port can be used for Configuration and troubleshooting using Web UI or the Command-Line Interface (CLI), and to Transfer images and configurations.	
S w i t c h	1. Automated device provisioning Internal	

h' s S o ft w ar e F e at u re s		
	2.API-driven configuration	
	3.Granular visibility -Switch should enable model-driven telemetry to stream data from a switch to a destination. The data to be stream e disidentified through subscription to a data set in a YANG	
	4.Seamless software upgrades and patching	
	5.In built Trust worthy Solutions-These technologies enable hardware and software authenticity assurance for supply chain trust and strong mitigation against man-in-the-middle attacks that compromise software and firmware.	

Access Switches POE-48x1G;4x10G Ports		
P ar a m et er s	Description	Co mp lian ce (Y es/ No)
T yp e	Switch should have minimum 48no. of 1GPoE ports with 4no.of10Gbps SFP+ uplink ports	
Pe rf or m an ce Fe at ur es	The switch should support switching capacity of 175 Gbps and forwarding rate of 261Mbps.	
	Switch should have 2GB RAM and 4GB Flash.	
	Shall have minimum 16K MAC Addresses and 1024 active plans.	
	Switch should have slot/ports (excluding uplinks) for minimum 80Gbps of stacking bandwidth with Dedicated stacking ports and cables with minimum 8 switch in stack	
	Switch should be able to support 3000 IPV4 & 1500 IPV6 routing entries.	
	Switch should support minimum 512 Switched Virtual Interfaces.	
	The switch should support Jumbo frames of 9216 bytes	
G en er al Fe at ur es	Proposed switch should be enterprise grade switch with x 86 based CPU architecture	
	The proposed switch should support native Full POE+ on all ports and required Power supplies for the same should be already populated.	
	Layer2, Routed Access (RIP, EIGRPS tub, OSPF-1000 routes), PBR, PIMS tub Multicast (1000routes), PVLAN, VRRP, PBR, CDP, QoS, FHS, 802.1X, MACsec-128, CoPP, SXP, IPSLA Responder	
	The proposed switch should be software defined networking capable and be able to at least integrate easily with the SDN controller from the same OEM.	

	Switch should have slot/ports (excluding uplinks) for minimum 80 Gbps of stacking bandwidth with Dedicated stacking ports and cables with minimum 8 switch in stack	
	The Switch stack should be based on Distributed forwarding Architecture, where in each stack member Forwards its own information on network.	
	Switch should have unique secure identity so that it's authenticity and origin can be confirmed with OEM. Switch BIOS, software image should be cryptographically signed to ensure integrity and switch should not boot with modified software regardless of user's privilege level.	
	Switch shall support application visibility and traffic monitoring with minimum 16K net Flow/s flow/j flow entries.	
	Switches should support both front and back beacon LEDs for easy identification of the switch being accessed.	
	Switches should have hardware support to connect a Bluetooth dongle to your switch, enabling you to use this wireless interface as an IP management port interface.	
High Availability & Resiliency	Switch should support redundant field replaceable power supplies.	
	Switch should support redundant fans.	
	Switch should support cross-stack ether channel.	
	Switch should be able to maintain the PoE+ power on an end point during a switch reload. This is important for critical end points, so that there is no disruption during a switch reboot.	
	Switch should support embedded event manager scripts	
	After are boot when power is restored to a switch, switch should start delivering power to end points Without waiting for the operating system to fully load.	
L2 Features	The switch should support Automatic Negotiation of Trunking Protocol, to help minimize the configuration & errors	
	The switch should support IEEE802.1Q VLAN encapsulation	
	The switch should support Spanning-tree Port Fast and Port Fast guard for fast convergence	
	The switch should support Uplink Fast & Backbone Fast technologies to help ensure quick fail over recovery, enhancing over all network stability and reliability	
	The switch should support Spanning-tree root guard to prevent other edge switches becoming the root bridge.	
	The switch should support Voice VLAN to simplify IP telephony installations by keeping voice traffic on a separate VLAN	
	The switch should support Auto-negotiation on all ports to automatically select half-or full-duplex Transmission mode to optimize bandwidth	
	The switch should support Automatic media-dependent interface cross over (MDIX) to automatically adjust transmit and receive pairs if an incorrect cable type (cross over or straight-through) is installed.	
	The switch should support Unidirectional Link Detection Protocol (UDLD) and Aggressive UDLD to allow for unidirectional links caused by incorrect fiber-optic wiring or port faults to be detected and disabled on fiber-optic interfaces.	
	The switch should support IGMPv1, v2 Snooping	
	Switch should support IPv4 and IPv6 The switch should be able to discover (on both IPv4 & IPv6 Network) The neighboring device giving the details about the platform, IP Address, Link connected through etc., thus helping in troubleshooting connectivity problems.	

N et w or k se cu rit y fe at ur es	The switch should support IEEE802.1x providing user authentication, authorization and CoA.	
	The switch should support SSHv2 and SNMPv3 to provide network security by encrypting administrator Traffic during Telnet and SNMP sessions.	
	The switch should support TACACS+ and RADIUS authentication enable centralized control of the switch and Restrict unauthorized users from altering the configuration.	
	The switch should support MAC address notification to allowed ministrators to be notified fusers added To or removed from the network.	
	The switch should support MAC Sec-128	
Q ua lit y of S er vi ce	Switch should support 802.1p Class of Service (CoS) and Differentiated Services Code Point (DSCP) field classification, Shaped Round Robin (SRR) scheduling, Committed Information Rate (CIR), and eight egress queues per port.	
L ay er -3 ea tu re s sh ou ld be su pp or te d p os t a li ce ns e U pg	The Switch should support routing protocols such OSPF, BSR, IS-ISv4, LISP, VXLAN, VRF. The Switch should support IPv6 Routing capable protocols such as OSPF v 3 in hardware. The Switch should support IP Multi cast and PIM, PIM Sparse Mode,& Source-Specific Multi cast for Wired And Wireless Clients. The Switch should support basic IP Unicast routing protocols (static, RIPv1&RIPv2). The Switch should support IPv6&IPv4Policy Based Routing (PBR) The Switch should support Inter-VLAN routing. The Switch should support HSRP for IPv4 & IPv6. The Switch should support VRRPv3. The Switch should support uRPF for IPv4 and IPv6.	
	Internal	

ra de fr o m L 2 to L 3		
N at iv e su p P or to ff oll o wi ng L 3 fe at ur es fr o m da y - l	The Switch should support routing protocols such as OSPF, BSR, IS-ISv4, LISP, VXLAN, VRF. The Switch should support IPv6 Routing capable protocols such as OSPF v 3 in hardware. The Switch should support IP Multicast and PIM, PIM Sparse Mode, & Source-Specific Multicast for Wired And Wireless Clients. The Switch should support basic IP Unicast routing protocols (static, RIPv1 & RIPv2). The Switch should support IPv6 & IPv4 Policy Based Routing (PBR) The Switch should support Inter-VLAN routing. The Switch should support HSRP for IPv4 & IPv6. The Switch should support VRRPv3. The Switch should support uRPF for IPv4 and IPv6.	

Ce rtif ica tio ns	Safety certifications-IEC60950-1, UL60950-1, CAN/CSAC22.2No.60950-1, EN60950-1, AS/NZS 60950.1, Class I Equipment.	
	Electromagnetic emissions certifications-47CFRPart15, CISPR22ClassA,CISPR32ClassA,CNS13438,EN 300386*, EN 55022 Class A, EN 55032 Class A, EN61000-3-2, EN61000-3-3, ICES-003 Class A, KN 32, TCVN 7189 Class A, V-3 Class A, CISPR 24, EN300386*, EN55024, KN35, TCVN7317	
	Environmental-Reduction of Hazardous Substances (ROHS)5	
Op era tin g Te mp erat ure Ra ng e	Normal operating temperature*and altitudes:	
	-5 °Cto+45 °C, upto 5000 feet (1500m)	
Ga rtn er	Switch should be of an OEM who Is a Gartner leader in campus switching.	

Smart Monitoring	The switch should support from Day-1 the following basis SDN principles	
	Full network visibility and monitoring	
	End-to-end Quality of Experience (QoE)	
	Fast issue resolution and network remediation	
Smart operation	Web UI:	
	Web UI to be used as an embedded GUI-based device-management tool that provides the ability to provision the device, to simplify device deployment and manage ability We should be able to use Web UI to build configurations, and to monitor and trouble shoot the device with out having CLI expertise.	
	RFID tags:	
	Switches should have an embedded RFID tag that facilitates easy asset and inventory management using Commercial RFID readers.	
	Blue beacon:	
	Switches should support both front and back blue beacon LEDs for easy identification of the switch being accessed.	
	Bluetooth ready:	
	Switches should have hardware support to connect a Bluetooth dongle to the switch, enabling us to use this wireless interface as an IP management port inter face. The port can be used for configuration and Trouble shooting using Web UI or the Command-Line Interface (CLI), and to transfer images and configurations.	
Switch's Software Features	1.Automated device provisioning	
	2.API - driven configuration	
	3.Granular visibility-Switch should enable model-driven tele me try to stream data from a switch to a destination. The data to be streamed is identified through subscription to a dataset ina YANG model.	
	4.Seamless software upgrades and patching	
	5.Inbuilt Trustworthy Solutions-These technologies enable hardware and software authenticity assurance for supply chain trust and strong mitigation against man-in-the-middle attacks that compromise software And firmware.	

WLC9800-40			
S . N o	Categ ory	Specifications	Co mpli ance (Yes /No)
		Wireless controller should support 2000 AP and 30000 clients from day1.	
	Hard ware	The control shall support deployment flexibility without compromising Any features	
		The controller shall support 400Gbps tunneling capacity	
		The controller shall support 4x10 GigSfp/ SFP+up link ports	

		Wireless Controller shall support link aggregation and load sharing Between Access Point to WLC links	
		The controller shall support hardware encrypted data plane between Access Point and Controller	
	High Availability	The controller shall be proposed with complete feature set including licensed feature	
		High Availability mode shall support controller in line data plane mode as well as local switching mode and Mesh mode	
		High Availability mode shall allow geographically dispersed installation between Controllers	
		The controller fail over shall not trigger client de-authentication and re-Association	
		Heart beat interval shall not be longer than 100msec	
		The controller shall support hot WLC software patching for fixing bugs	
		The controller shall support hot AP software patching for fixing bugs	
		The controller shall support new AP hardware without need for upgrading entire controller software.	
		The controller shall support rolling AP upgrade	
		The controller shall support rolling AP upgrade without need for clustering	
		The redundant Controller shall sync Access Point and Client Status, Including DHCP IP lease status	
	Software	Access Point shall be able to proactively distributes Client connection before and after association and tracking client condition in real time using data packet RSSI	
		The controller shall support standard-based, secure AP-Controller data & control protocol like CAPWAP.protocol that has known vulnerability Like PAPI cannot be used.	
		The controller shall support Inter-Controller Wireless Roaming	
		The controller shall maintains per-user application usage and shall be able to export it for network analytic.	
		The controller shall support Multi Languages options from embedded GUI management	
		The controller shall provide per-Client Connection Scoring and provide reasoning of Client Connection Score	
		The controller shall support Cellular off load using IPv6 tunneling to Mobile Core network	
	RF management	The controller shall be able to support multiple RF Management profile per group of APs, including Transmit Power Control And Dynamic Channel Assignment on both <u>2.4GHz</u> and 5Ghz	
		The controller shall be able to identify and avoid interferers with network performance impact analysis report	
		The controller shall support optimized, automatic channel width (20~160Mhz) selection over 5GHz, 802.11ac	
	Mesh	Mesh AP nodes shall provide quick convergence and fast fail over to new root mesh node	
		Mesh Back haul interface shall support full duplex operation using wired daisy chaining	
		Mesh AP shall support fast roaming for Wired-client through wired-to-	

		Wireless bridge client	
	Applic ation Recog nition and Contro l	The controller shall support per-user and per-WLAN based application Recognition and control that throttle usage by rate-limiting	
		The controller application recognition technology shall support exporting to 3 rd party compatible format, such as NetFlow v9	
		The controller shall provide policy-based on DNS gateway including Chrome cast gateway	
		The controller shall support new application signatures without upgrading controller software	
	BYOD & Securit y	The controller shall provide Device Profiling using multiple profiling Methods to reduce false-detection	
		The system shall provide secure onboarding service for both employee and guest based on standard-based security protocol Proposed system shall not use public cloud as user data repository	
		The controller shall be able to embedded custom web portal page (HTML) to fully customize user experience without additional cost or extra box	
		The controller shall provide rule-based rogue classification and automatically run rogue mitigation action	
		The controller shall be able to detect employee device connection to Rogue Access Point and contain it automatically. It should also support protection from Honey pot or Evil twin.	
		The controller shall support Content Security using DNS integration, Web classification shall be fully customizable	
		The system shall support control plane encryption on both IPv4 and IPv6	
		The Controller's image upgrade shall be done through secure, encrypted transport	
		The controller shall be able to provide unique pre-shared keys to the devices that do not support the 802.1x security protocol	
		The controller shall support Identity PSK for on boarding	
		The controller shall support identification & mitigation of there as inside Encrypted traffic	
	Netwo rk	The controller shall support mapping of specific VLANs to single SSID, depending on Access Point location and user	
	Config uration	The controller shall support automatic VLAN assignment per SSID to load- balance user connection assigned VLAN pool shall be same as number of available VLAN in the system	
		The controller shall support embedded best practice configuration profile and setup	
		The system shall support monitoring and provisioning from Mobile App, supporting iOS and Android	
		The controller shall support packet fragmentation between Access Point and controller communication	

NAC

S . N	Minimum Requirement Specification	Com plian ce (Yes/
	Internal	

0		No)
1	The Solution should provide a highly powerful and flexible attribute-based access control solution that combines authentication, authorization, and accounting (AAA); profiling; posture/health check	
2	Solution should include all required licenses to perform above mentioned capabilities for 4000 end points from day one	
3	It should allow enterprises to authenticate and authorize users and end points via wired, wireless, and VPN with consistent policy throughout the enterprise	
4	Proposed solution should include two appliances to be configured in Active / Standby	
5	Should enforces security policies by blocking, isolating, and repairing non-Compliant machines in quarantine area without requiring administrator attention	
6	Should support Identity source sequences which defines the order in which the Solution will look for user credentials in the different data bases. Solution should support the following databases: • Internal Users, Internal Endpoints, Active Directory, LDAP, RSA, RADIUS Token Servers, Certificate Authentication Profiles	
7	Allows Organization to configure the AD and LDAP server with IPv4 or IPv6 address	
8	Should utilizes standard RADIUS protocol for authentication, authorization, and accounting (AAA).	
9	Supports a wide range of authentication protocols, including PAP,MS-CHAP, Extensible Authentication Protocol(EAP)-MD5, Protected EAP (PEAP), EAP-Flexible Authentication via Secure Tunneling(FAST),and EAP-Transport Layer Security(TLS).	
10	Solution should support TACACS+ to simplify device administration and enhance Security through flexible, granular control of access to network devices	
11	TACACS+ device administration should support: Role-based access control Flow-based user experience Per Command level authorization with detailed logs for auditing	
12	Solution should support capability to customize TACACS+ Services by specifying Customer TACACS+ port number	
13	Solution should support capability to create different network device groups so that administrator can create: Different policy sets for IOS/OS or wireless controller OS Different for firewall Differentiate base on location of device	
14	Solution should be able to create TACACS+ profile like Monitor, Priviledge level, default, etc. to control the initial log in session of device administrator.	
15	Solution should be able to create TACACS+ authorization policy for device Administrator containing specific lists of commands a device admin can execute. Command sets should support; exact match, case sensitive,?(any character),*(matches any), etc. and support stacking as well	
16	Solution must support TACACS+ in IPv6 network	
17	Provides a wide range of access control mechanisms, including download able access control lists (d ACLs), VLAN assignments, URL redirect	

18	Solution should have profiling capabilities integrated into the solution in order to detect head less host. The profiling features leverage the existing infrastructure for device discovery. Should support the use of attributes from the following sources or sensors: * Profiling using MACOUIs * Profiling using DHC Pin formation * Profiling using RADIUS information * Profiling using HTTP information * Profiling using DNS information/Nessus * Profiling using Net Flow information/On guard Agent * Profiling using SPAN/Mirrored traffic	
19	Should have predefined device templates for a wide range of end points, such as IP phones, printers, IP cameras, smartphones, and tablets.	
20	Solutionshouldsupport the following endpoint checks for compliance for windows endpoints: Check process, registry, file& application Check operating system/service packs/hotfixes Check firewall product is running Check for Antivirus installation/Version/Antivirus Definition Date Check for Antispyware installation/Version/Antispyware Definition Date Check for windows update running & configuration	
21	Should support trouble shooting & Monitoring Tools	

Wireless LAN Controller		
S r . N O .	Specification	C o m p l i a n c e (Y e s / N o)
A Hardware Specifications		
A1	Must become pliant with IEEE802.11n or equivalent for controller-based WLANs.	
A2	Should have at least 2x10 Giga bit Ethernet interface.	
A3	Should support both centralized as well as distributed traffic forwarding architecture with L3 roaming support from day 1. Should have IP v6 ready from day one.	
A4	Controller should have hot-swappable internal redundant power supplies.	
A5	Controller should support minimum 20000 concurrent devices.	
A6	WLAN controller should have scalability to support 1500 Access points from day 1 without any Hardware change. License as per requirement.	
A7	AP must securely download image from WLC and should be configured from WLC only.	
A8	WLAN controller should provide Application visibility with both traffic forwarding mode. when traffic coming to controller and when traffic moving locally from Ap to connected access switch. Admin should have option to create policies to allow deny access based on applications.	
A9	WLC should support AP License Migration from one WLC to another	
A10	Should support minimum 4000 VLANs Internal	

0		
A 1 1	WLC must support TFTP, FTP and SFTP transfer mode.	
B	Wireless Controller Features	
B 1	Must support stateful switch over between active and stand by controller in a sub second time frame.	
B 2	WLC should support L2 and L3 roaming for IPv4 and IPv6 clients	
B 3	WLC should support guest - access functionality for IPv6 clients.	
B 4	Should support IEEE 802.1p priority tag.	
B 5	Should ensure WLAN reliability by proactively determining and adjusting to changing RF conditions.	
B 6	Should provide real-time radio power adjustments based on changing environmental conditions and signal coverage adjustments.	
B 7	Should support automatic radio channel adjustments for intelligent channel switching and real-time Interference detection.	
B 8	Should support client load balancing to balance the number of clients across multiple APs to optimize AP and client throughput.	
B 9	Should support policy based forwarding to classify data traffic based on ACLs	
B 1 0	WLC should support PM IPv6 and EoGRE tunnels on north bound interface	
B 1 1	Should support flexible DFS to prevent additional 20/40 Mhz channels from going unused	
B 1 2	Should support dynamic band width selection among 20Mhz,40 Mhz and 80 Mhz channels, ensuring one access point on 20 Mhz and another on 80 Mhz channel connected on the same controller at same WLAN group.	
B 1 3	Should support minimum 500 WLANs	
B 1 4	Should support dynamic VLAN assignment	
B 1 5	Should support Hot Spot 2.0	
B 1 6	To deliver optimal band width usage, reliable multicast must use single session between AP and Wireless Controller.	
B 1 7	Should able to do dynamic channel bonding based on interference detected on particular channel.	
B 1 8	Must support coverage hole detection and correction that can be adjusted on a per WLAN basis.	
B 1 9	Must support RF Management with 40 MHz and 80 Mhz channels with 802.11n & 802.11ac	
B 2 0	Should provide visibility to Network air time in order to set the air time policy enforcement	
B 2 1	Must support dynamic Air time allocation on per WLAN, per AP, Per AP group basis.	
B 2 2	Must be able to restrict the number of logins per user.	
C	Security	Internal

C 1	Should support web-based authentication to provide a browser-based environment to authenticate clients that do not support the IEEE802.1X supplicant.	
C 2	WLC should support web based authentication in different traffic forwarding modes.i.e Central Switching and Local switching when traffic move locally from AP to connected switch.	

C 3	Should support port - based and SSID - based IEEE802.1X authentication.	
C 4	Should support MAC authentication to provide simple authentication based on a user's MAC address.	
C 5	WLC should be able to exclude clients based on excessive/ multiple authentication failure.	
C 6	Shall support AES or TKIP encryption to secure the data integrity of wireless traffic	
C 7	Shall able to provide an air quality index for ensuring the better performance	
C 8	Shall able to provide real time chart showing interference per access point on per radio and per-Channel basis.	
C 9	Should support AP location-based user access to control the locations where a wireless user can Access the network	
C 10	Should support Public Key Infrastructure (PKI) to control access	
C 11	Must be able to set a maximum per-user band width limit on a per- SSID basis.	
C 12	WLC Shall support WIDS/WIPS, and spectral analysis from day1.	
C 13	WLC should detect if someone connect a Rogue Access Point in network and able to take appropriate action to contain rogue Access point.	
C 14	WLC should detect and protect an Ad-hoc connection when a connected user forming a network with other system without an AP or try enabling bridging between two interface	
C 15	WLC should detect if a user try to impersonate a management frame.	
C 16	WLC should detect and take appropriate contain mentation if a smartphone user using tethering to Connect other device.	
C 17	WLC should detect and protect if a user try to spoof mac address of valid client or AP for unauthorized access / authentication.	
C 18	WLC should detect if a user trying to do internet sharing through a valid system to an unauthorized device.	
D	Management & QoS	
D 1	Should support SNMPv3, SSHv2 and SSL for secure management.	
D 2	Should support encrypted mechanism to securely upload / download software image to and from Wireless controller.	
D 3	Should provide visibility between a wired and wireless network using Link Layer Discovery Protocol (LLDP) / CDP ands Flow / Netflow.	

D 4	Should support APP lug and Play (PnP) deployment with zero-configuration capability	
D 5	Should support AP grouping to enable administrator to easily apply AP-based or radio-based Configurations to all the AP sin the same group	
D 6	Should support selective firmware upgrade Aps , typically to a group of APs minimize the impact of up-gradation	
D 7	Should have a suitable serial console port.	
D 8	Should have Voice and Video Call Admission and Stream prioritization for preferential QOS	
D 9	Controller should support deep packet inspection for all user traffic across Layer 4-7 network to analyses information about applications usage, peak network usage times for all access points from day one with different traffic forwarding modes i.e central switching with WLC and local switching When traffic move locally from AP to connected switch.	
D 10	Should be able to do application visibility for application running behind HTTP proxy.	
D 11	Support profiling of wireless devices based on known protocols like http and dhcp to identify clients	
D 12	Should support visibily and control based on the type of applications	

	Outdoor Access Point	
S r . N o .	Specification	Com p l i a n c e (Yes/ No)
1	Must support 2x2 MIMO for both 802.11 ac and 802.11n.	
2	Access Point shall be able to scale Wave-2MU-MIMO operation up to 160 MHz channel band width	
3	Access Point shall be equipped with dedicate Spectrum Analyzer ASIC that expandable to 160MHz width while maintaining 78 K Hz RBW (Resolution Bandwidth)	
4	Access Point shall be able to support dedicated, dual-band security monitor mode AP, while simultaneously serves as 802.11acWave-2AP	
5	Hardware-Accelerated Deep Packet Inspection (Application Visibility) and Control to increase overall access point performance	
6	Should have 1xRJ-45 auto-sensing 10/100/1000 Mbps LAN port and 1x Built-in Gigabit SFP port for direct fiber uplink.	
7	Must support minimum of 30 dbm of EIRP in both 2.4 Gha and 5Ghz radios. And should follow the local regulatory Norms. Beamforming gain will not be Considered in calculating EIRP.	
8	Must support A Pen forced load-balance between 2.4Ghz and 5Ghz band.	
9	Must incorporate radio resource management for power, channel and Performance optimization	
10	Must have -97 dB or better Receiver Sensitivity.	
11	Must support Proactive Key Caching and/or other methods for Fast Secure Roaming.	
12	Must support Management Frame Protection.	
13	Should support locally-significant certificates on the APs using a Public Key Infrastructure (PKI).	
14	Access Points must support Hardware-based encrypted user data and Management traffic between controller and Access point for better security.	
15	Must support the ability to serve clients and monitor the RF environment concurrently.	
16	Same model AP that serves clients must be able to be dedicated to monitoring the RF environment.	
17	Must be plenum-rated (UL2043).	
18	Must support 16WLANs per AP for SSID deployment flexibility.	
19	Access Point Must continue serving clients when link to controller is down. It should also have option to authenticate user through Radius server directly from Access Point during link unavailability to controller.	
20	Must support telnet and/or SSH login to Aps directly for troubleshooting flexibility.	
2	802.11e and WMM Internal	

1		
2	Must support QoS and Video Call Admission Control capabilities.	
2		
2	The Access point shall be IP67 and NEMA rated	
3		
2	The Access point shall support operating temperature of -40 to 65°C	
4		
2	The equipment shall support up to 100MPH sustained winds & 165MPH	
5	wind gusts.	

S . N o	Firewall	Compliance (Yes/No)
	Specification required	
1 . 0 0	Industry recommendations	
1 . 1 0	The Firewall solution offered must be rate das 'leaders' or 'Challengers' in the latest Magic Quadrant for Enterprise Firewall published by Gartner	
2 . 0 0	Hardware Architecture	
2 . 1 0	The appliance-based security platform should provide firewall, AVC and IPS functionality in a single appliance from day one	
2 . 2 0	The appliance should support at least 12*1G Giga bitans 4x10 GSFP+ ports and should be scalable to additional 8*10G in future	
2 . 3 0	The appliance hardware should be a multi core CPU architecture with a hardened 64-bit operating system to support higher memory and should support minimum of 64GB of RAM	
2 . 4 0	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.	
2 . 5 0	The proposed solution shouldn't use a proprietary ASIC hardware for any kind of performance Improvement. If option to disable ASIC is there than OEM must mention the performance numbers in data sheet	
3 . 0 0	Performance & Scalability	
3 . 1 0	Should support 8Gbps of NGFW (FW, AVC and IPS) real-world/production/Enterprise Testing/ 1024BHttP/64KBHttP performance	
3 . 2 0	Firewall should support at least 3,000,000 concurrent sessions	
3 . 3 0	Firewall should support at least 40,000 connections per second	
3 . 4 0	Firewall should have integrated redundant hot-swap able power supply	
3 . 5 0	Firewall should have integrated redundant hot-swap able fan tray/modules	
3 . 6 0	High Availability Configurations shall support Active/Passive ro Active/Active-Clustering	
4 . 0 0	NG Firewall Features	
4 . 1 0	Fire wall should support creating access-rules with IPv4 & IP v 6 objects, user/groups, application, Geo location, u r l, zones, vlan, etc.	
4 . 2 0	Firewall should support static nat, dynamic nat, dynamic port	
4 . 3 0	Firewall should support Nat 66(IPv6-to-IPv6), Nat64(IPv6-to-IPv4) & Nat46(IPv4-to-IPv6) Functionality	
4 . 4 0	Should support Static, RIP, OSPF, OSPFv3 and BGP, BGPv6	
4 . 5	Should support Multicast protocols like IGMP, PIM, etc. Internal	

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4 . 6 0	Should support capability to create multiple virtual context/instances with strict hardware resource (CPU, Memory & Storage) reservation and ensure traffic isolation between virtual context/instance	
4 . 7 0	Should support capability to integrate with other security solutions to receive contextual information Like security group tags/names	
4 . 8 0	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.	
4 . 9 0	Should support more than 3000(excluding custom application signatures) distinct application Signature as application detection mechanism to optimize security effectiveness and should be able to create 40 or more application categories for operational efficiency	
4 . 1 0	Should be capable of dynamically tuning IDS/IPS sensors (e.g., selecting rules, configuring policies, Updating policies, etc.) with minimal human intervention.	
4 . 1 1	Should support more than 25,000(excluding custom signatures) IPS signatures or more. Should Support capability to configure correlation rule where multiple rules/events can be combined together for better efficacy	
4 . 1 2	Should be capable of automatically providing the appropriate inspections and protections for traffic Sent over non-standard communication ports.	
4 . 1 3	Should be able to link Active Directory and/ or LDAP user names to IP addresses related to suspected Security events.	
4 . 1 4	Should be capable of detecting and blocking IPv6 attacks.	
4 . 1 5	The solution should be able to identify, decrypt and evaluate both in bound and out bound SSL traffic on-box	
4 . 1 6	Should support the capability to quarantine endpoint by integrating with other security solution like Network Admission Control	
4 . 1 7	Solution should support full-featured NBA capability to detect threats emerging from inside the network. This includes the ability to establish "normal" traffic base lines through flow analysis Techniques (e.g., NetFlow) and the ability to detect deviations from normal base lines.	
4 . 1 8	The solution must provide IP reputation feed that comprised of several regularly updated collections Of poor reputation of IP addresses determined by the proposed security vendor	
4 . 1 9	Solution must support IP reputation intelligence feeds from third party and custom lists of IP Addresses including a global blacklist	
4 . 2 0	Should must support DNS threat intelligence feeds to protect against threats	
4 . 2 1	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.	
4 . 2 2	The detection engine should support capability of detecting and preventing a wide variety of threats (e.g., network probes/reconnaissance, VoIP attacks, buffer over flows, vP2P attacks, etc.).	

4 . 2 3	Should be able to identify attacks based on Geo-location and define policy to block on the basis of Geo-location	
4 . 2 4	The detection engine must incorporate multiple approaches for detecting threats, including at a minimum exploit-based signatures, vulnerability-based rules, protocol anomaly detection, and behavior anomaly detection techniques.	
4 . 2 5	Should support Open based Application ID/Custom Application ID for access to community Resources and ability to easily customize security to address new and specific threats and applications quickly	
5 . 0 0	Anti-APT/Malware Features	
5 . 1 0	Should support the capability of providing network-based detection of malware by checking the disposition of unknown files using SHA-256file-has horsig nature (update to be provided in300 seconds) as they transit the network and capability to do dynamic analysis on-premise on purpose built-appliance	
5 . 2 0	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	
5 . 3 0	Proposed solution shall have required subscription like Threat Intelligence for proper functioning	
5 . 4 0	Local Malware analysis appliance shall be capable of executing MS Office Documents, Portable Documents, Archive Files, Multimedia Files and executable binaries or More in a virtual environment.	
5 . 5 0	Local Malware analysis appliance shall have minimum of2x10Gor10Gig ports or more	h i r p s a n e o u v t d w p e e u e p g n r l r d a y t n e t d
7 . 0 0	Management	
7 . 1 0	The management platform must be accessible via a web-based interface and ideally with no need for Additional client software	
7 . 2 0	The management platform must be a dedicated OEM appliance and VM running on server will not be accepted	
7 . 3 0	The management appliance should have2x10Gp or t and integrated redundant power supply from day one	
7 . 4 0	The management platform must be able to store record of15000 user or more	Internal

7 . 5 0	The management platform must provide a highly customizable dashboard.	
7 . 6 0	The management platform must support multi-domain management	
7 . 7 0	The management platform must provide centralized logging and reporting functionality	
7 . 8 0	The management platform must be capable of integrating third-party vulnerability information into threat policy adjustment routines and automated tuning workflows	
7 . 9 0	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.	
7 . 1 0	Should support troubleshooting techniques like Packet tracer and capture	
7 . 1 1	Should support REST API for monitoring and configuration programmability	
7 . 1 2	The management platform must provide multiple report output types or formats, such as PDF, HTML, and CSV.	
7 . 1 3	The management platform must support multiple mechanisms for issuing alerts (e.g., SNMP, e-mail, SYSLOG).	
7 . 1 4	Solution should be able to provide insights of hosts/user on basis of indication of compromise, any license required for this to be included from day one	
7 . 1 5	The management platform must provide built-in robust reporting capabilities, including selection of pre-defined reports and the ability for complete customization and generation of new reports.	
7 . 1 6	The management platform support running on-demand and scheduled reports	
7 . 1 7	The management platform must risk reports like advanced malware, attack sand network	
7 . 1 8	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.	

S n o	PQ Criteria for Active Switches& Components
1	The OEM should be in Gartner magic quadrant for LAN and WLAN in leader's quadrant in last 2 years + IDC report
2	OEM should have registered hard wares pare de pots at least 24 number in India covering major cities.
3	OEM should have presence in India at least from last 10 years and making no loses in Networking business in last 5years.
4	The OEM should have certified partner in the city of the tender/customer with 3 certified engineers on the technology
5	OEM must be ISO Certified in Networking Business in terms of operations, Services & Support
6	The OEM of active network devices to be quoted by the bidder should have local Technical Assistance Centre (TAC) support in India through a tollfree number and Returned Materials Authorization (RMA) depot in India. Where customer can directly Log de a complaint againt any failure.
7	The OEM should have done at least 3WLAN deployment swith more than 3000 Outdoor Ap sand in total of 20,000 Outdoor APs deployment in Public Sector and Telecom within INDIA. The SI/OEM should provide Client Certificate regarding the same with the name of signatory and his details.

1. 144 CORES-OUTSIDE PLANT FIBER CABLE: -

Internal

Physical Specifications			
a) loaded: 25.7cm	Minimum Bend Radius,		
cm	Minimum Bend Radius, unloaded: 17.1		
Max: 800N	Tensile Load, long term,		
d) Max:	Tensile Load, short term,		
2700N			
Environmental Specifications			
Aerial, lashed or Buried	Environmental Space:		
Temperature: -30 degree Celsius to +70 degree Celsius	Installation		
	Operating Temperature: -40 c		
	Storage Temperature: -40 c		
Mechanical Test Specifications			
(asper IEC 60794-1 E3)	Compression:44N/mm		
IEC 60794-1E6)	Flex:35Cycles (as per		
IEC 60794-1E4)	Impact:6.62N-m (as per		
	Water Penetration Test M		

Optical Specifications Attenuation, Maximum			
a)	0.22dB/km@1550 nm		
b)	0.27dB/km@1490 nm		
c)	0.31dB/km@1385 nm		
d)	0.34dB/km@1310 nm		
Index of Refraction			
a)	1.467@1310nm		
b)	1.468@1385nm		
c)	1.468@1550nm		
Cabled Cut off Wave length, maximum:1260nm			

2. 12CORES-OUTSIDEPLANT FIBER CABLE: -

Standard Compliance	Compliance (Yes/No)	Remarks
Shall be Single mode (OS2), Single Jacket, Single Armor, Gel-free Fiber.		
Qualification Standards: ANSI/ICEAS-87-640, EN187105and TelcordiaGR-20 Standards Compliance: ITU-TG.652. D, ITU-TG.657. A1(bend insensitive) and TIA-492CAAB (OS2)		
Regulatory Compliance: RoHS2011/65/ EU compliant		
No. of Fibers:12 No. of Tubes:1		

Construction Materials			
i)	Jacket Material: MDPE		
j) Steel	Armor Type: Corrugated		
k) fiberspertube:12	Number of		
l)	Filler Quantity:4		
m)	Jacket Color: Black		
Stabilized	Jacket UV Resistance: UV		
o)	Subunit Type: Gel-free		
p)	No. of Ripcords:2		
q) Yes	Water Swellable Tape:		
Dimensions			
Diameter:11.50mm (0.45in)	Cable		
d)	Cable Weight:108kg/km		
Physical Specifications			
e) loaded: 17.3cm	Minimum Bend Radius,		
cm	Minimum Bend Radius, unloaded: 11.5		
Max: 800N	Tensile Load, long term,		
Max: 2700N	Tensile Load, short term,		
Environmental Specifications			
Aerial, lashed or Buried	Environmental Space:		
Temperature: -30 degree Celsius to +70 degree Celsius	Installation		

	Operating Temperature: -40 c		
	Storage Temperature: -40 c		
Mechanical Test Specifications			
(asper IEC 60794-1 E3)	Compression:44N/mm		
IEC 60794-1E6)	Flex:35Cycles (as per		
IEC 60794-1E4)	Impact:2.94N-m (asper		
	Water Penetration Test M		
Optical Specifications Attenuation, Maximum			
e)	0.22dB/km@1550 nm		
f)	0.27dB/km@1490 nm		
g)	0.31dB/km@1385 nm		
h)	0.34dB/km@1310 nm		
Index of Refraction			
d)	1.467@1310nm		
e)	1.468@1385nm		
f)	1.468@1550nm		
Cabled Cut off Wave length, maximum:1260nm			

3. **06CORES-OUT SIDE PLANT FIBER CABLE: -**

Standard Compliance	Compliance (Yes/No)	Remarks
Shall be Single mode (OS2), Single Jacket, Single Armor, Gel-free, Zero Water Peak Fiber.		
Qualification Standards: ANSI/ICEAS-87-640, EN187105and TelcordiaGR-20 Standards Compliance: ITU-TG. 652. D, ITU-TG. 657. A1(bend insensitive) and TIA-492CAAB (OS2) _{Internal}		

Regulatory Compliance: RoHS2011/65/EU compliant			
No. of Fibers:6			
No. of Tubes:1			
Construction Materials			
r)	Jacket Material: MDPE		
s)	Armor Type: Corrugated		
Steel			
t)	Number of fibers		
spertube:12			
u)	Filler Quantity:4		
v)	Jacket Color: Black		
	Jacket UV		
Stabilized	Resistance: UV		
x)	Subunit Type: Gel-free		
y)	No. of Ripcords:2		
z)	Water Swellable Tape:		
Yes			
Dimensions			
	Cable		
Diameter:11.50mm (0.45in)			
f)	Cable Weight:108kg/km		
Physical Specifications			
i)	Minimum Bend Radius,		
loaded:			
17.3cm			
	Minimum Bend		
cm	Radius, unloaded: 11.5		
Max: 800N	Tensile Load, long term,		
Max: 2700N	Tensile Load, short term,		

Environmental Specifications			
Aerial, lashed or Buried	Environmental Space:		
	Installation		
Temperature: -30 degree Celsius to +70 degree Celsius			
	Operating Temperature:	-40 c	
	Storage Temperature:	-40 c	
Mechanical Test Specifications			
i) (as per	Compression:44N/mm		
IEC60794-1E3)			
IEC 60794-1E6)	Flex:35 Cycles (as per		
IEC 60794-1E4)	Impact:2.94N-m (as per		
	Water Penetration Test M		
Optical Specifications Attenuation, Maximum			
i)	0.22dB/km@1550 nm		
j)	0.27dB/km@1490 nm		
k)	0.31dB/km@1385 nm		
l)	0.34dB/km@1310 nm		
Index of Refraction			
g)	1.467@1310nm		
h)	1.468@1385nm		
i)	1.468@1550nm		
Cabled Cutoff Wave length, maximum: 1260nm			

4. Fiber Joint Enclosure (IP68Rated)

Standard Compliance	Compliance (Yes/No)	Remarks
Internal		

Shall be abut type enclosure with a dome and base (IP68Rated)		
The Cable entries should be through the cable ports located in the base.		
The dome and base should be sealed using a clamp with O-ring system. The cable entry ports should be sealed mechanically, Gel- Sealed and no need of added tools for cable Installation.		
This block can be opened and closed repeatedly without the need to remove or replace the gel.		
General Specifications a) IP68Rated b) No.ofSplicetrays:6nos. c) SpliceTrayCapacity:24Fibers No.ofcableentryports:4 round ports and 1 oval port.		

The closure should have the capability to accommodate loop cables (un cut loose tube cables)		
The cables should be secured to the closure using hose clamps and a cable attachment device.		
The closure should have a basket for storing loose tubes.		

5. **144 Sliding Fiber Shelf**

Standard Compliance	Compliance (Yes/No)	Remarks
Shall accommodate 12 coupler plates or 12 pigtail cassettes for a total of 144 fiber terminations.		
The width shall be 19 inches and height of 4U (7 inches), with a maximum of 18-inch depth.		
The shelf/LIU shall be sliding.		
The Fiber shelf must be intelligent ready and must support field upgrade to intelligent fiber panels without removal of existing patch cords and without disruption of network services.		
Shall have splice trays to splice minimum 144 fibers.		

6. **48/24/12 Sliding Fiber Shelf**

Standard Compliance	Compliance (Yes/No)	Remarks
Shall accommodate 4 coupler plates or 4 pigtail cassettes for a total of 48 fiber terminations.		
The width shall be 19 inches and height of 1U (1.75 inches), with a maximum of 18-inch depth.		
The shelf/LIU shall be sliding.		
The Fiber shelf must be intelligent ready and must support field upgrade to intelligent fiber panels without removal of existing patch cords and without disruption of network services.		
Shall have splice trays to splice minimum 32 fibers.		

Internal

7. **12 Fiber Single mode Fiber Pigtail Cassettes**

Standard Compliance	Compliance (Yes/No)	Remarks
Shall be Single mode OS2, zero water peak fiber.		
Standards Compliance: G.652.D, G.657.A1 and OS2 Regulatory Compliance: RoHS 2011/65/EU Safety Standard: UL		
Number of Fiber: 12 Interface, Front: LC Adapter Color: Blue		
Optical Performance a) Insertion Loss Change, mating: 0.30dB 0.30 dB Insertion Loss Change, temperature: c) Insertion Loss, Typical: 0.30dB d) Return Loss, Min: 55.0dB		
Pigtail Environmental Specifications Environmental Space: Plenum Operating Temperature: -10degree Celsius to +60degree Celsius Cable Retention Strength, Max: 1.00 lb. @ 0-degree, 1.00 lb. @ 90degree Ferrule Geometry: Pre-radiused Ferrule Material: Zirconia Optical Components Standard: ANSI/TIA-568-C.3		

8. LC–LC Single mode LSZH Patch Cords

Standard Compliance	Compliance (Yes/No)	Remarks
Internal		

	)	
Shall be Single mode (OS2), zero water peak, LC to LC, Fiber patch cords.		
Standards Compliance: G. 652.D, G.657.A1andOS2 Regulatory Compliance: RoHS 2011/65/EU Jacket: Low Smoke Zero Halogen (LSZH) compliant to IEC 60332-3, IEC 60754-2, IEC 61034-2, IEEE 383, UL 1666, UL 1685 Flame Test Listing: NECOFNR-LS(ETL) and c(ETL)		
Cable Qualification Standards: ANSI/ICEAS-83-596 and Telcordia GR- 409 Optical Components Standard: ANSI/TIA-568-C.3		
General Specifications Connector Color: Blue Connector Interface: LC Operating Temperature: -10degreeCelsiusto+60degreeCelsius		
Connector Optical Performance Insertion Loss, Typical:0.20dB Return Loss, minimum:55.0dB Insertion Loss Change, mating:0.30dB Insertion Loss Change, temperature:0.30dB		

9. 6CORES-OUTSIDE PLANT OM 4 FIBERCABLE:-

Standard Compliance	Compliance (Yes/No)	Remarks
Shall be Multi mode (OM4),50/125llllll Single Jacket, Indoor/Outdoor, Non-Metallic Arm our, Gel-free, LSZHS heath, Tight Buffer Cable.		
Qualification Standards: ANSI/ICEAS-104-696, EN187105and TelcordiaGR-409.		
Regulatory Compliance: RoHS2011/65/EU compliant All OM4 Fiber strands shall be Bend-Insensitive Multi mode Fiber		
No. of Fibers:6		

Internal

Construction Materials:		
Non-Armored		
Jacket Color: Black		
Jacket UV Resistance: UV Stabilized		
Core Diameter:50llm		
Cladding Diameter:125llm		
Tight Buffer Diameter: 900llM		
e)Aramid Yarn with central strength member		
Dimensions		
than or equal to): 6 mm (0.47 in)	Cable Diameter (less	
h)	Cable Weight (less than	
or		
Equal to):27kg/km		
Physical Specifications		
m)	Minimum Bend Radius,	
loaded:		
8.3cm		
	Minimum Bend	
	Radius, unloaded: 5.5 cm	
	Tensile Load, long term,	
Max: 400N		
	Tensile Load, short term,	
Max: 1335N		
Environmental Specifications		
	Environmental Space: Low	
	Installation	
Temperature: -30 degree Celsius to +60 degree Celsius		
	Operating	
	Temperature: -40 c	
	Storage Temperature: -40 c	

Mechanical Test Specifications			
(asper IEC 60794-1 E3)	Compression:22N/mm		
IEC 60794-1E6)	Flex:100 Cycles (as per		
IEC 60794-1E4)	Impact:5.88N-m (as per		
	Water Penetration	Test M	
Optical Specifications Attenuation, Maximum			
m)	1.00dB/km@1300 nm		
n)	3.00dB/km@850nm		
Index of Refraction			
j)	1.479@1300nm		
k)	1.483@850nm		
Distance Supported			
1Gbps Ethernet Distance:600m@1300nm			
1110m@850nm			
10	bps Ethernet		
Distance:550m@850nm			

10. 48/24/12 Fixed Fiber Shelf

Standard Compliance	Compliance (Yes/No)	Remarks
Shall accommodate 48 fiber terminations.		
The width shall be 19 inches and height of 1U (1.75 inches), with a maximum of 14inch depth.		
Thes half/LIU shall be Fixed.		
Shallhavesplicetraystospliceminimum32fibers.		
The Couplers shall accommodate OM2, OM3, OM4fiber types		

General Specifications			
a)	Interface: LC		
b)	Body Style: Duplex		
c)	Color: Aqua		
d)	Alignment Sleeve Material:		
Phosphorous Bronze			
Transmission Standards: TIA/EIA 568			
B.3 and TIA/EIA-604 FOCIS-3			
Regulatory Compliance: RoHS2011/65/EU			

11. OM4 Multi mode Fiber Pigtail

Standard Compliance	Compliance (Yes/No)	Remarks
Shall be Multi mode OM4, Bend In sensitive fiber.		
Standards Compliance: Superior toTIA-492AAACandIEC60793-2-10 at 850 nm Regulatory Compliance: RoHS 2011/65/EU Flame Test Listing: NECOFNR-LS(ETL) and c(ETL) Flame Test Method: IEC60332-3, IEC60754-2, IEC61034-2, IEEE 383, UL 1666, UL 1685		
NumberofFiber:1 Interface A: LC Interface B: Unterminated		

Adapter Color: Beige		
Optical Performance e) Insertion Loss Typical:0.17dB Insertion Loss Change, temperature: 0.30 dB g) Insertion Loss Change, Mating: 0.30dB h) Return Loss, Min:25.0dB Attenuation, Max:1.00dB/Km @ 1300 nm 3.00dB/Km@850nm		
Pigtail Environmental Specifications Environmental Space: Low Smoke Zero Halogen (LSZH) and Riser Rated Operating Temperature: -10degree Celsius to +60degree Celsius Cable Retention Strength, Max: 5.00 lb. @ 0 degree, 5.00 lb. @ 90 degree Ferrule Geometry: Pre-radiused Ferrule Material: Zirconia Optical Components Standard: ANSI/TIA-568-C.3		

12. LC–LC Multimode OM4LSZH Patch Cords

Standard Compliance	Compliance (Yes/No)	Remarks
Shall be Multimode (OM4), Bend Insensitive, LC to LC, Fiber patch cords.		

Standards Compliance: IEC 60793-2-10, type A1a.3a IEC 60793-2- 10, type A1a.3b TIA-492AAAD (OM4) Regulatory Compliance: RoHS2011/65/EU Flame Test Method: Low Smoke Zero Halogen (LSZH) compliant to IEC60332-3, IEC60754-2, IEC61034-2, IEEE383, UL1666, UL1685 Flame Test Listing: NECOFNR-LS(ETL) and c(ETL) Cable Qualification Standards: ANSI/ICEAS-83-596 and Telcordia GR- 409 Optical Components Standard: ANSI/TIA-568-C.3		
General Specifications		
Connector Color: Beige Connector Interface: LC Operating Temperature: -10degree Celsius to +60degree Celsius		
Connector Optical Performance Insertion Loss, Typical: 0.17dB Return Loss, minimum: 25.0dB Insertion Loss Change, mating: 0.30dB Insertion Loss Change, temperature: 0.30dB		

13. Outdoor Street Cabinet/Fiber Distribution Cabinet

S . N o	Minimum Specifications/Functionalities/Capabilities	Compliance (Yes/No)	Remarks

I	Street Cabinet/Fiber Distribution Cabinet the Street cabinet shall be used for Fiber Cable distribution at field side and is a plinth mountable outdoor unit. It should at least have the following features: Should be loaded with adequate number of SCPC/SCAPC Adapters and pigtails so that all the Distribution fiber ports can be patched to the incoming and outgoing main cables. The numbers of Ports shall exceed 12 numbers at the maximum. Should have provision for loading up to 4nos of 24F splice trays, the product should be loaded with adequate number of splice trays for splicing the conventional fibers. The splice trays should be book type and should be fixed on to a tray tower The tray tower should be rotatable for ease of installation Plastic tray wedge should be provided for ease of working on lower trays The splice tray should have a maximum of 6 splice holder locations placed on the edge of the splice trays. Each location should have a provision to hold 2 nos. fusion splice protectors The box should have the provision to terminate 6nos Armoured drop cable and 1 no. of 96Fiber loop cable The adapter panel should have the following features The panel should be swing out type The 96F, Main Fiber Cable & Distribution fiber Cable in put and out puts should be patched to the front of the adapter		

	panel The pigtails should be patched to the rear of the adapter panel The adapter panel should be pre-loaded with adequate number adapters and pigtails There should be a provision for fixing 96F adapters The adapters should be fixed using screws to the adapter panel The blank adapter ports should be closed with plastic blanking plugs Basket should be provided for looping the un cut loose tubes The Cabinet should have locked System. The top should have a canopy to protect against weather The cabinet should have document holder. The Cabinet should have plinth for easy cable entry The cabinet should be supplied with all the required accessories for installation viz. Fusion splice protectors (40mm), cable ties, IPA, tissue paper, hose clamps, red adhesive tape, grounding accessories, route card, transport tube (non inking type 3mm diameter), cable ties, foam tape.		

14. Fiber Patch cords SCPC/SCAPC–SCPC/SCAPCSM, Simplex for Cross Connectivity at Fiber Distribution Cabinet

S r N o .	Minimum Specifications/Functionalities/Capabilities	Compliance (Yes/No)	Remarks
1	Type: SCAPCSCAPCSMITU-TG.652. D & G.657.A1 Simplex Patchcord, 1/2/3mtr.		
2	Cable Qualification Standards: ANSI/ICEA		
3	Cable Diameter: 1.7mm Simplex		
4	Tensile Load, short term, maximum: 33lb for 147N		
5	Compression: 10N/mm as per IEC 60794-1		
6	Tight Buffer Diameter: 900µm easy strip		
7	Insertion Loss: MAX 0.3 dB Internal		

8	Return Loss:>65dB		
9	Temperature Range: -20Deg.C+70Deg.C		

Technical Specifications for CAT6 A Copper Cable with Components

1. Specification for CAT6 ALSZHU/UTP Cable

Standard Compliance	Compliance (Yes/No)	Remarks
Channel Performance		
The Category 6A/Class EAUTPSCS shall comply with the following standards ISO/IEC 11801:2010 EN 50173 Part 1 through Part 5:2010 and 2011 ANSI/TIA-568-C IEC 60603-7-4 IEEE802.3 applications as outlined in section 2		
The Category 6A/Class EAUTP system should support the following IEEE Ethernet applications		
802.3e - 10BASE5 802.3i - 10BASE-T 802.3u - 100BASE-TX, 100BASE-T4 802.3y - 100BASE-T2 802.3z - 1000BASE-X 802.3ab - 1000BASE-T 802.3af - Power Over Ethernet (15.4W) 802.3at - Power Over Ethernet Enhancements (25.5W) 802.3az - Energy Efficient Ethernet		
Additionally, the Category 6A/ Class EA UTP SCS shall be capable of supporting the following Fiber Channel Applications Standards, per Technical Committee 11 of INCITS:		
1GFC-BASE-T 2GFC-BASE-T 4GFC-BASE-T		
It is critical that guaranteed worst-case values are provided to ensure the SCS can support 10 G transmission without risk. "Average value" or "Typical Value" is not acceptable as they do not account for lower performance channels. The proposed Category 6AUTPSCS, when configured as a worst-case 100 meter channel shall provide performance headroom over limits specified by Cat6A		

Internal

NEXT- Minimum3db above the standards; Should support a minimum of 4 connector Channel with a minimum 3db guaranteed NEXT		
Insertion Loss-3%		
Return Loss-1.0db		
The Category 6A cable and Category 6A channel components shall be manufactured by a single manufacturer. The manufacturer shall warrant the Category 6A channel cable, components, and applications for a period of 20 – 25 years.		
The Category 6A system should support channels that are shorter than 15 meters for 2, 3, 4 connector channels without any minimum length requirements. Intertek (ETL) report for 4 connector channels has to be submitted for full100meter channel and 15 meter or lower channel.		
The Cable should meet ANSI/TIA 568C.2 Category 6A Specifications		
Cables should have TRACKING Number to check the Genuity/details of the test reports online.		
The cable should consist of Eight 23 AWG copper conductors. Copper Clad Aluminum or any other combinations are not allowed		
The Cable should be round in shape		
The nominal Jacket thickness should be0.05 inches		
The nominal Outside diameter should not be more than0.285 inches (7.24 mm)		
The cable should support the installation temperature:0to600C It should support Operating temperature of -20 to 60 0 C		
The cable shall be Low-Smoke, Zero Halogen (LSZH) compatibility and must comply with the following Fire Safety standards: ISO/IEC60332-3-22: Vertical Flame Spread ISO/IEC60754-2: Acidity ISO/IEC61034-2: Smoke Density		
The cable and cordage shall be "True UTP" components that do not include internal or external shields, screened components or drain wires. No Special Grounding requirements.		

The horizontal cable shall have a unique print string on the cable jacket. This unique identifier shall also be used for on-line reference to a full set of factory tests that were performed on a sample from the same mater reel. The test parameters shall include NEXT, PSNEXT, Return Loss, Attenuation, ELFEXT and PSELFEXT. The on-line reference must be available on the SCS vendor public website, such that it can be accessed at any time.		

2. Specification for Category6AU/UTP Information Outlets

Standard Compliance	Compliance (Yes/No)	Remarks
The 8-pin modular (RJ-45) jacks shall comply with IEC 60603-7-4		
The Category 6A outlets shall be backward compatible with Category 6 and 5 E cords and cables.		
The Category 6A outlet shall be of a universal design supporting T568 A & B wiring.		
The information outlet shall have a Current Rating of 1.5A at 20°C		
The information outlet must support 90 degree cable termination. As some mounting hardware does not allow for cable entry directly from the rear, this capability is necessary		
3rd Party Verification test certificates shall be provided to show compliance to ISO/IEC 11801 Amendment 2 testing for Cat 6A components.		
The information outlet will have insertion life of 750 cycles minimum.		

3. Specification for CAT6 ALSZH/UTP RJ45 Patch Cords

Standard Compliance	Compliance (Yes/No)	Remarks
SCS must support patch cord lengths of 1 meter minimum and equipment cords of 2 meter minimum and The Patch cords shall be solid core construction		
Cords shall be equipped with 8-pin modular plugs on each end.		

All cords shall be round, and consist of copper conductors, tightly twisted into individual pairs.		
Nominal cord age diameter shall not exceed 7.24 mm.		
Plugs shall be designed with an anti-snag latch to facilitate easy removal during move, add and change processes.		
The LSZH jacket must comply with the following Fire Safety standards: ISO/IEC60332-3-22: Vertical Flame Spread ISO/IEC 60754-2: Acidity ISO/IEC61034-2: Smoke Density		
The cordage shall be UTP components that do not include internal or external shields, screened components or drain wires.		
The patch cords will have insertion life of 750cycles minimum.		

4. Specification forCAT6A Jack Panel

Standard Compliance	Compliance (Yes/No)	Remarks

24or48Port Patch Panel		
The ganged adapter style patch panel will utilise increments of six RJ-45 style jacks in a common moulded component.		
The ganged adapters shall have RJ45 jack in the front and Insulation Displacement Connector (IDC) at the rear of the module.		
The panel must be capable of supporting an upgrade to an intelligent system without any interruption to service due to patch cord removal or terminal block re-termination.		
Termination managers must be provided with the panel. These termination managers provide proper pair positioning, control, and strain relief features to the rear termination area of the panel.		
When configured in worst-case 100meter channels with full cross- connects and consolidation points with the other products proposed in this tender, the panel shall be capable of delivering the minimum guaranteed channel performance		
The patch panel type shall be a 1U (24 port) or 2U (48 port) panel capable of supporting 24 or 48 unshielded modular 8-pin connectors compliant with IEC 60603-7-4 while meeting the Channel Performance as specified in Amendment 1 to ISO/IEC 11801:2002		
The panel shall be equipped with a removable rear mounted cable management bar and front and rear labels		
The panel shall be UL and c UL Listed		
Operating Temperature Range=14°Fto140°F(-10°Cto60°C)		
Storage Temperature Range=-40°Fto158°F(-40°Cto70°C)		
Humidity=95%(noncondensing)		
Nominal Solid Conductor Diameter=0.025to0.020in (0.64to 0.51 mm)(22to24AWG)		
Nominal Stranded Conductor Diameter: =0.025to0.020in (0.64to 0.51mm (22to24AWG)		
Insertion Life=750minimum insertions of an FCC8-Position Telecommunications Plug		

5. 2&4 Port Shuttered Face Plate

Standard Compliance	Compliance (Yes/No)	Remarks
Internal		

Shall be available in 2 port and 4port square versions.		
General Specifications		
a) Color: White		
b) Width:86.36mm(3.4in)		
c) Height:86.36mm(3.4in)		
d) Depth: 13.72mm(0.54in)		
Material shall be high impact, flame retardant, UL-rated94V-0, thermoplastic.		
Flammability Rating: UL94V-0		
Safety Standard: UL Listed		
Shall be compatible with CAT5e/CAT6/CAT6A information outlets.		
Shall have in built shutters to prevent dust to accumulate on the information outlets which are not in use.		

6. Specification for Ceiling Connector module for Ceiling applications (Wi-Fi & CCTV)

Standard Compliance	Compliance (Yes/No)	Remarks
The module shall consist of a connector kit and an 18" CAT 6 or CAT 6A stranded copper cable. The end of the copper cable shall have a factory terminated RJ 45 plug.		
The Cable jacket material of the cable shall be LSZH. The material of the connector kit shall be High-impact, flame retardant, thermoplastic.		
Safety compliance: ETL Listed; UL1863andCAN/CSA-C22.2(ETL File 3166536CRT-001)		
The storage temperature shall be14°Fto140°F(-10°Cto60°C). The operating temperature shall be -40°F to 158°F (-40°C to 70°C).		
ShallsupportsIEEE802.3af,802.3atandproposed802.3bt*PoE applications.		
Shall supports 20 re-termination cycles		

7. CAT6A,SHIELDED,OUTDOOR,BURIEDCABLE:-

Internal

S . N o .	Minimum Specifications/Functionalities/Capabilities	Make, OE Model/ OE Model Part No.	Meets Spec [Y/N]	Deviations, if any
	Cat 6A F/UTP Cable Outdoor, Black Jacket, Aluminum Tape Shield inner Jacket Cable, TIA- 568C.2, (305 Mtrs. /1000 feet per Box), RoHS Compliant			
1	Minimum Specifications			
1 . 1	Shall be of 4 twisted pairs of solid conductors			
1 . 2	Shall support network line speeds upto 10 gigabits per second as per ANSI/TIA-568-C.2.			
1 . 3	Shall be 4-pair overall Foiled twisted pair to restrict alien crosstalk & should have a cross filler/ divider/ isolator pair separator, meeting Category 6A tested to 500 MHz or more as per ANSI/TIA-568C.2.			
1 . 4	The cable should be in Black color and packaged as reel-in-box.			
2	Construction Materials.			
2 . 1	) Jacket Material: PE) Conductor Material: Bare Copper) Drain Wire Material: Tinned Copper) Insulation & Separator Material: Polyolefin) Shield (Tape) Material: Aluminum Diameter Over Jacket, nominal: 8.4mm			
3	Electrical Characteristics.			

3 . 1	ANSI/TIA Category6A Dc Resistance Unbalance, maximum:5% Dc Resistance, maximum:9.38ohms/100m Mutual Capacitance:6.0nF/100m@1KHz Operating Frequency, Maximum:500MHz Operating Voltage, Maximum:80V g) Dielectric Strength, minimum: 1500 Vac / 2500 Vdc			
4	Environmental Specifications.			
4 . 1	Environmental Space: Buried b) Environmental Note: UV resistant for outdoor and/or direct burial installations Installation Temperature: -30°Cto+70°C(-22 °Fto+158°F) Operating Temperature: -40°Cto+70°C (-40 °Fto+158°F)			

Technical Specifications for Network Racks

Description	Compliance	Remarks
TECHNICAL SPECIFICATION FOR 42 URACK:		
Racks manufactured out of steel sheet punched, formed, welded and Powder coated		
Rack should be from ISO9001:2008&ISO14001:2004 Certified Company with UL Listed product		
Rack should be embossed with manufacture name		
Standard for Racks configuration will be welded frame with side panel and vented top cover		
Rack should have Front Perforated Door and Dual Perforated door at Rear.		
Rack should have provision to mount rack son Floor		
Rack should be 42U (1U=44.45 mm) in Height		
It should available in 600 & 800 Width and 650/800/1000/1200Depth		
Rack should Conforms to DIN 41494 or Equivalent EIA/ISO/EN/CEA Standard		
Rack should have Adjustable mounting depth.		
Rack 4 No Adjustable, 19" verticals with Punched 10 mm Square Hole and Universal 12.7 mm - 15.875 mm - 15.875 mm alternating hole pattern offers greater mounting flexibility, maximizes usable mounting space.		
Rack should have Numbered U positions,		
Rack should have 100 % assured compatibility with all equipment's conforming to DIN 41494 (General industrial standard for equipment's)		
Powder coated finish with seven Tanks pretreatment process meeting IS		
Rack should have Proper Grounding & Bonding		
Server/ IT Rack mount power distribution unit, 1Ph, 230V, 32A, 50/60Hz, Zero U standard with I2XC13 & 4 XC19, Inlet Plug (Not Installed, Recommended IEC30932A2P+E), 16AMCB X2 Circuits -PDU Rating 7.3KVA/Bottom feed-3Mt/ Black		
Rack should have Fan module Mount Provision on top Cover		
Rack should have provision for cable entry Exit from Both top & Bottom.		
Rack should have 1 Packet of mounting hardware, Pack of 20. Internal		

Rack Should carry ly	years warranty		

Description	C o m p l a n c e	R e m a r k s
TECHNICAL SPECIFICATION FOR WALL MOUNT RACK:		
Racks manufactured out of steel sheet punched, formed, welded and Powder coated		
Rack should be from ISO9001:2008 & ISO14001:2004 Certified Company & UL Listed		
Standard for Racks configuration will be welded frame integrated with side panel and vented top cover		
Rack should have Front Toughened Glass Door with lock & Key		
Rack should have provision to mount racks on wall.		
Rack should be 9U/12U/15U(1U=44.45mm) in Height, 550 MM Width, 400MM Depth and overall height 749 MM.		
Rack should Conform to DIN41494 or Equivalent EIA/ISO/EN Standard		
Rack should have Adjustable mounting depth,		
Rack 2 No Adjustable, 19" verticals with Punched 9mm Square Hole and Universal 12.7mm - 15.875mm-15.875 mm alternating hole pattern offers greater mounting flexibility, maximize usable mounting space.		
Rack should have 100% assured compatibility with all equipments conforming to DIN41494(General industrial standard for equipments)		
Powder coated finish with seven Tank pretreatment process meeting IS		
Rack should have Proper Grounding & Bonding		
Rack should have the provision for mounting 1or 2 Fan on Top cover		
Rack should have 1 No Cantilever Shelf for mounting NON Rack mountable Equipments		
Rack should have 1 No Power Distribution Units with 6 No 5 A Indian Round Pin with PDU Rating 1.8 KVA		
Rack should have 1 No Horizontal Cable Organizer with Plastic Loops.		
Rack should have provision for cable entry Exit from Both top & Bottom.		
Rack should have 1 Packet of Mounting hardware, Pack of 20		

25.0 Main IP-PBX Exchange

1). Necessary Technical terms & conditions for Interested Vendors

- 1.1 The offered system shall be modular in design. The Architecture of the EPABX shall be capable of seamless migration to its maximum capacity by simply adding peripheral cards/Expansion Cabinet sand without compromising on any function/ features of this system or any degradation of service. The system should be capable to expand up to at least 960 extensions, including Analog, Digital and IP.
- 1.2 The EPABX shall support IP distributed architecture for future scope. IP access points shall be centrally administrable from the host system. Peer to Peer connectivity shall be possible on IP end points. The system shall have universal ports for line/trunk cards, where in any peripheral card can be inserted in any slot of the peripheral shelf, thereby enhancing the flexibility of the configuration
- 1.3 The system should be having a Minimum equipped capacity of 5 PRI / 16 CO Lines/ 200 Digital/ 2000 Analog extensions
- 1.4 System is inclusive of all cables & accessories required from exchange to MDF/IDF though Proper cable managers/cable tray etc.
- 1.5 The bidder should be able to provide after sales service, spares etc. for at least Seven years from the date of commissioning. The firm shall submit the under taking by OEM on Non-Judicial stamp Paper / OEM's letter head for providing after sales support for providing service, spares etc. for at least Seven years from the date of commissioning.

1. General Terms

1.1 Any application software as required for completion of the project shall be within the scope of The bidder.

1.2 The supplier shall be responsible for all upgrades and updates of the firmware and application software during the warranty period and no separate amount should be claimed for this.

1.3 Supply, Installation and Commissioning of MDF/IDF with their all accessories required will be in supplier's scope.

1.4 Cabling & Termination from EPABX up to MDF/IDF with their accessories required will be in supplier's scope. Internal Cable and UPS will be in the scope of the department.

Internal

1.5 Supplier will complete whole job in the presence of existing maintenance staff.

2. SYSTEM FEATURE AND FACILITIES: -

1. Central Processing Unit:

The Central Processing Unit of the EPABX shall be Next Generation Converged, Linux based Unified Communication Server, with in-built, Ethernet LAN Port Connectivity, WAN Port and Maintenance Port, MOH Connectivity, External Paging Connectivity, and USB Port for Up-gradation Purpose. No additional hardware or ports shall be utilized for these functions.

2. Storage Media: The system should be able to download and back up all Data on a PC or external Hard disk and recover the same on the standby unit. The Backup Data should be in a single file for accurate and faster recovery of system Features.

3. Trunks ISDN (Integrated Services Digital Network)- The offered exchange shall support ISDN & only the necessary ISDN BRI & PRI Cards (Basic Rate Interface & Primary Rate Interface) need to be added for functionality.

4. Operating System: The system should be ready to connect Analog Phones and Digital Phones. In addition, the system should support IP extensions, (Proprietary IP and SIP Phones of the same make as the EPABX/IP-PBX) using MGCP/SIP Protocol resp. The operating system of EPABX should be reliable or proprietary make and should be protected against loss / alteration of memory due to power failure / unauthorized command or due to any other faulty condition The system should support Auto Restore of data in case of Power Failure; No Manual intervention should be required and all Features and facilities should be working on Power Restore.

5. Network: The EPABX system should support DHCP server, built-in Router / functionality with capability to create VPN Network within the system, with no additional 3rd Party Hardware or Application.

6. Voice Response System: The system shall be equipped with integrated (in-built) Voice Response System (VRS) with a minimum of 4 channels for voice processing applications allowing the incoming call to be directly connected to the desired extension number

after the voice response from the VRS. OGM messages could be uploaded as wave file using PC, to be used to Voice Response from within the system, without using any 3rd Party Hardware. The system should support DISA restriction to designated subscriber through Programming. At least 16 Multi Levels of DISA

/ Voice prompts should be supported by the system. The multi-level should be Upgraded to 64 Level as required, within the same embedded Server, with no additional Hardware.

The offered system shall have the following standard features i.e. Direct Inward Dialing (DID), Direct Inward Station Access (DISA), Direct Outward Dialing (DOSA) , password protected. The system should support subscriber feature access by remote using Password.

7. **Voice Mail:** The system shall be equipped with an integrated (in-built) 4 Port Voice Mail System to be accessible to all ports of the EPABX. The recording time for voice Mail should be 200 Hours, Expandable to 1000 hours without using and 3rd Party device. The User shall be able to access the system internally or remotely from any phone and shall be able to record standard /personal greetings within the mailbox. The system shall be able to inform the outside caller about the exact status of the desired extension (no answer /busy). The system should support Name dialing to reach the designated user. The system shall also support recording of name & personalized greeting within each mailbox. In the event of a Voice message, the system should support the following Notifications, an email should be sent to the designated user to inform the user of the message, If configured the entire message should be sent on the email in a wave file format. Message Indication on Digital Phones/ Voice Call to be made by the Voice Mail to advice of the pending Message. The Voice mail should be equipped for 2-way Manual Call Conversation recording by Attendant Console in case of an Emergency, by giving a command on the Attendant Console / Digital Phone or PC.
8. **Conversation Recording:** System should be equipped for 2-way call recording and should have option to select different extensions for recording based on number of Licenses available for simultaneous recordings. Supervisor should be able to select and record Analog/Digital/Proprietary IP phones without using any 3rd party Hardware or Application
- 9 **Caller Line Identification CLI on Analog Extension and Trunks:** The offered system shall have the capability to offer CLI on Analog Extensions for all internal calls. The system shall also offer CLI on Analog Trunks. The CLI shall provide Name/Number on the display of the Analog Extension. (If the Analog Phone support this feature) It should also support CLI based Routing.
- 10 The legacy TDM circuits should not utilize any IP bandwidth when any TDM-TDM switching is being done in the system.
- 11 **Conference:** It shall be possible for Digital extension user to initiate a conference of maximum 8 parties each and for Analog Phones a 3 Party Conference with any combination of internal stations & outside circuits to talk to each other at the same time on the conference circuit, (Ad hoc Conference without using Conference Bridge) It should support 30 Conference capacity Slots for a Supervised meet-me conference facility, both by Analog and Digital Phone users. (SIP based Conference Bridge to be integrated with EPABX/IP-PBX)

The system should support Group Dial for Outbound Calls where up to 30 participants can be simultaneously dialed through an Analog or Digital Instrument, using ISDN PRI Lines. Upto 8 such groups should be supported by the system.

12 VOIP-Voice over IP:

Internal

The system shall support Voice over IP (VOIP) applications; the system should support SIP trunks, SIP and H.323 Protocol for Gateway functioning, SIP Extensions for remote extensions, the remote Extensions should be able to work without any VPN and use Built in functioning of the EPABX System.

13. **Music-On-Hold:**

The system shall support in-built music-on-hold. It shall also be able to upload wave file for customized Music on Hold.

13. **Message Waiting Indication for Voice Mail:**

The system shall have facility for lighting a Message Waiting Lam provided on Digital Phones

The Analog Extensions Telephone Instruments should get a Voice prompt Notification of the Waiting Message on the voice mail unit.

14. **Networking:**

The offered system shall be capable of networking with other exchanges using normal LAN cable, signaling inter faces like E&M, E1, ISDN, BRI/PRI and IP Trunking. The system Support in built Logical Partioning, without any external hardware or Software on an external device or PC. Log for Logical Partioning should be available for audit and control purposes

15. **DECT/IP DECT:**

The system should support DECTH and sets for Future Wireless communication.

The DECT Base unit and the DECT Phones should be of the same make as that of the EPABX Main Unit. The Base Station should also support connectivity on LAN, i.e. IPDECT Base Station

Each DECT Base Station shall be capable of handling minimum of 2/4/8 DECT Phones calls Simultaneously. The DECT communication should support call handover without call disconnect.

16. **Networking with Multiple Exchanges/Remote Sites**

The system should support IP networking with other remote sites on VOIP connectivity. The remote sites

should be of the same make as the make of the Central EPABX /IP-PBX (No 3rd Party Gateway is to be used). The Command and Control of the entire Network should be with the Central unit and the slave / remote site should work seamlessly without any feature loss. The system solution should support minimum 12 such remote site connectivity. The system should support the following Protocols

- SIP/H.323
- ISDNBRI/PRI-QSIG

17. Unified Messaging:

The system should be capable of In Skin; Card based Unified Messaging facility to provide Fax and E-mail on the same desktop. The same will be required for Future use and should be possible with additional Hardware or equipment from the same OEM.

18. **Unified Messaging:** The system offered should be equipped with a Communication Software to enhance the functioning of the subscriber user by integration with the PC, Features like, Click to Dial, Chat functioning, Missed Calls, Microsoft Outlook Integration, Speed Dial search by Name and Dial, FWD Set and Cancel, should be supported by the Software. Existing PC have to be used for the functioning of the software. The same should be supported for Digital/Analog

Phones/Proprietary IP Phones. The Basic version should be available with Unlimited Activations as default functionality.

19. **UCD/ACD:** The system should support ACD routing for Contact Center/Helpdesk functionality, with Queue Message announcing Caller, waiting number and time, without using any 3rd Party Hardware. The same will be required for Future use and should be possible with additional Hardware or equipment from the same OEM.

20. Diagnostic & Enhanced Maintenance Facility

The system shall have in-built diagnostic features. The system should be programmable using Browser, without using /installing any Application in the PC. The offered system shall have remote maintenance facility over IP. The system should have in - built Web Server for Remote Web-based Maintenance and support, SNMP, FTP, HTTPS, IMAP4, NTP, NAS connectivity ON NFS, in case of an error an email should to the Administrator, conveying the error message. The system should be capable of firmware update through FTP/USB/PC

The system shall be capable of working in a suitably ventilated non-air-conditioned environment. System design shall be immune to noise from various sources like power supplies, lighting system etc. The Power Supply of the equipment should be Fan cooled to provide maximum uptime.

All components should be rated for continuous operation of the system. It should be designed in such a way that any damage in any circuit /subassembly /assembly should be self-containing and should not be propagate to other parts of the system. The system should support Hot Swappable facility for Trunk, Extension & Interface Cards.

EPABXs operating on AC shall have in built battery charging arrangement within the Power Unit for providing battery Backup for 1hr minimum. Batteries for this purpose shall be ordered Separately

21. ATTENDANT CONSOLE:

The offered exchange should include 1 No. of Attendant Console. Exchange shall be capable of supporting up to a minimum of 2 nos. of Attendant Consoles. The administrator should be able to monitor the status of trunks & should be capable of

attending /holding multi calls at one time. The Attendant Console should have dual color LED Indication for differentiating between the used & self-used lines. It should also have a Large Graphic Display, to distinguish between Trunk calls and Extension calls.

Following minimum facilities in console shall be

- 6 lines Graphic Display with LCD backlit
- Visual Display of Calling & Called Station
- Missed Call List, minimum 10 calls
- Volume Control
- Hand set and Head set MIC Mute
- Keypad Dialing
- Computer Software based Call Control with Caller ID Display, Call Hold, Call transfer, Conference, Speed Dialing, Presence for Specified Extensions, Missed Call, Contact List of 1000 Users, Call Data Report for Operator response Functioning
- Inter face for Headset Operations-Wired
- Electronic Hook Switch Control Port (EHS)
- Busy Override
- Subscriber Identity for incoming Call

Internal

- Call Splitting
- Trunk to Trunk access/Transfer
- Transfer of trunk call to another Console
- Breaking into busy extension with an interruption tone
- External Line Hold
- Call Parking
- Selective pickup of call son Hold
- Call Pickup
- Camp on Busy
- Night Service Control
- DSS (Direct station selection) with at least 40keysindication.
- OHCA, Off Hook Call Announcement (in case of Busy Operator)
- Call Waiting

2. **Subscriber Facility**

(i) The offered system shall have the capability of assigning to use extension a variety of specified services. Further class of service restriction shall be available to the subscribers.
Call forwarding shall be available in the offered system

(ii) The system shall support abbreviated dialing system for numbers.

(iii) The system shall be capable of allowing the users to access all the facilities from any extension of the EPABX. The system shall allow user to assign passwords to their phones to prevent misuse of subscriber's facilities provided.

(iv) Least cost routing through alternate public network son different time of day basis shall be available

(v) Night Service: When night service is activated, the operator calls shall be routed to predefine answering position.

Internal

23. The offered system shall have the following minimum features for the subscriber:

Hot line Attendant Recall

Call forwarding preset/busy/No answer Call Hunting

Automatic Call Back Call Waiting

Station Camp on Call back on busy

Hunting method change for each type of calls

DND (Do Not Disturb)

DNDO (Do Not Disturb Override) Consultation hold

Call Pickup

Call Parking and Retrieve

Extension to extension intercom barring Storage of last number dialed

Discriminative Ringing-between Internal and external Calls

Walking Station Class of Service Busy Override

Auto Answer on Digital Phones Boss- Secretary Functioning

One Extension for Sr. executives (2Digital Phones should work in parallel as a single extension, Table /Sofa Concept)

24. The offered system shall have the following minimum features for the Digital subscriber (Basic Digital)

- 1Line Graphic LCD Display with Back Lit
- Missed Call List, minimum 10 numbers
- Headset Provision, 2.5mm or similar
- Minimum 8 DSS/BLF Keys for easy dialing
- Full Duplex Speaker phone Quality
- Prefixed keys for MIC Mute, Redial, Auto Answer, Volume Control, Navigation Keys
- Multiple ringing tones
- Open Listening/Off hook Monitor
- Automatic Redial with Programmable time difference.
- OHCA, Off Hook Call Announcement
- Call Waiting
- Extension List Search by Alphabet

25. XDP (In-built or with external Adaptor, If External Adaptor the cost to be included in Phone)

The offered system shall have the following minimum features for the Digital subscriber
Internal
(Executive Digital)

- 3Line Graphic LCD Display with Back Lit
- Missed Call List, minimum 10 numbers
- Headset Provision, 2.5mm or similar
- Minimum 20 DSS/BLF Keys for easy dialing
- Full Duplex Speaker phone Quality
- Prefixed keys for MIC Mute, Redial, Auto Answer, Volume Control, Navigation Keys
- Multiplering tones
- Open Listening/Off hook Monitor
- Automatic Redial with Programmable time difference.
- OHCA, Off Hook Call Announcement
- Call Waiting
- Extension List Search by Alphabet.
- XDP (In-built or with external Adaptor, If External Adaptor the cost to be included in Phone)

24. The system should support UCD/ACD based routing and MIS reporting. The group members should be able to LOG IN and LOG OUT for Receiving Calls on the Analog and Digital Phone. The Data should be available on the MIS Reporting Software.

25. The system should support ACD based Reporting for Future use by Activating Feature Key

S . n o	Feat ures	Specifications	om pli a nc e	le m a r k s
1	Main IP- PBX Tele pho ne Exc han ge , (cov erin g Mai n unit s & SI	Main Unit with IP Card, Universal Slots, SMPS Power Supply having a capacity of 2 PRI /16 CO Lines/84 Digital / 200 IP Extensions/1172 Analog extensions, expandable to at least 2000 Extension, Including License, System is inclusive of all cables & accessories required from exchange to MDF/IDF though proper cable managers/cable tray etc. (Pls refer to specifications for details) Internal		

	aves unit s)			
SYSTEM FEATURE AND FACILITIES:				
2	Cent ral Proc ess in g Unit :	The Central Processing Unit of the EPABX shall be Next Generation Converged, Linux based Unified Communication Server, with in-built, Ethernet LAN Port Connectivity, and Maintenance Port, MOH Connectivity, External Paging Connectivity, and USB Port for Up- gradation Purpose. No addition al hardware or ports shall be utilized for these functions.		
3	Ope rati ng Syst em:	The system should be ready to connect Analog Phones and Digital Phones. In addition, the system should support IP extensions, (Proprietary IP and SIP Phones of the same make as the EPABX/IP-PBX) using MGCP/SIP Protocol resp. The operating system of EPABX should be reliable or proprietary make and should be protected against loss / alteration of memory due to power failure / unauthorized command or due to any other faulty condition The system should support Auto Restore of data in case of Power Failure; No Manual intervention should be required and all Features and facilities should be working on Power Restore.		
4	Net wor k:	The EPABX system should support DHCP server, built-in Router / functionality with capability to its own Network. The system should support the below mentioned Trunk and Interface Protocols -ISDN PRI - IP H.323 - SIP - QSIG		

5	Voice Response System:	The system shall be equipped with integrated (in-built) Voice Response System (VRS) with a minimum of 4 channels for voice processing applications allowing the incoming call to be directly connected to the desired extension number after the voice response from the VRS. OGM messages could be uploaded as wave file using PC, to be used to Voice Response from within the system, without using any 3rd Party Hardware. The system should support DISA restriction to designated subscriber through Programming. At least 16 Multi Levels of DISA / Voice Prompts should be supported by the system.		
6	Voice Mail:	The system shall be equipped with an integrated (in-built) 4Port Voice Mail System to be accessible to all ports of the EPABX. The recording time for voice Mail should be 200 Hours, Expandable to 1000 hours without using and 3rd Party device. The User shall be able to access the system internally or remotely from any phone and shall be able to record standard / personal greetings within the mail box. The Voice mail should be equipped for 2-way Manual Call Conversation recording by Attendant Console in case of an Emergency, by giving a command on the Attendant Console / Digital Phone or PC.		
7	Conversation Recording:	System should be equipped for 2-way call recording and should have option to select different extensions for recording based on number of Licenses available for simultaneous recordings. Supervisor should be able to select and record Analog/Digital/Proprietary IP phones without using any 3rd party Hardware or Application		
8	Conference:	It shall be possible for Digital extension user to initiate a conference of maximum 8 parties each and for Analog Phones a 3 Party Conference with any combination of internal stations & outside circuits to talk to each other at the same time on the conference circuit, (Ad hoc Conference without using Conference Bridge).It should support 30 Party Conference capacity for a meet-me conference facility, both by Analog and Digital Phone users. The system should support Group Dial for Outbound Calls where participant scan be dialed using IS DNPRI Lines. Upto 8 such groups should be supported by the system		

9	VOIP-Voice over IP:	The system shall support Voice over IP (VOIP) applications; the system should support SIP trunks, SIP and H.323 Protocol for Gateway functioning, SIP Extensions for remote extensions, the remote Extensions should be able to work without any VPN and use Built in functioning of the EPABX System.		
10	Music-On-Hold:	The system shall support in-built music-on-hold. It shall also be able to upload wave file for customized Music on Hold		
11	Message Waiting Indication for Voice Mail :	The system shall have facility for lighting a Message Waiting Lamp provided on Digital Phones the Analog Extensions Telephone Instruments should get a Voice prompt Notification of the Waiting Message on the voice mail unit.		
12	Networking :	The offered system shall be capable of networking with other exchanges using normal LAN cable, signaling interfaces like, E1, ISDN, BRI, PRI and IP Trunking. The system support in built Logical Partitioning, without any external hardware or Software on an external device or OPC. Log for Logical Partitioning should be available for audit and control purposes		
13	DECT/IP DECT:	The system should support DECT Handsets for Future Wireless communication. The DECT Base unit and the DECT Phones should be of the same make as that of the EPABX Main Unit. The Base Station should also support connectivity on LAN ,i.e. IP DECT Base Station		
14	Networking with Multiple Exchanges /Re	The system should support IP networking with other remote site son VOIP connectivity. There mote sites should be of the same make as the make of the Central EPABX/IP- PBX (No 3rd Party Gateway is to be used). The Command and Control of the entire Network should be with the Central unit and the slave / remote site should work Seamlessly without any feature loss. Internal		

	mot e Sites			
1 5	Unif ied Mes san g:	The system should be capable of In Skin; Card based Unified Messaging facility to provide Fax and E-mail on the same desktop. The same will be required for Future use and should be possible with additional Hardware or equipment from the same OEM		
1 6	UC D/A CD:	The system should support ACD routing for Contact Center/Helpdesk functionality, with Queue Message announcing Caller, waiting number and time, without using any 3rd Party Hardware. The same will be required for Future use and should be possible with additional Hardware or equipment from the same OEM.		
1 7	ATT EN DA NT CO NSO LE:	The offered exchange should include 1 No. of Attendant Console. Exchange shall be capable of supporting up to a minimum of 2 nos. of Attendant Consoles. The administrator should be able to monitor the status of trunks & should be capable of attending / holding multi calls at one time. The Attendant Console should have dual color LED Indication for differentiating between the used & self-used lines. It should also have a Large Graphic Display, to distinguish between Trunk call and Extension calls. *More Details See Specification.		
1 8	Subs crib er Faci lity:	The offered system shall have the following minimum features for the subscriber: Hot line, Attendant Recall, Call forwarding preset/busy/No answer, Smart Desk for Walking Extension / Free seating across Campus, Call Hunting, Automatic Call Back, Call Waiting, station Camp on Call back on busy, Hunting method change for each type of calls *More Details See Specification.		

19	The Digital Phones should have these minimum features and specifications (Basic Digital - Type I)	1Line Graphic LCD Display with Back Lit, Missed Call List, minimum 10 numbers, Headset Provision, 2.5 mm or similar, Minimum 8 DSS / BLF Keys for easy dialing Full Duplex Speakerphone Quality. *More Details See Specification.		
20	The Digital Phones should have these minimum features and specifications (Executive Digital)	3 Line Graphic LCD Display with Back Lit, Missed Call List, minimum 10 numbers, Headset Provision, 2.5 mm or similar, Minimum 20 DSS / BLF Keys for easy dialing Full Duplex Speakerphone Quality. *More Details See Specification.		

Internal

	tal- Typ e II)			
2 1	The Anal og Pho nes shou ld have mini mu m feat ures and spec ifica tion Ons (An alog Han dset s- Basi c No Sp- pho ne) TYP E-I	2 Line LCD Display, LCD Contrast level – 4 Levels Caller ID memory, minimum30 numbers, Redial Memory– 5Numbers Flash timing–Programmable, Speaker Phone–No, Ringer Volume – Off / Low/ High, Wall Mountable – Yes Batter– Not required, Time Display		

2 2	The Analog Phones should have minimum features and specifications (Analog Handsets-Basic with Sp-phone) TYP E-II	2 Line LCD Display, LCD Contrast level – 4 Levels Caller ID memory, minimum 30 numbers, Redial Memory– 5Numbers Flash timing–Programmable, Speaker Phone–Yes Ringer Volume–Off/Low/High, Wall Mountable– Yes, Batter – Not required, Time Display		
2 3	CD/ACD based routing and MIS reporting	The system should support UCD/ACD based routing and MIS reporting. The group members should be able to LOG IN and LOG OUT for Receiving Calls on the Analog and Digital Phone. The Data should be available on the MIS Reporting Software. Queue Message should be available by default in case the members are All Busy, Routing to Operator / Supervisor should be available		
2 4	Cabling and MDF	Cabling & Termination from EPABX up to MDF/IDF with their accessories required will be in supplier's scope. Internal Cable, LAN Network, OFC, and UPS will be in the scope of the department		

26.0 Audio Visual System

Technical Specifications:

The bidder should refer the block schematic in conjunction to the specification for providing the appropriate Make and Model. The bidder shall consider the brands from the approved list only. Bidders can quote only one Make & Model against each line item. If any line item needs multiple items to meet the total specification the bidders must mention, Make & Models for all the sub items with respective OEM part no's & model nos. The same cannot be changed once quoted. Clarification if any will be asked for the quoted models only. The bidder has to submit a detailed AV & control schematic with the quoted make & Model along with the technical bid.

1. 5000 Lumens DLP Projector

DLP (Laser Phosphor) Projection System with an Ultra Short Throw Lens is hereby proposed. The projection system features a high brightness of 5000 or more Lumens, ensuring clear and vibrant visuals even in well-lit environments. It also supports 3D capability, enhancing the immersive viewing experience for compatible content. With a resolution of 1920 x 1200, the projection system delivers sharp and detailed imagery, providing excellent visual clarity. The contrast ratio of 1800:1 or better further enhances the image quality, offering rich and deep color reproduction. The system incorporates a long-lasting illumination life of 20000 hours, reducing maintenance requirements and ensuring prolonged usage. For seamless connectivity, the system is equipped with HDMI and HD Base T inputs, enabling easy integration with various multimedia devices and sources. This ensures flexibility and compatibility for different connectivity needs. The supply of the projection system will be completed, including a mounting bracket and other necessary accessories for convenient installation and operation. The comprehensive package ensures a hassle-free setup and optimal performance.

Projection Screen Motorized projection screen with a diagonal size of 115 inches and an aspect ratio of 16:10. The screen shall be equipped with a Tubular Motor controlled by a low voltage relay for seamless operation. To ensure safety and compliance, the screen fabric should adhere to DIN 4102-1 Class B2 standards, certifying it as a fire-resistant material. It should be capable of sustaining a temperature range of 23 ± 2 °C and a relative humidity of $50 \pm 6\%$, making it suitable for various environmental conditions. The screen should incorporate an Anti-Heat Cut Off feature, safeguarding against potential risks or accidents at the installation site. Furthermore, a heavy dowel shall be provided to maintain the screen's flatness and stability during operation. The screen fabric must meet the requirements of Class B2 building materials, ensuring its fire resistance and safety. The complete package will include all standard accessories necessary for installation and operation.

75” Interactive Display 4K 75-inch interactive professional display. The display shall provide an immersive touchscreen experience and support simultaneous multi-user writing, enhancing collaboration and productivity. The display shall have the following specifications:

Resolution: 3,840 x 2,160

Brightness: 350 nits or higher

Contrast: 3000:1 or higher

Viewing Angle (H/V): 178 degrees

Response Time: 6 MS or faster

Built-in Speakers: 10W x 2

Input: 2 x HDMI, 1 x DP, Stereo Mini Jack, RS-232, RJ-45, IR. The display should seamlessly support keyboard and mouse input and offer a touch response time of 6 MS or faster. It shall feature heat semi-strengthened glass and provide 20 touch points using a passive pen with a magnet. Additionally, it should be equipped with an embedded Wi-Fi/BT module and include useful features like a document viewer, video player, web browser, and whiteboarding app. The display's CPU shall have a clock speed of 1.7 GHz quad-core or better, with memory consisting of 1.6 GHz 64-bit 3.0 GB, and a storage capacity of 16 GB. To minimize glare, the display shall have an anti-glare film, along with a shatter-proof film for added durability. It shall also be coated with an anti-microbial layer for hygiene purposes. Moreover, the display shall have the capability to connect up to 50 users, allowing up to 4 users to collaborate simultaneously from tablets, mobiles, or PCs over the network. It should be supplied with the necessary mounting bracket shall be supplied as required.

2. 85” Interactive Display

4K 85-inch interactive professional display. The display shall provide an immersive touchscreen experience and support simultaneous multi-user writing, enhancing collaboration and productivity. The display shall have the following specifications:

Resolution: 3,840 x 2,160

Brightness: 350 nits or higher

Contrast: 3000:1 or higher

Viewing Angle (H/V): 178 degrees

Response Time: 6 MS or faster

Built-in Speakers: 10W x 2

Input: 2 x HDMI, 1 x DP, Stereo Mini Jack, RS-232, RJ-45, IR. The display should seamlessly support keyboard and mouse input and offer a touch response time of 6 MS or faster. It shall feature heat semi-strengthened glass and provide 20 touch points using a passive pen with a magnet. Additionally, it should be equipped with an embedded Wi-Fi/BT module and include useful features like a document viewer, video player, web browser, and whiteboarding app. The display's CPU shall have a clock speed of 1.7 GHz quad-core or better, with memory consisting of 1.6 GHz 64-bit 3.0 GB, and a storage capacity of 12 GB. To minimize glare, the display shall have an anti-glare film, along with a shatter-proof film for added durability. It shall also be coated with an anti-microbial layer for hygiene purposes. Moreover, the display shall have the capability to connect up to 50 users, allowing up to 4 users to collaborate simultaneously from tablets, mobiles, or PCs over the network. It should be supplied with the necessary mounting bracket shall be supplied as required.

65" 4K UHD Display 65" 4K display panel boasts a diagonal screen size of 65 inches, providing a stunning visual experience. With a resolution of 3840×2160 pixels, shall offer a sharp and detailed picture quality. The display's brightness should be 350 cd/m^2 or better and have a 1200:1/4000:1 or better contrast ratio. ensuring vibrant and vivid colors. The viewing angle is wide, allowing for clear visibility from both horizontal and vertical perspectives at 178° each. For connectivity, the panel shall include two or more HDMI inputs, 2 x USB 2.0, Additionally, it shall have one 3.5 mm Stereo Audio output for easy connection to external audio devices. The display shall have a built-in speaker system that delivers powerful sound with a total output of 20 W (10 W + 10 W), enhancing the audio experience while eliminating the need for external speakers, Certificate: CE, FCC, BIS, UL etc. complete with standard accessories as required.

3. 55” 4K UHD Display

55" 4K display panel boasts a diagonal screen size of 55 inches, providing a stunning visual experience. With a resolution of 3840 × 2160 pixels, shall offer a sharp and detailed picture quality. The display's brightness should be 350 cd/m² or better and have a 1200:1/4000:1 or better contrast ratio. ensuring vibrant and vivid colors. The viewing angle is wide, allowing for clear visibility from both horizontal and vertical perspectives at 178° each. For connectivity, the panel shall include two or more HDMI inputs, 2 x USB 2.0, Additionally, it shall have one 3.5 mm Stereo Audio output for easy connection to external audio devices. The display shall have a built-in speaker system that delivers powerful sound with a total output of 20 W (10 W + 10 W), enhancing the audio experience while eliminating the need for external speakers, Certificate: CE, FCC, BIS, UL etc. complete with standard accessories as required.

43” 4K UHD Display 43" 4K display panel boasts a diagonal screen size of 43 inches, providing a stunning visual experience. With a resolution of 3840 × 2160 pixels, shall offer a sharp and detailed picture quality. The display's brightness should be 350 cd/m² or better, shall have 3000:1 or better contrast ratio. ensuring vibrant and vivid colors. The viewing angle is wide, allowing for clear visibility from both horizontal and vertical perspectives at 178° each. For connectivity, the panel shall include two or more HDMI inputs, 2 x USB 2.0, Additionally, it shall have one 3.5 mm Stereo Audio output for easy connection to external audio devices. The display shall have built-in speaker system delivers powerful sound with a total output of 20 W (10 W + 10 W), enhancing the audio experience while eliminating the need for external speakers, Certificate: CE, FCC, BIS, UL etc. complete with standard accessories as required.

4. Network Conferencing Camera -type-1

Network 4K PTZ Conference camera for Presenter with 12x optical zoom & 80-degree horizontal coverage. Low Noise CMOS 4K image sensor with User-configurable resolution and quality for IP streams (up to 1080p). HDMI resolutions up to 4K30 and SDI-3G resolution up to 1080p60. Image rotation controls to allow for inverted mounting using ceiling bracket. Minimum Illumination - 0.5 Lux @ (F1.8, AGC ON), Horizontal Rotation Range - ±170°, Vertical Rotation Range - -30° to +90°, White

Balance controls- Auto, indoor, outdoor, one-push, manual, specified colour temperature. Power – PoE & AUX. Wall mounting bracket included.

5. Network Conferencing Camera – Type-2

4K Network PTZ Conference camera for Participants with 12x optical zoom & 80-degree horizontal coverage. Low Noise CMOS 4K image sensor with User-configurable resolution and quality for IP streams (up to 1080p). HDMI resolutions up to 4K30 and SDI-3G resolution up to 1080p60. Image rotation controls to allow for inverted mounting using ceiling bracket. Minimum Illumination - 0.5 Lux @ (F1.8, AGC ON), Horizontal Rotation Range - $\pm 170^\circ$, Vertical Rotation Range - -30° to $+90^\circ$, White Balance controls- Auto, indoor, outdoor, one-push, manual, specified colour temperature. Power – PoE & AUX. Wall mounting bracket included.

6. Recorder & Streamer

Recording, Streaming & Webcasting Hardware simultaneously, Built-in 4x HDMI & IP Inputs with 4x Line Inputs, 2x HDMI Outputs. The system should be capable to record up to any four inputs simultaneously in a single frame and as well as individual sources simultaneously. Should have minimum 1TB inbuilt storage and can be connected to local NAS storage. The system should be able to support minimum 3 unicast streams. The recorded files should have the option of time and date stamp. OEM should be CE, FCC, RoHS & BIS Certified

7. AV over IP Encoder

1G HDMI Video Encoder. Inputs- 3 HDMI capable of streaming of 3-HDMI sources simultaneously. Resolution-up to 4K60 4:4:4, Power - PoE and AUX PSU. Ports Connections - RS232, GPIO, Audio Inputs, Audio Output & USB-B port supporting AV USB Bridging for software or web-based conferencing applications. Content Protection: HDCP 2.2 compliant, EDID Management. Dante/AES67 Audio Support. Mounting accessories included. USB-B for Software or web-based Conferencing can be added by required additional hardware to fulfil the requirement. If Encoder is capable of streaming only one input, match the qty as per the requirement (3 inputs).

8. Wireless Presentation Device

Wireless Presentation Solution that revolutionizes the way presentations are conducted. This solution enables seamless wireless presentation of 4K content, eliminating the need for cumbersome cables and allowing for a truly wireless experience. The Wireless Presentation Solution boasts several advanced features, including app-free functionality, wireless touch capabilities, and extended screen support. Users can effortlessly share their screens without the need for any additional applications or software. With the ability to support up to four shared screens simultaneously, multiple presenters can collaborate and share content effortlessly. Additionally, users can annotate directly in Office 365 apps and share their notes with other devices or the front-of-room display, promoting enhanced collaboration and engagement. The device shall support a wide range of display resolutions, including up to 4K, Full HD 1080P, and UXGA/WUXGA, ensuring crystal-clear visuals. It shall Provide HDMI / VGA / mini-DisplayPort, and analog audio outputs. Furthermore, the solution incorporates enterprise management features, enabling centralized control and management of the wireless presentation system. This simplifies administration, enhances security, and streamlines deployment across the organization. The supply of the Wireless Presentation Solution shall include all necessary components and accessories for seamless installation and operation.

9. Smart Podium

Digital Podium in a Metallic Frame. The podium shall include a 21-inch Full HD Interactive Display with an Electromagnetic Pen. The Interactive Panel should have Motorized Tilting capabilities. The podium should also provide provisions for installing a Gooseneck Microphone, an Interactive Panel, a Keyboard Tray, a Visualizer Tray, and space to store AV equipment. The Interactive Display should feature a full HD resolution of 1920x1080, utilizing IPS LCD technology with an aspect ratio of 16:9. The brightness should be 250 cd/m2, and the contrast ratio should be 1000:1. The Pen Type used should be Pressure-sensitive and cordless. The top connectivity plate of the podium should include HDMI, USB x 2 and a Power socket for external Laptop connectivity. It should also feature a built-in 4 x 2 HDMI Matrix Switcher supporting 4K@60Hz (4:4:4, 8-bit), as well as 16-bit Deep Color, HDR (High Dynamic Range), 3D contents, HD audio, and other features defined by the HDMI 2.0 specification. Additionally, it should support Audio De-embedding for internal connectivity. The podium should have a built-in 9 U Rack space to accommodate AV Equipment. It should be supplied with an i5 Mini PC with Windows 10, as well as a Keyboard and Mouse, as required.

10. Flush Mount Cable Cubby

Flush Mount Cable Cubby with premium features. The cable cubby shall be specifically designed with a slow-motion flip-open cover and include multi-format cables to accommodate various connectivity needs. The cover of the desktop socket shall be made of aluminum alloy finishing, ensuring durability and a sleek appearance. It shall be designed to seamlessly integrate into office furniture, providing a seamless and aesthetically pleasing solution. The cable cubby shall feature a soft opening mechanism, prioritizing user comfort and safety during operation. It shall provide connectivity such as 2 x Universal Power outlets, 2 x USB-A Charger ports, 1 x HDMI port, 1 x USB port, and 1 x RJ-45 Network port. These versatile connectivity options enable easy integration with a range of devices and ensure efficient data and power transfer. The supply of the cable cubby will include all standard accessories required for installation and operation, ensuring a comprehensive and hassle-free solution.

4x4 HDMI Matrix Switcher 4x4 HDMI Matrix Switcher with Audio Output. Should enable for the seamless switching between All Inputs and Outputs. HDMI Switcher should support for 18Gbps resolutions, including 4K@60Hz (4:4:4, 8-bit), ensuring high-quality video transmission. Compatibility with 16-bit Deep Color, HDR (High Dynamic Range), HD audio, and other features specified in the HDMI 2.0 specification. Should have EDID management feature, providing options to select from built-in default EDID, EDID copied from connected sink devices, or a configurable EDID. Should support for a resolution of 4096×2160p@60 @4:4:4 or higher. Should be HDCP compliance, ensuring compatibility with protected content. The Switcher should be supplied with standard accessories necessary for its operation. It should be designed to provide a reliable and efficient solution for managing multiple HDMI sources and displays, supporting high-resolution video, audio, and advanced HDMI features.

11. 1:2 HDMI distribution Amplifier

A 1×2 HDMI distribution amplifier meeting the following specifications: The HDMI distribution amplifier should have the capability to support downscaling of video signals. Should be able to handle resolutions up to 4096x2160 @ 60 with a 4:4:4 chroma subsampling, ensuring high-quality video output. Should supports High Dynamic Range technology, enabling superior contrast and color accuracy in the displayed content. The device should be fully HDCP compliant to ensure secure content transmission and compatibility with protected sources. Should incorporate EDID management, allowing for automatic and reliable detection and configuration of connected display devices.

12. 1:4 HDMI distribution Amplifier

A 1×4 HDMI distribution amplifier meeting the following specifications: The HDMI distribution amplifier should have the capability to support downscaling of video signals. Should be able to handle resolutions up to 4096x2160 @ 60 with a 4:4:4 chroma subsampling, ensuring high-quality video output. Should supports High Dynamic Range technology, enabling superior contrast and color accuracy in the displayed content. The device should be fully HDCP compliant to ensure secure content transmission and compatibility with protected sources. Should incorporate EDID management, allowing for automatic and reliable detection and configuration of connected display devices.

13. HDMI Extender

HDMI and Control Extender Set that offers seamless transmission of uncompressed HDMI signals over a single CAT x cable. This advanced solution enables efficient and reliable signal extension for enhanced connectivity. The extender set should support HDMI 1.4 or better with 3D and 4k capabilities, ensuring compatibility with high-definition content. It should be HDCP compliant, allowing for secure transmission of protected content. The extender set should be capable of transmitting uncompressed signals up to a distance of 100 meters, providing flexibility in installation. Furthermore, the extender set should support audio formats up to 7.1 channels, including Dolby True HD and DTS-HD, delivering exceptional sound quality and immersive audio experiences. To simplify installation and operation, the extender set should feature built-in RS-232, IR control, and Power over Ethernet (PoE) capabilities, eliminating the need for additional cables and power supplies. This enables seamless control and extension of signals over a single CAT x cable, reducing clutter and enhancing convenience. The extender set should have a minimum bandwidth of 10.2Gbps, ensuring reliable and high-speed data transmission. The transmitter unit should be equipped with 1 x HDMI input and 1 x HDBT (HD Base T) output, while the receiver unit should have 1 x HDBT input, 1 x HDMI output, and support for RS-232 and IR pass-through, allowing for easy integration with control systems. The supply of the HDMI and Control Extender Set will include all necessary components and accessories required for successful installation and operation.

14. Wall Plate Type Transmitter

A Wall Plate type 2x1 HDMI transmitter. The transmitter should be equipped with the following ports: 1x HDMI input, 1x VGA input, 1x Audio input, and 1x HDBT output. It must be capable of sending video audio and Data signals over a single CAT x cable, reaching distances of up to 100 meters. The device should support power over HDBT, allowing it to receive power through the same CAT x cable, and it should also have the option of being powered locally. Automatic switching between inputs should be supported, enabling seamless transitions. Furthermore, the HDMI transmitter should have the ability to support resolutions up to 4096×2160p@60, ensuring high-quality video output. It should also include support for CEC bypass, allowing for easy control of connected devices. To ensure compatibility with various content sources, the HDMI transmitter must be HDCP compliant. Additionally, it should support EDID management, allowing for efficient communication and negotiation between the connected devices.

15. HDBT Receiver

An HD Base T Receiver. The receiver should be capable of supporting 3D and 4K content, and it should be compatible with DVI 1.0. It must be able to handle resolutions of up to 4K@60Hz, ensuring high-definition video output. The HD Base T Receiver should include support for CEC bypass, enabling seamless control of connected devices. It should be designed to transmit video, audio, and data over a single CAT X cable, with a maximum transmission distance of 100 meters, offering convenient and efficient connectivity. For ease of control and integration with other devices, the receiver should support bidirectional IR/RS-232 control pass-through, allowing for communication in both directions. The device should have 1x HDBT Input and 1x HDMI output, facilitating connectivity with compatible audio-visual equipment. Additionally, to ensure content security and compliance with copyright protection standards, the HD Base T Receiver must be HDCP compliant. Efficient EDID management support is also essential, as it enables smooth communication and optimal resolution negotiation between connected devices.

16. Digital Chairman Unit

Should have Integrated Flush Mount Chairman Discussion Unit with Gooseneck Microphone of minimum Length 400mm with Bi-colour led ring indication (red / green) complete with Windscreen Chairman Discussion Unit with built-in Digital Signal Processing
Unit with Priority and Next-in-Line Configuration Priority button silences all delegate microphones and

allows only the chairperson to speak. Next-in-line button gives the floor to the next speaker in a waiting list of speakers who requested to speak. Shielded microphone, immune to mobile phone interference (RFI Shielding), Loop-through, daisy-chain cabling, Different LED Signalling for Mic On/Off OR Request-to-Speak Push Button, Audio Quality 16Bit digital

Frequency Response: 30Hz-15kHz, Polar Pattern: Unidirectional, Cardioid

Max SPL @ 1kHz: 110dB SPL, S/N Ratio: 67dB-A, Connection: Screw Lock

Material: Brass / Steel. Certification: CE

17. Digital Delegate Unit

Should have Flush Mount Delegate Discussion Unit with Gooseneck Microphone of minimum Length 500mm with Bi-colour led ring indication (red / green) complete with Windscreen (Shared between Two delegates), Delegate Discussion Unit with built-in Digital Signal Processing, Unit with Microphone On / Off Button, Shielded microphone, immune to mobile phone interference, Loop-through, daisy-chain cabling

Different LED Signalling for Microphone On/Off OR Request-to-Speak Push Button

Audio Quality 16Bit digital, Frequency Response: 30Hz-15kHz, Polar Pattern: Unidirectional, Cardioid,

Max SPL @ 1kHz: 110dB SPL, S/N Ratio: 67dB-A

Connection: Screw Lock, Material: Brass / Steel, Certification: CE

18. Digital Audio-Conferencing control unit

Should have up to Central Conference Controller with Recording & Web Server, Conference Controller with built-in Digital Signal Processing, control up to minimum 50 Discussion Unit and expandable up to 150 Discussion Unit by configuring multiple Controller Unit, Controller unit with 4 Bus Connection. 4 Branches. OR 2 Closed Loop for redundancy mechanism.

Control & Configure the Controller via the Integrated Web Server. Should be able to call camera present for look at me feature using built-in or external controller Two USB Connections to connect USB Storage Device for Direct Recording of the Meeting. The Second USB Storage Device will take over automatically in-scenario the First USB Storage get full. Camera Control Integration Capability Controller with LCD display to implement several Conference Mode: Direct access, Request, push to talk, FIFO, Vox control, Selectable Voice Activation Digital Acoustic, Feedback Reduction with Audio Input & Output for connectivity with external system like amplifier, microphone & audio/video conference system, Audio Quality 16Bit digital With Power Saving Mode allows controller to sleep state if it has been left ON, Headphone Port, Certification: CE

19. Surface Mount Speakers

High-quality Passive Two-Way Wall-Mount Speaker. This exceptional audio solution should be designed to provide clear and immersive sound experiences for diverse applications and venues.

Key Specifications:

The speaker shall be equipped with a high-performance 6.5-inch LF transducer or better, delivering robust and precise low-frequency output and a high-quality 1-inch HF transducer or better. The speaker should offer 30 Watts or more RMS power @8Ω impedance and includes 70V/100V transformer taps, ensuring versatility in audio installations. Should have a wide Frequency Range spanning from 80 Hz to 18 kHz, Ensuring full spectrum sound reproduction. The speaker features a sensitivity rating of 85 dB or better, ensuring efficient sound conversion and clear audio output. The loudspeaker should provide a broad 130° or better conical coverage, delivering even and consistent sound dispersion across the listening area. The speaker should have a maximum Peak SPL of 105 dB, providing ample audio projection for various settings. The speaker package should include a complete mounting kit, simplifying and facilitating the installation process.

20. Ceiling Speaker

6.5" Two-way Ceiling-Mount Loudspeaker with a back can. The loudspeaker shall be designed to deliver high-quality audio performance and reliable sound reproduction. The loudspeaker should have a minimum continuous power rating of 30 Watts or better, ensuring sufficient power handling capability for clear and impactful sound output. It should also possess a sensitivity of at least 86 dB SPL or better, enabling efficient sound distribution and coverage within the designated area. To ensure effective sound dispersion, the loudspeaker should provide a coverage angle of 110° or better, allowing for even sound distribution across the listening area. Additionally, it should be capable of delivering a maximum peak SPL of at least 110 dB or better, providing ample volume for various applications. The rated impedance of the loudspeaker should be 8 /16 Ohms, ensuring compatibility with standard audio systems. It should also feature transformer tapping options of 70V/100V with power settings of 30 and 15 Watts or better. This allows for flexible installation in systems utilizing distributed audio setups. The loudspeaker should incorporate high-quality transducers, with a minimum 6.5-inch LF (low-frequency) driver or better, and a coaxially mounted HF (high-frequency) driver of at least 0.8 inches or better. This configuration ensures accurate sound reproduction across the frequency spectrum. The supply of the loudspeaker shall include OEM-supplied mounting brackets for easy and secure installation.

2x60 watts Amplifier Dual Channel Class-D Amplifier with the following specifications:

The amplifier should have 2 channels, each providing 60 watts per channel at $8\Omega/4\Omega$, ensuring powerful and efficient audio delivery. The amplifier should support 70V/100V in bridge mode, enhancing versatility and catering to diverse speaker configurations. Should have a Signal to Noise ratio greater than 100 dB, the amplifier ensures minimal noise interference, ensuring pristine and clear sound reproduction. Should have a Frequency Response spans from 20 Hz to 20 kHz, allowing for accurate and faithful audio reproduction across the entire audible spectrum. Should equipped with user-friendly Front Panel Indicators, the amplifier features Power status, per-channel Signal strength, as well as Protect/Limit indications, enabling easy monitoring and diagnostics. The successful bidder is expected to provide all necessary mounting accessories, ensuring seamless installation and integration into the existing audio setup.

21. 4x60 watts Amplifier

Quad Channel Class-D Amplifier with the following specifications:

The amplifier should have 4 channels, each providing 60 watts per channel at $8\Omega/4\Omega$, ensuring powerful and efficient audio delivery. The amplifier should support 70V/100V in bridge mode, enhancing versatility and catering to diverse speaker configurations. Should have a Signal to Noise ratio greater than 100 dB, the amplifier ensures minimal noise interference, ensuring pristine and clear sound reproduction. Should have a Frequency Response spans from 20 Hz to 20 kHz, allowing for accurate and faithful audio reproduction across the entire audible spectrum. Should equipped with user-friendly Front Panel Indicators, the amplifier features Power status, per-channel Signal strength, as well as Protect/Limit indications, enabling easy monitoring and diagnostics. The successful bidder is expected to provide all necessary mounting accessories, ensuring seamless installation and integration into the existing audio setup.

22. 8 Channel Amplifier

An eight Channel Class-D amplifier. Each channel of the amplifier should provide a minimum power output of 200W at $8\Omega/4\Omega/70V/100V$ or better, ensuring ample power for a variety of audio setups. The amplifier should support power sharing or Bridge/Parallel modes, allowing for improved power distribution and flexibility in different configurations. Should have Frequency Response: 20 Hz – 20 kHz or better, ensuring a wide range of audio reproduction. Signal to Noise ratio: >100 dB or better, indicating high-quality audio with minimal background noise. Input impedance: >10k, balanced or unbalanced or better, offering compatibility with various audio sources. The amplifier should have front and rear panel indicators for Power, signal (per channel), limit/mute/protected, or better, providing visual feedback for monitoring purposes. Additionally, it is preferred for the amplifier to have remote standby and power-saving features, such as Auto-standby, promoting energy efficiency and convenience. The amplifier shall ensure reliable and powerful audio amplification, meeting the requirements of a wide range of applications.

Audio Mixer 12-Input 2-Bus Mixer with XENYX Mic Preamps and British EQ, a professional-grade audio mixing solution. The key features of this mixer are as follows:

The mixer shall be equipped with 4 or more-pre-amp mic inputs, providing versatile connectivity options for microphones and other audio sources. Each channel includes 1 post-fader FX send, allowing precise control over the FX signal level for individual channels. It offers Main mix outputs, along with separate control room, phones, and stereo CD/tape outputs, providing comprehensive audio monitoring and routing capabilities. The CD/tape inputs should be assignable to either the main mix or control room/phones outputs, offering flexible integration of external audio devices. With high-quality XENYX mic preamps and British EQ, this 12-Input 2-Bus Mixer ensures exceptional audio performance and professional sound shaping capabilities. It should be suitable for a wide range of applications, including recording studios, live performances, and audio production setups. Our team will handle the supply, installation, testing, and commissioning to ensure a seamless and efficient audio mixing experience.

Digital Signal Processor Digital Signal Processor, shall offer advanced audio processing capabilities for various applications. The DSP shall provide enhanced control and management of audio signals. The DSP shall include a minimum of 12 Mic/Line inputs and 12 Line outputs, allowing for flexible audio routing and connectivity. The bidder can offer single or multiple products to meet the requirement. Each microphone input shall support phantom power. The DSP shall feature a minimum of 12 or more AEC channels. This enables effective echo cancellation and improved audio quality, particularly in conferencing or telecommunication applications. To facilitate network audio integration, the DSP shall support a minimum of 8x8 Dante channels and provide compatibility with up to 128x128 network audio channels via Dante/AES67 or a similar protocol. This ensures seamless integration with networked audio systems and simplifies audio routing. For audio conferencing, the DSP will offer POTS and SIP Softphone integration, allowing for seamless integration with telephony systems and audio-conferencing solutions. The DSP shall also feature a USB port supporting AV USB Bridging, enabling compatibility with software or web-based conferencing applications. This allows the DSP to emulate USB Audio and USB Video drivers, enhancing compatibility and versatility for conferencing purposes. The DSP will incorporate high-quality 24-bit A/D-D/A converters or better, ensuring accurate audio signal conversion. It shall operate at a sample rate of 48 kHz or better, delivering high-fidelity audio reproduction. The input frequency response will be 20 Hz to 20 kHz or better, and the input dynamic range will exceed 109 dB or better, providing excellent audio performance. The supply of the DSP will include all necessary components and accessories for installation and operation.

23. Wireless Handheld Microphone

Wireless Handheld Microphone transmitter, RF output 10mW or more, cardioid pickup pattern, Frequency Response of 20Hz to 20kHz, Frequency range: 470.2 to 1799.8 MHz, Channels: 90 or more, switching bandwidth: 56MHz or more, manage and monitor through OEM app over network (specifications includes single microphone set of transmitter and capsule), etc. and complete as required.

24. Wireless Lapel Microphone

Wireless Lapel Microphone transmitter, RF output 10mW or more, cardioid pickup pattern, Frequency Response of 20Hz to 20kHz, Frequency range: 470.2 to 1799.8 MHz, Channels: 90 or more, switching bandwidth: 56MHz or more, manage and monitor through OEM app over network (specifications includes single microphone set of transmitter and capsule), etc. and complete as required

25. Gooseneck Microphone

Cardioid condenser gooseneck microphone with Table stand base. Mute/Unmute button and status light ring. Gooseneck length min 40 cm, connector type - XLR, Impedance - $<100\Omega$, Frequency response - 50Hz - 20kHz, Max SPL -130 dB SPL.

26. All-In-One Video BAR

Supply, Installation, Testing & Commissioning of 8MP Video Conferencing Soundbar with 4K PTZ Camera, minimum F o V 120deg and 4x Zoom, Built-in Hands-Free Auto Framing Feature, should have minimum 4 Beamforming Microphone Arrays covering a distance of up to 5 meters, should have minimum 20W Speaker Element with 1x Passive Diaphragm, Frequency Response: 100Hz ~ 20KHz, USB 3.0 & Ethernet output, should be supplied with IR Remote Controller and TV Mount Bracket. Should be BIS, CE, RoHS & FCC Certified. Country of origin should not be China.

27. Control System

Comprehensive Hardware or Software-based Control System shall be proposed. The control system shall offer minimum 8 multi-purpose I/O ports that can be configured as per the specific requirements of the project. These versatile I/O ports ensure flexibility and compatibility with a wide range of devices. The control system shall be designed to seamlessly control the devices mentioned in the Bill of Quantities (BOQ). It includes perpetual licenses to connect Wall/Table mount touch screen controllers, as well as iOS and Windows devices, enabling wireless touch control capabilities. This shall allow for intuitive and convenient control over the connected devices, enhancing user experience and facilitating efficient operation. The Hardware or Software-based Control System provides a user-friendly interface for seamless device management and control. It shall offer a range of features and functionalities to ensure optimal performance and compatibility with the specified devices in the BOQ. The supply of the control system includes all necessary hardware components, software licenses, and associated peripherals required for installation and operation.

28. Wireless Touch Display

Wireless 10-inch Touch Panel with the following specifications:

Network Support: The touch panel should support Wi-Fi connectivity with compatibility for 802.11a/b/g/n/ac standards. It should be dual band, operating on both 2.4GHz and 5GHz frequencies, and feature HT80 with MIMO capabilities for enhanced wireless performance.

Bluetooth Technology: The touch panel should be equipped with Bluetooth 4.2 technology, enabling seamless connectivity with compatible devices.

Display Brightness: The touch panel's display should have a brightness of 500 nits, ensuring clear visibility in various lighting conditions.

Speaker Cable Speaker Cable with the following specifications: 1.5 Sq. mm (48/0.20mm) x 2 core cable. The cable should have an ATC copper conductor and PVC insulation. The cores should be twisted together, and the cable should have an outer jacket with a PVC sheath. This speaker cable should be designed to provide reliable and high-quality audio signal transmission. The 1.5 Sq. mm size ensures sufficient current carrying capacity, while the ATC copper conductor offers excellent conductivity. The PVC insulation provides electrical insulation and protection. The twisted cores help to minimize interference and crosstalk, ensuring clear audio transmission. The cable should have finished with an outer jacket featuring a PVC sheath, which adds durability and protects against external factors.

29. Mic Cable

18 AWG (24/0.20mm) x 2 core ATC copper conductor, PE insulated, core twisted in a circular form, Inner sheathed with moisture Proof Polymer, braid shielded (80%) with ATC copper, outer Jacketed with Matt finish Rugged Flexible PVC.

30. HDBT Cable

Category 6A F/UTP EN Series Shielded Cable. The cable should have a 23 AWG (American Wire Gauge) size and consist of 4 pairs. It should be designed with solid annealed bare copper conductors for optimal conductivity. Should be High-density polyethylene insulation, ensuring electrical insulation and protection. The 4 pairs should be twisted in varying lays and cabled together to minimize interference and crosstalk. The cable should have a flame-rated PVC jacket for added safety and protection. It should comply with the TIA/EIA-568-C Category 6A standards, meeting the requirements for high-speed data transmission. The cable should also be compliant with NEC CMR and CEC CMR FT4 standards, ensuring it meets the necessary safety regulations. It should be RoHS compliant, indicating its adherence to environmental standards. Category 6A shielded cable shall provide reliable and high-performance data transmission while ensuring compliance with industry standards and regulations.

31. 6-10 ft HDMI Cable

A high-performance 6-10 ft cable that supports signals up to 4K@60Hz (4:4:4) and Deep Color. The cable should feature Gold Plated pins and have a 28 AWG thickness. Its flammability rating should be CL3/FT4, ensuring compliance with fire safety standards. Additionally, the cable should meet the requirements of RoHS 2011/65/EU, demonstrating its adherence to environmental regulations.

32. 10-15 M HDMI Cable

A 10–15-meter HDMI Active Optical Cable with the following specifications:
The cable should support 4K60 4:4:4 18Gbps bandwidth, ensuring high-quality video transmission with vivid colors and clear details. It should be Plenum rated and have a small diameter, making it suitable for installation in plenum spaces and ensuring easy cable management. The cable's video compliance should include HDMI 2.0, HDCP 2.3, and HDR, ensuring compatibility with the latest HDMI standards and technologies. The cable should utilize active circuitry in the permanent HDMI connectors, allowing for reliable and robust HDMI signal transmission over long distances. It should support HDMI signals with video resolutions up to 4K@60Hz (18.0Gbps), providing smooth and high-definition video playback. This 15-meter HDMI Active Optical Cable shall be designed to provide a reliable and high-performance solution for extending HDMI connections over long distances while maintaining excellent video and audio quality. Its advanced features and specifications make it suitable for various audiovisual applications, such as home theater setups, professional AV installations, and multimedia presentations.

33. Bulk Connectors

Various types of bulk connectors as per site requirements, including XLR Male, XLR Female, AUX, RCA, RJ-45, Velcro Tape, Cable ties, and more. These connectors will cater to different audio, video, and data connectivity needs, providing flexibility and versatility in the setup.

34. 24-Port network Switch

24-port 1000base-T Gigabit PoE+ Smart Managed Switch. The switch should support Network Protocol and Standards Compatibility, including IEEE 802.3 Ethernet, IEEE 802.3i 10BASE-T, and IEEE 802.1x. It should also have the capability to implement Access Control Lists (ACLs) at L2 (Layer 2) / L3 (Layer 3) / L4 (Layer 4). The switch shall be designed to provide reliable and efficient network connectivity, offering high-speed Gigabit Ethernet connections with Power over Ethernet (PoE+) capabilities. It shall enable the management and control of network traffic, ensuring secure and efficient data transmission. The switch will include standard accessories necessary for its installation and operation, ensuring a complete and functional networking solution.

35. 8-Port network Switch

8-port 1000base-T Gigabit PoE+ Smart Managed Switch. The switch should support Network Protocol and Standards Compatibility, including IEEE 802.3 Ethernet, IEEE 802.3i 10BASE-T, and IEEE 802.1x. It should also have the capability to implement Access Control Lists (ACLs) at L2 (Layer 2) / L3 (Layer 3) / L4 (Layer 4). The switch shall be designed to provide reliable and efficient network connectivity, offering high-speed Gigabit Ethernet connections with Power over Ethernet (PoE+) capabilities. It shall enable the management and control of network traffic, ensuring secure and efficient data transmission. The switch will include standard accessories necessary for its installation and operation, ensuring a complete and functional networking solution.

36. Wi-Fi Router/Access point

Wi-Fi router/Access point for wireless meeting collaboration. This device will enable seamless and reliable wireless connectivity for meeting collaboration purposes. The supply of the Wi-Fi router/Access point shall include all standard accessories necessary for its installation and operation. These accessories shall ensure a complete and functional wireless networking solution, providing a robust and efficient platform for collaborative meetings.

Floor Box- Type 1 A Customized Floor Box with the following features:

1x Microphone Input, 2x LAN Ports, 2x Power Sockets and Provision for mounting an HDBT Transmitter. The floor box shall be designed to provide convenient connectivity solutions in a floor-mounted configuration. It shall include a dedicated microphone input for audio input, two LAN ports for network connectivity, and two power sockets for powering devices. Additionally, the floor box shall have a provision to mount an HDBT Transmitter, allowing for seamless transmission of high-definition audio and video signals over long distances. The supply, installation, testing, and commissioning of floor box shall provide a reliable and efficient solution for convenient connectivity, enhancing the functionality of the space.

37. 24 U Rack

24 U equipment rack shall be designed to house all rack-mountable equipment. The equipment rack should be equipped with internal wiring to ensure proper connectivity and organization. It should feature a front glass door to provide visibility and security for the housed equipment. Should have Heat dissipation fans to maintain optimal temperature levels within the rack and prevent overheating of the equipment. Shall have Power distribution units (PDUs) to efficiently distribute power to the various devices within the rack. The equipment rack shall also include all standard accessories required for its installation and operation. This 24 U equipment rack shall offer a secure and organized solution for housing rack-mountable equipment. With its internal wiring, front glass door, heat dissipation fans, and power distribution units, it provides a complete setup to accommodate and manage various equipment.

12 U Rack 12 U equipment rack shall be designed to house all rack-mountable equipment. The equipment rack should be equipped with internal wiring to ensure proper connectivity and organization. It should feature a front glass door to provide visibility and security for the housed equipment. Should have Heat dissipation fans to maintain optimal temperature levels within the rack and prevent overheating of the equipment. Shall have Power distribution units (PDUs) to efficiently distribute power to the various devices within the rack. The equipment rack shall also include all standard accessories required for its installation and operation. This 12 U equipment rack shall offer a secure and organized solution for housing rack-mountable equipment. With its internal wiring, front glass door, heat dissipation fans, and power distribution units, it provides a complete setup to accommodate and manage various equipment.

29.0 SPECIAL CONDITIONS OF ELECTRICAL WORK

1.0 GENERAL

- 1.1 All electrical work shall be carried out in compliance with specifications given hereunder in this section and in compliance with Indian Standard Specifications and Indian Electricity Acts and Rules in force. The works shall also conform to any special requirement of local State Electricity Board. In any case, the above-mentioned rules, regulations etc. are not in accord, the decision of the Architect/ Engineer-in-Charge regarding rules to be followed or manner of execution of work shall be final and binding.
- 1.2 Work shall be executed through licensed electrical contractor approved by the Owner/Architect. These special conditions of contract shall be read in conjunction with the General Conditions of Contract, Schedule of Quantities, Technical Specifications, Drawings and other documents relating to the work and shall have preference over laid down general conditions and specifications.
- 1.3 Notwithstanding the sub-division of the documents into these separate sections and volumes, every part of each shall be deemed to be supplementary and complementary to every other part and shall be read with and into the contract, so far as it may be practicable to do so.
- 1.4 The contractors shall mobilise and employ sufficient resources to achieve the detailed schedule within the broad frame work of the accepted methods of working and safety. The contractor shall provide everything necessary for the proper carrying out of the work, including tools, plants and other materials.
- 4.1.5 No additional payment will be made to the contractor for any multiple shift work or other incentive methods contemplated by him in his work schedules even though the time schedule is approved by the Architect/Engineer-in-Charge.

- 1.6 The work shall be executed as per the programme drawn or approved by the Architect and it shall be so arranged as to have full coordination with any other agency employed at site. No claim for idle labour shall be entertained nor shall any claim on account of the delay in the completion of the building work to be tenable except extension of time secured by the Contractor as stated elsewhere.
- 1.7 The Contractor shall permit free access and afford normal facilities and usual conveniences to other agencies or departmental workmen to carry out connected work or other work services under separate arrangements. The Contractor will not be allowed any extra payment on this account.
- 1.8 All soil, filth or other matter of any offensive nature taken out of any trench, sewer drain, caspool or other place shall not be deposited on the surface, but shall at once be carted away by the contractor free of charge to a suitable pit or place to be provided by him.
- 1.9 The contractor shall provide all equipment, instruments labour and such other assistance required by the Engineer-in-Charge for measurement of the work, materials etc.

2.0 Materials

- 2.1 All materials, equipment's, fittings and fixtures used in electrical works shall conform to the attached Appendix-A. All material shall be new, sound and robust in construction and well finished. Surplus material after completion of work shall be taken back by the contractor and the cost shall be recovered if the advance payment has been made earlier by the Client.
- 2.2 Unless otherwise stated in the conditions of contract, samples of all materials, fittings and fixtures to be supplied by the Contractor shall be submitted to the Architect/Engineer-in-charge for his approval. The contractor shall not commence the work until the samples are approved, in writing from the Owner/Architect. The Contractor shall ensure that all the materials incorporated in the work are identical in all respects with the approved sample. All samples not destroyed in testing shall be returned to the Contractor after completion of contract. No payment shall be made for samples destroyed in testing.

3.0 Drawings

- 3.1 The drawings, specifications and bill of quantities shall be considered as a part of this contract. Any work or materials shown on the drawings but not included in the schedule of quantities or vice versa, shall be executed as if specifically called drawings indicate the extent and general arrangement of various equipment's and their wiring etc. and are essentially diagrammatic. The work shall be installed if found essential to coordinate the installation of this work with other trades shall be made without any additional cost to the Owner. The data given herein and on the drawings is as could be secured, but its complete accuracy is not for the assistance and guidance of the contractor, the exact locations, distances and levels will be governed by the space conditions. The contractor shall be responsible to check exact location of all electrical outlets, the routes and lengths of

cables etc.

4.0 Clarifications of Discrepancies

- 4.1 In case of any discrepancy between specifications and drawings etc. furnished by the Architect or disputes in respect thereof, the interpretation of CPK and Engineer- In-Charge shall be final and binding.

18.0 Work and Workman ship

- 18.1 The work shall be of the highest standard, and confirm to the technical specifications both as regard its design and workmanship. Modern tools and first class, latest techniques shall be employed for its execution.
- 18.2 Any damage done to the building during the execution of work shall be responsibility of the contractor and it shall be made good by him, at his cost, to the entire satisfaction of the Architect.
- 18.3 All electrical work shall be executed by skilled and duly licensed electricians under the direct supervision of whole time, fully qualified electrical Engineers and Supervisors. The contractor shall produce requisite evidence regarding the qualifications of his Engineers, supervisors and other workers.
- 18.4 The contractors shall possess all the relevant and valid licenses as per the regulations of the Indian Electricity Rules and the Local Electrical Inspector's requirements.
- 18.5 The work shall have to be co-ordinated with the building work and other allied jobs/trades to the entire satisfaction of Engineer-in-Charge.

6.0 Certificate of Inspection

- 6.1 The contractor shall be responsible for getting the installation inspected and approved by the electrical Inspector and other local electric supply company as required.
- 6.2 The contractor shall obtain and deliver to the Owner the certificate of final inspection and approval of the local electrical authorities concerned. The inspection fees etc. shall be borne by the contractor which shall be reimbursed by owner on producing documentary proof.
- 6.3 In case of any defects are pointed out by the Electrical Inspector, the contractor shall remove these defects at his own cost and arrange for re-inspection or inspection by the Electrical Inspector, till such time the installation is finally approved and the required certificate is issued. The contractor shall bear all expenses and

deposit the necessary fees for subsequent inspection by the Electrical Inspector.

- 6.4 The Architect shall have full powers to get the material or workmanship etc. inspected and tested by an independent agency, at the contractor's expenses in order to ascertain their soundness and adequacy.
- 7.0 Miscellaneous
- 7.1 A site order book will be maintained at site which will be in the custody of the Owner or his representative and all instructions given to the contractor will be recorded in the site order book and the same has to be signed by the contractor to comply with the instructions given therein.
- 7.2 After completion of the work the whole installation shall be tested by the contractor in the presence of the Architect Engineer-in-charge. The tests shall comply the following I.E.E. Regulations and shall be submitted along with the final bill.
- a) The result of the insulation test shall comply with the I.E.E. Regulations 1101 to 1108A and 1008B as may be applicable.
 - b) Test shall be carried out to as certain that all the non-linked SP switches have been connected to the phase conductor.
 - c) The continuity test of the earthing system shall comply with I.E.E. Regulations 1108 to 1109 to the latest addition. If the result of the above tests does not comply with the I.E.E. Regulations, the contractor shall be bound to rectify the faults so that the required results are obtained. The contractor shall be responsible to provide all the necessary testing instruments, such as megger insulation tester, earth tester multimeter, AVO meter etc. for carrying out the above tests.
- 7.3 The work will not be considered as complete and taken over by the employer till all the components of the work after being completed at site in all respects have been inspected/tested by the Architect/Owner to his entire satisfaction and a completion certificate issued by the Owner/Architect to this effect.
- 7.4 Shop drawing for electrical work e.g. equipment, cable earthing and conduit layout for all systems shall be prepared by contractor and got approved before starting of the work.
- 7.5 At the completion of the work and before issuance of certificate of virtual completion, the contractor shall submit 6 sets of drawing, two tracing and 2 CDs containing of each drawing to Owner of each layout drawings drawn at approved scale indicating the complete conduit wiring/cabling/earthing as installed.
- 7.6 Contractor shall submit 2 sets of photographs for electrical installation carried out.

- 7.7 The contractor will submit within 15 days of the award of work, a detailed schedule of programme of work.
- 8.0 Preamble to schedule of quantities
- 8.1 Tender shall be on the basis of item rates which shall include the cost of materials, labours, all taxes, duties and all other services required for the complete installation, testing and commissioning in accordance with the relevant IS Codes in practice including the fees for inspection together with the liabilities and obligations as detailed in the general conditions of contract. It will also be the responsibility of the tenderer to obtain all types of sanctions etc. like power/ light connections and the drawings etc. if any, required by the concerned local authorities.
- 8.2 Prices shall remain firm and free from variation due to rise and fall in the cost of materials and labours or any other price variation whatsoever whether during extended period of completion, if any.
- 8.3 Item rates shall remain valid for any variation in the estimated quantities given in schedule of quantities.
- 8.4 In order to facilitate the technical scrutiny of the various quotations, the tenderer must supply with their quotations detailed technical particulars make catalogues and erection drawings for various items under different parts specified in the schedule of quantities.
- 8.5 Power supply shall be 3phase, 4 wire, 415/230 Volts A.C. and frequency of 50 cycles per second. All-consuming devices shall be suitable for voltage and frequency mentioned above.
- 8.6 The drawing and specifications lay down minimum standard of equipment and workmanship and the deviations. In the absence of any deviations, it will be deemed that the tenderer is fully satisfied with the intents of the specifications & drawings and their compliance with the statutory and fire insurance provisions including local codes. Where the drawings and specifications conflict, the more stringent shall apply.
- 8.7 All equipments and the installations shall be tested as specified and a test certificate in the prescribed form as required by the local supply authorities shall be furnished.
- 8.8 The entire installation shall be guaranteed against defective materials or workmanship for a period of 12 months from the date of the installation certified by the consultant and taken over by the owner. During the guarantee period all the defects shall be rectified by the contractor free of cost.
- 8.9 The successful tenderer shall submit the shop drawings for wiring L.T. boards, distribution boards and any other to the consultant for approval prior to start the work. The approval of these drawings will be general and will not absolve the contractor of the responsibility of the correctness of these drawings. At least 6 copies of

the approved drawings shall be supplied to the consultant for their distribution to the various agencies at site at no cost to the employer.

- 8.10. The position of distribution boards and switchboards may require some minor adjustments due to either site requirements or change in structural layout. All such changes from the position, shown in the drawings, shall be required to be incorporated without any extra payment or deduction for change in length of wiring etc.
- 8.11 The tenderers must see the site conditions and take all the aforesaid and foregoing factors while quoting the rates, as no extra will be allowed on any ground arising out of or relating to the aforesaid and foregoing.
- 8.12 In single phase (230-V) A.C. supply system circuit wires of same phase shall be drawn in same conduit. For 3phase, 4wire wiring system wires of different colour shall be used and for insulated neutral only black colour wire shall be used.
- 8.13 The successful tenderer shall include in his rates for painting with 3 coats of synthetic enamel paint to match the surroundings or as directed by the consultant for all down rod hangers pertaining to light fixtures, fans, steel structure used for electrical work at no extra cost.
- 8.14 The successful tenderer shall supply completion drawings of the entire installation on tracing cloth as well as 3prints of each drawing showing the complete wiring diagram as executed at site drawn to scale approved by the consultant after the completion of work but before completion certificate is given by the consultant.
- 8.15 After laying and jointing the cables shall be subject to necessary tests as stipulated in IS:5959 (Part-I):1970.
- 8.16 As more than one make is mentioned, prior approval of particular make for use shall be obtained from the Consultant as per his discretion. All samples of all electric fittings and other accessories shall be approved by the consultant prior to their installation. In case there is a substantial cost difference be indicated in the tender itself or it will be deemed that any of the specific make of material may be asked by the consultant at the quoted prices.
- 8.17 No alteration whatsoever is to be made to the text of quantities of this schedule of quantities, unless such alteration is authorised in writing by the consultant. Any such alteration or addition shall, unless authorised in writing, be dis-regarded when tender documents are considered.
- 8.18 Any error in description or in quantity or omission of items from the contract shall not vitiate this contract but shall be corrected and demand to be a variation required by the consultants.
- 8.19 All measurements shall be taken in accordance with the Indian Standard Electrical Installation in buildings method of Measurements of IS:5908: 1970, unless otherwise specified.

8.20 The contractor shall provide, within one month after completion of the work or along with the final bill, three sets of manuals properly bound which shall contain the following information:

- a) Description of installation items using main items of equipments.
- b) Description of all equipments and system operation with trouble shooting manuals.
- c) Line diagram of each system including main feature of equipment sand showing method of setting controls.
- d) Method of faultfinding, routine, adjustment and wiring diagram.
- e) Description of routine maintenance, oil and greasing points and recommended lubricants.
- f) Manufacturer service manuals for all equipments.
- g) Spares reference manuals.

8.21 The contractor shall provide the following at no extra cost to the Employer:

- a) Danger Notice Boards
- b) Treatment for electric shock giving details of FIRST AID TREATMENT with chart diagrams (mounted in suitable frame).
- c) Line wiring diagrams of the electrical system mounted in suitable frame.

8.22 The contractor will remove all the debris & surplus earth from work site (belonging to work) free of

8.23 Note: -

- 1 The contractor will use one of the approved makes as approved by the Department
- 2 In case of different quality/pattern of same make, the pattern/quality shall be approved by the Department.
- 3 For materials/equipment/to be used in items of work for which approved makes are not given herein, the makes of such materials/equipment shall be as decided by Department
- 4 If any major equipment is using as small component of make other than that given as a standard component with the equipment, the same shall be accepted subject to approval of Engineering-in charge
5. Equipment /Gadget/Civil Fittings meeting the design / Stipulated performance parameters as per DBR

from among the list of approved make shall be considered even if in significant deviations from the stipulated specification are observed/offered equipment/Gazette/Other civil fitment safter due verification and approval of the department.

6. If the Equipment/Gadget/Civil Fitments of required specification is not available as per the list of approved than upgraded models of same make has to be used. If it is not available with same make than other equivalent makes may be considered as offered by the contractor after due verification and approval of the department for which contactor shall be provide the OEM certificate in this regards that the particular Equipment/Gadgete/Civil Fitments has been discontinued

3nos. INTERNATIONAL STADIUM SCOREBOARD

1. GENERAL OVERVIEW

Type: Outdoor, LED Digital Scoreboard

Usage: Multi-sport compatibility (e.g., football, cricket, rugby, athletics)
Viewing Distance: Minimum 200 meters
Brightness: ≥ 6000 nits (daylight viewable)
Mounting: Wall-mounted / gantry / free-standing pole-based

2. LED DISPLAY MODULELED Type: SMD 3-in-1 (RGB)Pixel Pitch: P10mm / P8mm / P6mm (customizable based on viewing distance)Resolution: Minimum 1280 × 720 pixels (HD)Color Capability: 281 trillion colors (16-bit processing)Viewing Angle: Horizontal ≥ 160°, Vertical ≥ 120°Refresh Rate: ≥ 3840 Hz (to prevent flickering on broadcast)Contrast Ratio: ≥ 5000:1Lifetime: ≥ 100,000 hours3. CONTROL SYSTEMController: Advanced LED control system with real-time data inputConnectivity: Fiber Optic / Ethernet / Wireless (Wi-Fi/5G optional)Input Interfaces:HDMI / DVI / SDI / VGA / USBSerial/RS232 for scoreboard consolesReal-time data integration from scoring systemsSoftware Features:Multi-sport scoring templatesLive video support (optional with video processor)Sponsor/logo displayMatch timer, countdown, and programmable animations

4. POWER SUPPLYVoltage Input: AC 100–240V, 50/60 HzPower Consumption:Max: ~800 W/m²Average: ~250–350 W/m²Power Redundancy: Dual power input (optional)Surge Protection: Built-in to meet IEC 61000 standards

5. ENVIRONMENTAL PARAMETERS

Operating Temperature: -20°C to +60°C

Humidity Range: 10%–90% RH (non-condensing)

IP Rating: IP65 front / IP54 rear (for outdoor use)

Cabinet Material: Die-cast aluminum / Galvanized steel

6. DIMENSIONS & STRUCTURE

Standard Sizes:

Large: 13m x 8m or custom

Cabinet Dimensions: Modular, e.g., 960mm x 960mm panels

Weight: Approx. 50–60 kg/m² (varies by cabinet type)

7. AUDIO SYSTEM (Optional)

Integrated PA system with: 100V line audio output
Weatherproof speakers
Emergency announcement override
8. MAINTENANCE
Access Type: Front/rear maintenance
Monitoring: Optional remote monitoring system for diagnostics
Spare Parts: LED modules, power supplies, receiving cards included

9. COMPLIANCE & CERTIFICATIONS

Certifications: CE, RoHS, FCC, ISO 9001
EN50121 (for EMC compliance)
Standards: FIFA / ICC / IAAF display and timing compliance (depending on sport)
10. OPTIONAL ADD-ONS
Instant Replay System
Video Processor (4K/HDMI)
Live Score Interface (API for integration with 3rd-party apps)
Weatherproof CCTV for officiating
Solar Backup / UPS Integration

| ****ICC Playing Handbook**** | Requires digital scoreboards showing team names, scores, batsmen, overs, run rate, etc. |
| ****DRS Integration**** | Scoreboards must support DRS (Decision Review System) output and real-time stats. |

Supply Installation testing and commissioning of manual score board as per ICC / BCCI norms as required. 1 Nos.

End of Section

SUB HEAD :1 CCTV Surveillance Work

Scope of work involves IP based CCTV system for security comprising of PTZ/ fixed camera, cabling, digital recording, HD display system with display and hardware & software support both for indoor and external surveillance.

CCTV cameras and storage server/ NVR shall have compliance for interoperability. The proposed IP CCTV camera: NVR and VMS shall have cyber security certificate BIS, UL, EN, CE, FCC certifications. The proposed IP CCTV camera, NVR and VMS shall be compliant to original licensed H.265 video compression for recording and streaming. The recorded images to be stored for at least 30 days.

The proposed camera should use signed firmware to validate the firmware's integrity before accepting to install it.

The proposed camera should use secure boot process, based on the use of signed firmware, ensures that the camera can boot only with authorized firmware.

The proposed camera should have built in feature of Brute force delay protection to prevent camera from hacking.

The camera shall provide a platform allowing the upload of third-party analytics applications into the camera.

The proposed camera should have a built-in Memory of 1024 MB RAM, 512 MB Flash

The manufacturer must provide firmware with long-term support that only contains corrections for critical bugs, security flaws and performance issues.

The OEM should have own RMA centre located in India for at least 10 years or more.

MTBF of minimum 100,000 hours for cameras

The camera should send trigger via HTTP/HTTPS to IP Speaker for active alerts.

The proposed camera should be NDAA compliant.

The Camera to be provided by the bidder should not have Hisilicon chipset/Processor.

The OEM should either have an IPR of technology (for both Software and Hardware) being deployed in offered models or Design for each offered model registered in their company name.

OEMs of equipment, Hardware, Software and Firmware (proposed to be supplied for this tender) own the Intellectual Property Rights of Hardware and "Source Code" of Firmware & Software, and that they are actual manufacturers, and are not getting any 3rd party manufacturing done e.g., branding & reselling in India through importing/ trading from a country that shares a Land Border with India.

5Years OEM Warranty

IR PTZ Cameras with mounting arrangement & power supply in weather-proof enclosure should be provided at all parking entrances and main gates of the campus.

License for camera & software for minimum 10 years.

CCTV Camera Dome (for indoor/ Outdoor application): -

Supply, installation, testing and commissioning of 5 MP Dome camera with following specifications:

Sr. No.	Camera Characteristics	Minimum Specifications
1	Sensor type	1/2.7" progressive scan RGB CMOS
2	True Day and Night	The camera shall provide a removable IR-cut filter, providing day/night functionality
3	Lens type	The camera shall be equipped with a varifocal 3-8 mm IR-corrected megapixel P-Iris lens with a 5MP image sensor and The camera shall provide remote zoom and remote focus functionality.

4	Field of View	The camera shall be equipped with P-Iris, providing a horizontal field of view between 100°-40°
5	Sensitivity	The camera shall meet or exceed the following illumination specifications: a. Color: 0.15 lux at 50 IRE, F1.3, B/W: 0.05 lux at 50 IRE, F1.3, 0 lux with IR illumination on
6	Shutter Speed	The camera shall incorporate an electronic shutter operating in the range of 1/33,000s to 2s.
7	Video Compression	The camera shall provide independently configured H.264, H.265 and Motion JPEG streams.
8	Total sensor pixels & FPS	The camera shall support video resolutions including: 5MP (2592x1944) at up to 25 frames per second (50Hz mode) with WDR using H.264, H265 or Motion JPEG.
9	Video Streams	Minimum Two simultaneous H.265 streams in 5MP at 25/30 fps or four simultaneous H.265 streams in HDTV 1080P at 60 fps or eight simultaneous H.265 streams in HDTV 1080P at 25/30 fps.
10	Smart compression	The camera shall support scene adaptive bitrate control with one of the following capabilities to lower bandwidth and storage: a. Automatic dynamic Region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements. b. Automatic dynamic Group of Pictures to lower bandwidth and storage requirements c. Automatic dynamic Frames per Second to lower bandwidth and storage requirements
11	Image Settings	The camera shall support manually defined values for: a. Saturation b. Brightness c. Sharpness d. Contrast
12	Intelligent defog	The camera shall incorporate automatic defog functionality
13	IR Range	The camera shall be equipped with built-in IR LEDs with adjustable angle of illumination and intensity and with a range of up to 40 m (130 ft) with a wavelength of 850 nm

14	IP addresses	a. The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server. b. The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a computer with an operating system supporting this feature. c. The camera shall provide support for both IPv4 and IPv6. d. The camera shall provide support for IPv6 USGv6.
15	Protocol	1. The camera shall incorporate support for at least HTTPS, HTTP/2, TLS, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP,DNS/DNSv6, DDNS, NTP, NTS, RTSP, RTP, SRTP/RTSPS, TCP, UDP,RTCP, DHCPv4/v6, SSH, LLDP, CDP, MQTT.
16	Text Overlay	Provide the possibility to choose different font sizes for embedded on-screen text, and to use white or black text on at least four different backgrounds
17	Security	The use of HTTPS and TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
18	Password Protection	Restrict access to the built-in web server by usernames and passwords at three different levels.
19	Centralized certificate management	Provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services
20	Hardware for data security	The product shall include a tamper-resistant hardware module, certified to at least Common Criteria EAL6+. The product shall include a tamper-resistant hardware module. The module shall use a Trusted Execution Environment (TEE), providing a set of cryptographic features suitable for protecting private keys from unauthorized access.
21	Signed Firmware	The use of signed firmware validates the firmware's integrity before accepting to install it
22	Secure Boot	The use of a secure boot process, based on the use of signed firmware, ensures that the camera can boot only with authorized firmware.
23	Brute force attacks	The proposed camera should have builtin feature of Brute force delay protection to prevent camera from hacking.

24	Connectivity	Profile G,S,T and M
25	Application Programmers Interface	The camera shall provide a platform allowing the upload of third-party applications into the camera.
26	Analytics	The camera shall support advanced video analytics capabilities with a built-in hardware-accelerated object detect engine, capable of automatically detecting several simultaneously visible objects metadata from a set of pre-trained object categories (such as vehicles, license plates, people and faces). line crossing, object in area, Cross line counting, Loitering, occupancy, Video Motion Detection, Tampering, Audio Detection
27	Ethernet	The camera shall be equipped with one 10BASE-T/100BASE-TX PoE Ethernet-port using a RJ45 connector and shall support auto negotiation of network speed and transfer mode (full and half duplex).
28	Digital I/O (Alarms)	The camera shall be equipped with one digital (alarm) input and one digital output.The output shall be able to provide 12 V DC, 15 mA.
29	Local Storage	The camera shall have built-in SD card slot upto 1 TB and The camera shall incorporate encryption functionality for the SD card (AES-XTS-Plain64 256bit).
30	Audio In	The camera shall be equipped with one 3.5 mm jack for line/mic input.
31	Audio Out	Speaker pairing
32	Encoding	AAC-LC 8/16/32/44.1/48 kHz, G.711, G.726
33	Housing	IP52 and IK10 impact-resistant aluminum enclosure
34	Power	The camera shall support power over Ethernet IEEE 802.3at Type 1 Class 3
36	Access log	The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart.
37	Firmware Update	The manufacturer must provide firmware with long-term support that only contains corrections for critical bugs, security flaws and performance issues.
38	Operating Temp	Operate in a temperature range of 0 °C to 50 °C
39	Operating Humidity	Operate in a humidity range of 10–85% RH
40	WDR approved	The camera shall incorporate forensic wide dynamic range functionality providing up to 120 dB dynamic range.
41	Camera OS	The camera shall operate Linux-based platform, and include a built-in web server.
42	Cybersecurity Approval	The camera OS should be ETSI EN 303 645

43	Certifications	NIST SP500-267,UL/cUL, IEC 60068-2-1, IEC 60068-2-2, IEC 60068-2-6, IEC 60068-2-14,EN 55035, EN 55032 Class A, IEC/EN 60529 IP52/IP66, IEC/EN 62262 IK10, BIS
44	Memory	2048 MB RAM, 8192 MB Flash
45	Protocol	The Camera to be provided by the bidder all the components / parts / assembly / software used in the offered hardware and software, should not be complying to GB28181, GB/T 28181-2011; GB/T28181-2011; GBT 28181-2011; GBT28181-2011 standards. There should be no option to activate or deactivate these standards in the camera web page/Settings.
46	Active alerts on speaker	The camera should send trigger via HTTP/HTTPS to IP Speaker for active alerts.
47	NDAA Compliant	The proposed camera should be NDAA compliant.
48	Chipset/Processor	The Camera to be provided by the bidder should not have Hisilicon chipset/Processor.
49	Warranty	5 Years OEM Warranty

CCTV Camera Bullet (for indoor/ Outdoor application): -

Supply, installation, testing and commissioning of 2 MP Bullet camera with following specifications:

Sr. No.	Camera Characteristics	Minimum Specifications
1	Sensor type	1/2.8"Progressive Scan CMOS or better
2	True Day and Night	The camera shall provide a removable IR-cut filter, providing day/night functionality
3	Lens type	The camera shall be equipped with a varifocal 3-9 mm lens with and a 2 MP image sensor and The camera shall provide remote zoom and remote focus functionality.
4	Field of View	The camera shall be equipped with P-Iris, providing a horizontal field of view between 113°-37°
5	Sensitivity	The camera shall meet or exceed the following illumination specifications: a. Color: 0.1 lux at 50 IRE, F1.6, B/W: 0.05 lux at 50 IRE, F1.6, 0 lux with IR illumination on
6	Shutter Speed	The camera shall incorporate an electronic shutter operating in the ranges of - 1080p @25/30 fps: 1/50,500 s to 2 s
7	Video Compression	The camera shall provide independently configured H.264, H.265 and Motion JPEG streams.
8	Total sensor pixels & FPS	The camera shall support video resolutions including: 2 MP (1920x1080) at up to 25 frames per second (50Hz mode) with WDR using H.264,

		H265 or Motion JPEG.
9	Video Streams	Minimum 4 simultaneous Streams @ H.265 with 25fps @1920 x1080 or better
10	Smart compression	The camera shall support scene adaptive bitrate control with one of the following capabilities to lower bandwidth and storage: a. Automatic dynamic Region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements. b. Automatic dynamic Group of Pictures to lower bandwidth and storage requirements c. Automatic dynamic Frames per Second to lower bandwidth and storage requirements
11	Image Settings	The camera shall support manually defined values for: a. Saturation b. Brightness c. Sharpness d. Contrast
12	Intelligent defog	The camera shall incorporate automatic defog functionality
13	IR Range	The camera shall be equipped with built-in IR LEDs with adjustable angle of illumination and intensity and with a range of up to 40 m (131 ft) with a wavelength of 850 nm
14	IP addresses	a. The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server. b. The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a computer with an operating system supporting this feature. c. The camera shall provide support for both IPv4 and IPv6. d. The camera shall provide support for IPv6 USGv6.
15	Protocol	1. The camera shall incorporate support for at least HTTPS, HTTP/2, TLS, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP,DNS/DNSv6, DDNS, NTP, NTS, RTSP, RTP, SRTP/RTSPS, TCP, UDP,RTCP, DHCPv4/v6, SSH, LLDP, CDP, MQTT.
16	Text Overlay	Provide the possibility to choose different font sizes for embedded on-screen text, and to use white or black text on at least four different backgrounds
17	Security	The use of HTTPS and TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both

		administration data and video streams.
18	Password Protection	Restrict access to the built-in web server by usernames and passwords at three different levels.
19	Centralized certificate management	Provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services
20	Hardware for data security	The product shall include a tamper-resistant hardware module, certified to at least Common Criteria EAL6+.
21	Signed Firmware	The use of signed firmware validates the firmware's integrity before accepting to install it
22	Secure Boot	The use of a secure boot process, based on the use of signed firmware, ensures that the camera can boot only with authorized firmware.
23	Brute force attacks	The proposed camera should have builtin feature of Brute force delay protection to prevent camera from hacking.
24	Connectivity	Profile G,S,T and M
25	Application Programmers Interface	The camera shall provide a platform allowing the upload of third-party applications into the camera.
26	Analytics	The camera shall be equipped with a built-in, Machine-learning processing unit capable of executing neural network algorithms, such as object detection, classification and segmentation (including vehicle types, license plates, people and faces. line crossing, object in area, Loitering, Video Motion Detection, Tampering, Time in area.
27	Ethernet	The camera shall be equipped with one 10BASE-T/100BASE-TX/1000BASE-T PoE Ethernet-port using a RJ45 connector and shall support auto negotiation of network speed and transfer mode (full and half duplex).
28	Digital I/O (Alarms)	The camera shall be equipped with one digital (alarm) input and one digital output.The output shall be able to provide 12 V DC, 15 mA.
29	Local Storage	The camera shall have built-in SD card slot upto 1 TB and The camera shall incorporate encryption functionality for the SD card (AES-XTS-Plain64 256bit).
30	Audio In	The camera shall be equipped with one 3.5 mm jack for line/mic input.
31	Audio Out	Speaker pairing
32	Encoding	AAC-LC 8/16/32/44.1/48 kHz, G.711, G.726
33	Housing	IP66/IP67-, and NEMA 4X-rated IK10 impact-

		resistant aluminum enclosure
34	Power	The camera shall support power over Ethernet IEEE 802.3at Type 1 Class 3
35	Access log	The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart.
36	Firmware Update	The manufacturer must provide firmware with long-term support that only contains corrections for critical bugs, security flaws and performance issues.
37	Operating Temp	Operate in a temperature range of -40 °C to 60 °C
38	Operating Humidity	Operate in a humidity range of 10–100% RH (condensing).
39	WDR approved	The camera shall incorporate forensic wide dynamic range functionality providing up to 120 dB dynamic range.
40	Camera OS	The camera shall operate Linux-based platform, and include a built-in web server.
41	Cybersecurity Approval	The camera OS should be ETSI EN 303 645
42	Certifications	NIST SP500-267,UL/cUL, IEC 60068-2-1, IEC 60068-2-2, IEC 60068-2-6, IEC 60068-2-14,EN 55035, EN 55032 Class A, IEC/EN 60529 IP66, IEC/EN 62262 IK10, BIS
43	Memory	1024 MB RAM, 512 MB Flash
44	Protocol	The Camera to be provided by the bidder all the components / parts / assembly / software used in the offered hardware and software, should not be complying to GB28181, GB/T 28181-2011; GB/T28181-2011; GBT 28181-2011; GBT28181-2011 standards. There should be no option to activate or deactivate these standards in the camera web page/Settings.
45	Active alerts on speaker	The camera should send trigger via HTTP/HTTPS to IP Speaker for active alerts.
46	NDAA Compliant	The proposed camera should be NDAA compliant.
47	Chipset/Processor	The Camera to be provided by the bidder should not have Hisilicon chipset/Processor.
48	Warranty	5 Years OEM Warranty

CCTV Camera Bullet (for indoor/ Outdoor application): -

Supply, installation, testing and commissioning of 5 MP Bullet camera with following specifications:

Sr. No.	Camera Characteristics	Minimum Specifications
1	Sensor type	1/1.2.8" progressive scan RGB CMOS
2	True Day and Night	The camera shall provide a removable IR-cut filter, providing day/night functionality

3	Lens type	The camera shall be equipped with a varifocal 3-8 mm IR-corrected megapixel P-Iris lens with a 5MP image sensor and The camera shall provide remote zoom and remote focus functionality.
4	Field of View	The camera shall be equipped with P-Iris, providing a horizontal field of view between 105°-38°
5	Sensitivity	The camera shall meet or exceed the following illumination specifications: a. Color: 0.1 lux at 50 IRE, F1.3, B/W: 0.05 lux at 50 IRE, F1.3, 0 lux with IR illumination on
6	Shutter Speed	The camera shall incorporate an electronic shutter operating in the range of 1/33500s to 1/5 s.
7	Video Compression	The camera shall provide independently configured H.264, H.265 and Motion JPEG streams.
8	Total sensor pixels & FPS	The camera shall support video resolutions including: 5MP (2592x1944) at up to 25 frames per second (50Hz mode) with WDR using H.264, H265 or Motion JPEG.
9	Video Streams	Minimum Two simultaneous H.265 streams in 5MP at 25/30 fps or eight simultaneous H.265 streams in HDTV 1080P at 25/30 fps.
10	Smart compression	The camera shall support scene adaptive bitrate control with one of the following capabilities to lower bandwidth and storage: a. Automatic dynamic Region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements. b. Automatic dynamic Group of Pictures to lower bandwidth and storage requirements c. Automatic dynamic Frames per Second to lower bandwidth and storage requirements
11	Image Settings	The camera shall support manually defined values for: a. Saturation b. Brightness c. Sharpness d. Contrast
12	Intelligent defog	The camera shall incorporate automatic defog functionality
13	IR Range	The camera shall be equipped with built-in IR LEDs with adjustable angle of illumination and intensity and with a range of up to 40 m (131 ft) with a wavelength of 850 nm

14	IP addresses	a. The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server. b. The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a computer with an operating system supporting this feature. c. The camera shall provide support for both IPv4 and IPv6. d. The camera shall provide support for IPv6 USGv6.
15	Protocol	1. The camera shall incorporate support for at least HTTPS, HTTP/2, TLS, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP,DNS/DNSv6, DDNS, NTP, NTS, RTSP, RTP, SRTP/RTSPS, TCP, UDP,RTCP, DHCPv4/v6, SSH, LLDP, CDP, MQTT.
16	Text Overlay	Provide the possibility to choose different font sizes for embedded on-screen text, and to use white or black text on at least four different backgrounds
17	Security	The use of HTTPS and TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
18	Password Protection	Restrict access to the built-in web server by usernames and passwords at three different levels.
19	Centralized certificate management	Provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services
20	Hardware for data security	The product shall include a tamper-resistant hardware module, certified to at least Common Criteria EAL6+. The product shall include a tamper-resistant hardware module. The module shall use a Trusted Execution Environment (TEE), providing a set of cryptographic features suitable for protecting private keys from unauthorized access.
21	Signed Firmware	The use of signed firmware validates the firmware's integrity before accepting to install it
22	Secure Boot	The use of a secure boot process, based on the use of signed firmware, ensures that the camera can boot only with authorized firmware.
23	Brute force attacks	The proposed camera should have builtin feature of Brute force delay protection to prevent camera from hacking.
24	Connectivity	Profile G,S,T and M

25	Application Programmers Interface	The camera shall provide a platform allowing the upload of third-party applications into the camera.
26	Analytics	The camera shall support advanced video analytics capabilities with a built-in hardware-accelerated object detect engine, capable of automatically detecting several simultaneously visible objects metadata from a set of pre-trained object categories (such as vehicles, license plates, people and faces). line crossing, object in area, Loitering, occupancy, Video Motion Detection, Tampering
27	Ethernet	The camera shall be equipped with one 10BASE-T/100BASE-TX/1000BASE-T PoE Ethernet-port using a RJ45 connector and shall support auto negotiation of network speed and transfer mode (full and half duplex).
28	Digital I/O (Alarms)	The camera shall be equipped with one digital (alarm) input and one digital output.The output shall be able to provide 12 V DC, 15 mA.
29	Local Storage	The camera shall have built-in SD card slot upto 1 TB and The camera shall incorporate encryption functionality for the SD card (AES-XTS-Plain64 256bit).
30	Audio In	The camera shall be equipped with one 3.5 mm jack for line/mic input.
31	Audio Out	Speaker pairing
32	Encoding	AAC-LC 8/16/32/44.1/48 kHz, G.711, G.726
33	Housing	IP66/IP67-, and NEMA 4X-rated IK10 impact-resistant aluminum enclosure
34	Power	The camera shall support power over Ethernet IEEE 802.3at Type 1 Class 3
35	DC Input, Power	The camera shall be equipped with one DC input connector - 10–28 V DC
36	Access log	The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart.
37	Firmware Update	The manufacturer must provide firmware with long-term support that only contains corrections for critical bugs, security flaws and performance issues.
38	Operating Temp	Operate in a temperature range of -40 °C to 60 °C
39	Operating Humidity	Operate in a humidity range of 10–100% RH (condensing).
40	WDR approved	The camera shall incorporate forensic wide dynamic range functionality providing up to 120 dB dynamic range.
41	Camera OS	The camera shall operate Linux-based platform, and include a built-in web server.
42	Cybersecurity Approval	The camera OS should be ETSI EN 303 645

43	Certifications	NIST SP500-267,UL/cUL, IEC 60068-2-1, IEC 60068-2-2, IEC 60068-2-6, IEC 60068-2-14,EN 55035, EN 55032 Class A, IEC/EN 60529 IP66, IEC/EN 62262 IK10, BIS
44	Memory	2048 MB RAM, 8192 MB Flash
45	Protocol	The Camera to be provided by the bidder all the components / parts / assembly / software used in the offered hardware and software, should not be complying to GB28181, GB/T 28181-2011; GB/T28181-2011; GBT 28181-2011; GBT28181-2011 standards. There should be no option to activate or deactivate these standards in the camera web page/Settings.
46	Active alerts on speaker	The camera should send trigger via HTTP/HTTPS to IP Speaker for active alerts.
47	NDAA Compliant	The proposed camera should be NDAA compliant.
48	Chipset/Processor	The Camera to be provided by the bidder should not have Hisilicon chipset/Processor.
49	Warranty	5 Years OEM Warranty

CCTV Camera ANPR Bullet (for indoor/ Outdoor application): -
Supply, installation, testing and commissioning of 2 MP ANPR Bullet camera with following specifications:

Sr. No.	Camera Characteristics	Minimum Specifications
1	Sensor type	1/2.8"Progressive Scan CMOS or better
2	True Day and Night	The camera shall provide a removable IR-cut filter, providing day/night functionality
3	Lens type	The camera shall be equipped with a varifocal 3-9 mm lens with and a 2 MP image sensor and The camera shall provide remote zoom and remote focus functionality.
4	Field of View	The camera shall be equipped with P-Iris, providing a horizontal field of view between 113°-37°
5	Sensitivity	The camera shall meet or exceed the following illumination specifications: a. Color: 0.1 lux at 50 IRE, F1.6, B/W: 0.05 lux at 50 IRE, F1.6, 0 lux with IR illumination on
6	Shutter Speed	The camera shall incorporate an electronic shutter operating in the ranges of - 1080p @25/30 fps: 1/50,500 s to 2 s
7	Video Compression	The camera shall provide independently configured H.264, H.265 and Motion JPEG streams.
8	Total sensor pixels & FPS	The camera shall support video resolutions including: 2 MP (1920x1080) at up to 25 frames per second (50Hz mode) with WDR using H.264, H265 or Motion JPEG.
9	Video Streams	Minimum 4 simultaneous Streams @ H.265 with

		25fps @1920 x1080 or better
10	Smart compression	The camera shall support scene adaptive bitrate control with one of the following capabilities to lower bandwidth and storage: a. Automatic dynamic Region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements. b. Automatic dynamic Group of Pictures to lower bandwidth and storage requirements c. Automatic dynamic Frames per Second to lower bandwidth and storage requirements
11	Image Settings	The camera shall support manually defined values for: a. Saturation b. Brightness c. Sharpness d. Contrast
12	Intelligent defog	The camera shall incorporate automatic defog functionality
13	IR Range	The camera shall be equipped with built-in IR LEDs with adjustable angle of illumination and intensity and with a range of up to 40 m (131 ft) with a wavelength of 850 nm
14	IP addresses	a. The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server. b. The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a computer with an operating system supporting this feature. c. The camera shall provide support for both IPv4 and IPv6. d. The camera shall provide support for IPv6 USGv6.
15	Protocol	1. The camera shall incorporate support for at least HTTPS, HTTP/2, TLS, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP,DNS/DNSv6, DDNS, NTP, NTS, RTSP, RTP, SRTP/RTSPS, TCP, UDP,RTCP, DHCPv4/v6, SSH, LLDP, CDP, MQTT.
16	Text Overlay	Provide the possibility to choose different font sizes for embedded on-screen text, and to use white or black text on at least four different backgrounds
17	Security	The use of HTTPS and TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
18	Password Protection	Restrict access to the built-in web server by usernames and passwords at three different levels.

19	Centralized certificate management	Provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services
20	Hardware for data security	The product shall include a tamper-resistant hardware module, certified to at least Common Criteria EAL6+.
21	Signed Firmware	The use of signed firmware validates the firmware's integrity before accepting to install it
22	Secure Boot	The use of a secure boot process, based on the use of signed firmware, ensures that the camera can boot only with authorized firmware.
23	Brute force attacks	The proposed camera should have builtin feature of Brute force delay protection to prevent camera from hacking.
24	Connectivity	Profile G,S,T and M
25	Application Programmers Interface	The camera shall provide a platform allowing the upload of third-party applications into the camera.
26	Analytics	The camera shall be equipped with a built-in, Machine-learning processing unit capable of executing neural network algorithms, such as object detection, classification and segmentation (including vehicle types, license plates, people and faces. line crossing, object in area, Loitering, Video Motion Detection, Tampering, Time in area.
27	Ethernet	The camera shall be equipped with one 10BASE-T/100BASE-TX/1000BASE-T PoE Ethernet-port using a RJ45 connector and shall support auto negotiation of network speed and transfer mode (full and half duplex).
28	Digital I/O (Alarms)	The camera shall be equipped with one digital (alarm) input and one digital output.The output shall be able to provide 12 V DC, 15 mA.
29	Local Storage	The camera shall have built-in SD card slot upto 1 TB and The camera shall incorporate encryption functionality for the SD card (AES-XTS-Plain64 256bit).
30	Audio In	The camera shall be equipped with one 3.5 mm jack for line/mic input.
31	Audio Out	Speaker pairing
32	Encoding	AAC-LC 8/16/32/44.1/48 kHz, G.711, G.726
33	Housing	IP66/IP67-, and NEMA 4X-rated IK10 impact-resistant aluminum enclosure
34	Power	The camera shall support power over Ethernet IEEE 802.3at Type 1 Class 3
35	Access log	The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart.

36	Firmware Update	The manufacturer must provide firmware with long-term support that only contains corrections for critical bugs, security flaws and performance issues.
37	Operating Temp	Operate in a temperature range of -40 °C to 60 °C
38	Operating Humidity	Operate in a humidity range of 10–100% RH (condensing).
39	WDR approved	The camera shall incorporate forensic wide dynamic range functionality providing up to 120 dB dynamic range.
40	Camera OS	The camera shall operate Linux-based platform, and include a built-in web server.
41	Cybersecurity Approval	The camera OS should be ETSI EN 303 645
42	Certifications	NIST SP500-267,UL/cUL, IEC 60068-2-1, IEC 60068-2-2, IEC 60068-2-6, IEC 60068-2-14,EN 55035, EN 55032 Class A, IEC/EN 60529 IP66, IEC/EN 62262 IK10, BIS
43	Memory	1024 MB RAM, 512 MB Flash
44	Protocol	The Camera to be provided by the bidder all the components / parts / assembly / software used in the offered hardware and software, should not be complying to GB28181, GB/T 28181-2011; GB/T28181-2011; GBT 28181-2011; GBT28181-2011 standards. There should be no option to activate or deactivate these standards in the camera web page/Settings.
45	Active alerts on speaker	The camera should send trigger via HTTP/HTTPS to IP Speaker for active alerts.
46	NDAA Compliant	The proposed camera should be NDAA compliant.
47	Chipset/Processor	The Camera to be provided by the bidder should not have Hisilicon chipset/Processor.
48	Warranty	5 Years OEM Warranty

PTZ Camera (for outdoor application):

Supply, installation, testing and commissioning of 4 MP PTZ camera with following specifications:

Sr. No.	Camera Characteristics	Minimum Specifications
1	Sensor type	1/2.9" Progressive Scan CMOS or better
2	True Day and Night	The camera shall provide a removable IR-cut filter, providing day/night functionality
3	Lens type	The camera shall be equipped with a varifocal 4.5 – 135 lens with and a 4MP image sensor and The camera shall provide with autofocus and auto-iris.
4	Zoom ratio	The camera shall be equipped with a motorized 30x optical zoom lens and 12x digital zoom or better
5	PTZ	Pan: 360° endless, Tilt 0° to 90° Pan and Tilt speed : 0.1°–220° /sec Provide more than 255 manually set preset positions

6	Tour	Provide a tour functionality which allows the dome to automatically move between selected presets using an individual speed and viewing time for each preset.
7	Field of View	The camera shall be equipped with P-IRIS, providing a Horizontal field of view: 57°–2°
8	Sensitivity	The camera shall meet or exceed the following illumination specifications: a. Color: 0.2 lux at 50 IRE, F1.6, B/W: 0.05 lux at 50 IRE, F1.6, 0 lux with IR illumination on
9	Shutter Speed	The camera shall incorporate an electronic shutter operating in the range of 1/50,000 s to 1/2 s.
10	Video Compression	The camera shall provide independently configured H.264, H.265 and Motion JPEG streams.
11	Total sensor pixels & FPS	The camera shall be designed to provide video streams in 4MP (2688x1512) at up to 30 frames per second (60Hz mode) or 25 frames per second (50Hz mode) using H.264, H265 or Motion JPEG.
12	Video Streams	Minimum 2 simultaneous H.265 streams in HDTV 4MP at 25/30 fps.
13	Smart compression	The camera shall support scene adaptive bitrate control with one of the following capabilities to lower bandwidth and storage: a. Automatic dynamic Region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements. b. Automatic dynamic Group of Pictures to lower bandwidth and storage requirements c. Automatic dynamic Frames per Second to lower bandwidth and storage requirements
14	Image Settings	The camera shall support manually defined values for: a. Saturation b. Brightness c. Sharpness d. Contrast
15	Electronic Image Stabilization (EIS)	The camera shall incorporate a function for Electronic Image Stabilization (EIS) for real-time image stabilization.
16	Intelligent defog	The camera shall incorporate automatic defog functionality
17	IR Range	The camera shall be equipped with built-in IR LEDs with adjustable angle of illumination and intensity and with a range of up to 200 m with a wavelength of 850 nm

18	IP addresses	a. The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server. b. The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a computer with an operating system supporting this feature. c. The camera shall provide support for both IPv4 and IPv6. d. The camera shall provide support for IPv6 USGv6.
19	Protocol	The camera shall incorporate support for at least HTTPS, HTTP/2, TLS, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP,DNS/DNSv6, DDNS, NTP, NTS, RTSP, RTP, SRTP/RTSPS, TCP, UDP,RTCP, DHCPv4/v6, SSH, LLDP, CDP, MQTT.
20	Text Overlay	Provide the possibility to choose different font sizes for embedded on-screen text, and to use white or black text on at least four different backgrounds
21	Security	The use of HTTPS and TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
22	Password Protection	Restrict access to the built-in web server by usernames and passwords at three different levels.
23	Centralized certificate management	Provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services
24	Hardware for data security	The product shall include a tamper-resistant hardware module, certified to at least Common Criteria EAL6+.
25	Signed Firmware	The use of signed firmware validates the firmware's integrity before accepting to install it
26	Secure Boot	The use of a secure boot process, based on the use of signed firmware, ensures that the camera can boot only with authorized firmware.
27	Brute force attacks	The proposed camera should have builtin feature of Brute force delay protection to prevent camera from hacking.
28	Connectivity	Profile G,S,T and M
29	Application Programmers Interface	The camera shall provide a platform allowing the upload of third-party applications into the camera.

30	Analytics	The camera shall support advanced video analytics capabilities with a built-in hardware-accelerated object detect engine, capable of automatically detecting several simultaneously visible objects metadata from a set of pre-trained object categories (such as vehicles, license plates, people and faces). Built-in Analytics - line crossing, object in area, Loitering, Cross line counting, Video Motion Detection, Shock detection and Auto tracking.
31	Ethernet	The camera shall be equipped with one 10BASE-T/100BASE-TX Ethernet-port using a RJ45 connector and shall support auto negotiation of network speed and transfer mode (full and half duplex).
32	Temperature control	The camera should have a built-in temperature control mechanism.
33	Local Storage	The camera shall have built-in SD card slot upto 1 TB and The camera shall incorporate encryption functionality for the SD card (AES-XTS-Plain64 256bit).
34	Housing	IP66, and NEMA 4X-rated IK10 impact-resistant aluminum enclosure
35	Power	The camera shall support power over Ethernet IEEE 802.3bt Type 4
36	Access log	The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart.
37	Firmware Update	The manufacturer must provide firmware with long-term support that only contains corrections for critical bugs, security flaws and performance issues.
38	Operating Temp	Operate in a temperature range of -20 °C to 50 °C, Maximum temperature : 65 °C during peak hours
39	Operating Humidity	Operate in a humidity range of 10–100% RH (condensing).
40	WDR approved	The camera shall incorporate forensic wide dynamic range functionality providing up to 120 dB dynamic range.
41	Camera OS	The camera shall operate Linux-based platform, and include a built-in web server.
42	Cybersecurity Approval	The camera OS should be ETSI EN 303 645
43	Certifications	NIST SP500-267,UL/cUL, IEC 60068-2-1, IEC 60068-2-2, IEC 60068-2-6, IEC 60068-2-14,EN 55035, EN 55032 Class A, IEC/EN 60529 IP66, IEC/EN 62262 IK10, BIS
44	Memory	1024 MB RAM, 512 MB Flash
45	Protocol	The Camera to be provided by the bidder all the components / parts / assembly / software used in the offered hardware and software, should not be complying to GB28181, GB/T 28181-2011; GB/T28181-2011; GBT 28181-2011; GBT28181-2011 standards. There should be no option to activate or deactivate

		these standards in the camera web page/Settings.
46	Active alerts on speaker	The camera should send trigger via HTTP/HTTPS to IP Speaker for active alerts.
47	NDAA Compliant	The proposed camera should be NDAA compliant.
48	Chipset/Processor	The Camera to be provided by the bidder should not have Hisilicon chipset/Processor.
49	Warranty	5 Years OEM Warranty

All-in-One Recording, Viewing and Management Solution with VMS:

Sr. No.	Description	Required Parameters
1	No. of Cameras supported	96 CH Included and can be upgraded to 150 CH by additional licenses.
2	Processor	Intel® Xeon® Silver
3	Memory	2x 16 GB
4	Storage	192 TB (12x16 TB) hot swappable Enterprise Class HDD, 160 TB usable space after RAID 6 RAID levels: 0, 1, 5, 6, 10
5	Operating Systems	Microsoft Windows 10 IoT Enterprise Operating system drive: 240 GB SSD
6	Network Card	2x RJ45 Ports 1GBPS
7	Recording	Shall support recording up to 150 video channels with a total recording rate up to 1.5 Gbit/s.
8	Software	Compatible with Cameras, Encoders including HD, Standard resolution, High Resolution, Pant Tilt, Zoom, Thermal, Cameras, Access Control, IP Speakers, Alarm IO Modules
9	Security	Support for encrypted operating system drive and recording drive FIPS 140-2 level 2 certified Trusted Platform Module (TPM 2.0)
10	Video compression	H.264 (MPEG-4 Part 10/AVC) Baseline, Main and High Profiles, H.265 (MPEG-H Part 2/HEVC) Main Profile, MPEG-4, Motion JPEG
11	Map function	Support Required
12	PTZ Control	Required
13	Smart Search for recordings	Required

14	Playback	Up to 64x or frame by frame Up to 25 cameras synchronized playback
15	Export	Manual and scheduled export, Digital signature on exported recordings, Password protection when exporting to ZIP, Export to ASF, MP4 and MKV
16	Scheduled recording	The software shall allow recordings for continuous, motion based, event based, or customized as per user/ scheduled
17	Alarm Manager	Yes Required
18	Microsoft Active Directory support	Yes, multiple user access levels with password protection using local or Windows domain users (Active directory)
19	Event triggers	Events triggered by video motion detection, Active Tampering Alarm, Cross Line Detection, External I/O, Action button, System triggers and device event triggers, Manual Triggers, Edge Based Analytic Triggers
20	Power	2 x 800 W hot-plug redundant power supplies
21	Connectors	2x USB 2.0, 1x USB 3.0, 2x VGA, 2x iDRAC dedicated Ethernet port, 2x RJ45 1 Gbps
22	Operating conditions	10 °C to 35 °C (50 °F to 95 °F)
23	Certification	IEC/EN/UL 60950-1, IEC/EN/UL 62368-1, EN 62311, NOM-019-SCFI-1998, NDAA (National Defense Authorization Act), 55032 Class A, EN 55024, EN 55035, EN 61000-3-2, EN 61000-3-3,
24	Form Factor	Rack/ Tower
25	Warranty	5 Years

VMS- Video Management System:

SERVER for Viewing :

Intel i7 latest generation or equivalent AMD latest generation RAM: 16 GB (8 GB recommended for larger systems) Operating system: 64-bit operating system, 256 GB SSD, Nvidia T600 or similar, 1x NIC @ 1 Gbps,

VMS Software:

Sr. No.	Video Management System
1	The video management software shall be of manufacturer's official product line, designed for commercial and/or industrial 24/7/365 use.
2	The video management software shall be based upon standard tools and proven technology using open and published protocols
3	The specified unit shall be manufactured in accordance with ISO 14001.

4	The specified unit shall be compliant with the EU directives 2011/65/EU (RoHS) and 2012/19/EU (WEEE)
5	The specified unit shall be compliant with the EU regulation 1907/2006 (REACH).
6	The specified software shall support relevant parts of the following video standards: 1. Video a. SMPTE 296M (HDTV 720p) b. SMPTE 274M (HDTV 1080p) c. SMPTE ST 2036-1 (UHDTV)
7	Interoperability a. Support video from IEC 62676-2-3 conformant devices b. Support video from ONVIF Profile S conformant devices
8	The specified software shall meet the following standards: 1. MPEG-4: a. ISO/IEC 14496-10 Advanced Video Coding (H.264) b. ISO/IEC 14496-2 (Profiles ASP and SP) (MPEG-4 Part 2)
9	The proposed VMS Clients can connect to multiple servers simultaneously.
10	c. The video management app shall provide full functionality when operated in the following environment: 1. One of the following versions: a. Apple iOS 10.3 or higher b. Google Android 5.0 or higher
11	The video management software shall accept video and audio from network cameras and video encoders compliant with relevant parts of IEC62676-2-3.
12	The proposed VMS should have Private network setup with cloud connectivity
13	The proposed VMS web client using Cloud Connect for server acces.
14	Cloud Services:- cloud web client
15	The video management software shall support traditional network cameras and video encoders as well as thermal network cameras.
16	The video management software shall, when operating in a fully supportive environment, be able to record at least 70 individually configured full frame rate video streams in full HDTV 1080p (1920x1080 pixels) over IP networks
17	The video management software shall, when operating in a fully supportive environment, be able to record full frame rate video streams in 4K Ultra HD (3840x2160) over IP networks.
18	The video management software shall provide a total recording capacity of at least 2100 frames per second.
19	The video management software shall, for each channel: a. Support Motion JPEG recording in a selectable range up to 30 fps. b. Support MPEG4 Part 2 recording in a selectable range up to 30 fps. c. Support H.264 recording in a selectable range up to 120 fps. d. Support Baseline, Main and High Profile H.264 decoding in up to 120 fps. e. Support Main Profile H.265 decoding in up to 120 fps. f. Support dynamic media profile selection for live view with all supported profiles.
20	The video management software shall support the use of wide angle / 360 degree camera.

21	Transmission a. The video management software shall allow for video to be transported over: 1. Multipart HTTP (Unicast) 2. RTP or RTSP over HTTP (Unicast) 3. MP4 over HTTPS (mobile apps)
22	The video management software shall support the following audio specifications:
23	The video management software shall support two-way, full duplex audio encoded with the video stream with supported network cameras (one-way for third-party cameras).
24	The video management software shall support the following audio quality: 1. 24bit LPCM 2. AAC-LC 8/16/32/48 kHz 3. G.711 PCM 8 kHz, G.726 4. ADPCM 8 kHz 5. Opus 8/16/48 kHz
25	It shall be possible to assign/link a microphone or speaker to a defined video device.
26	The video management software shall support active echo cancellation and noise reduction.
27	The video management software shall support the following Input/Output functionality: 1. Accept notifications and alarms from an unlimited number of auxiliary devices connected to the network. 2. Received notifications and alarms shall be able to generate events within the video management software.
	Client functionality
28	a. The video management software shall be equipped with a graphical user interface, providing the following functionality:
	1. Display up to 25 different video streams.
	2. Display up to 100 different video streams using multiple split views.
	3. Support optimized rendering for smooth display of video in resolutions up to 4K.
	4. Provide real-time navigation between multi-views using a quick view button.
	5. Support drag and drop of video sources within the user interface.
	6. Support multiple screens when operating on a computer supporting this.
	7. Be able to display facility maps with interactive camera icons to call up live video and audio from the selected camera.
	8. Be able to import graphical map data in the following formats: a. JPEG b. BMP c. PNG d. GIF
	9. Access to functions such as floor plans, video streams, split views, input/outputs, playback, snapshots and alerts shall be configurable on a user level.
	10. Support any aspect ratio provided by the camera, including landscape format (4:3 and 16:9 aspect ratio) and corridor format (3:4 and 9:16 aspect ratio).
	11. Availability in at least 20 different languages and include support for double byte character set.
29	The video management software shall provide the following user functionality.

	1. Live view functionality: a. Single camera live view b. Multi-views c. Sequence views d. Multi Ultra HD camera live views (3x 4K views) e. Flexible live view configuration f. Site maps and web page view g. Digital PTZ
	2. Recording functionality: a. Continuous recording b. Locking of prioritized recordings c. Scheduled recording - customization of weekday and weekend recordings d. Event driven recording e. Manually initiated recording f. Individually and configurable resolution and frame rate for each video source. g. Unlimited recorded material based on availability of storage device. h. Smart search for recordings based on camera, date and timeline visualization i. Video and audio shall be recorded using a manufacturer-designed format preventing manipulation of the content and shall contain information about date, time and source of the recorded material. j. Retrieval of failover recordings from cameras or encoders.
	3. Playback functionality: a. Synchronized playback from up to 36 cameras of at least four different recorded video streams, up to 64x or frame by frame. b. Playback at least eight simultaneous full frame rate Full HDTV 1080p (1920x1080 pixels) video streams. c. Export (manual or scheduled) multiple selected video and audio sequences to ASF-formats together with standalone player. d. Digital signature on exported recordings.
	4. Search functionality a. Provide an ability to search for video based upon the following criteria's: 1. Time & Date 2. By camera 3. Motion detection within a customizable area of the video 4. Video streaming content b. Support so called scrubbing for effective search functionality.
30	PTZ functionality:
	a. The video management software shall for each video channel
	1. Provide the ability to control Pan, Tilt and Zoom functionality directly from the user interface.
	2. Provide at least 100 present positions, camera depending.
	3. Support guard tour functionality, which allows the PTZ device to automatically move between selected presets using an individual viewing time for each preset
	4. Support PanTilt control by clicking in the image to move the camera using the mouse.
	5. Support zoom control by selecting an area in the image using the mouse.
	6. Support the use of hotkeys, joystick, keyboard and other control boards.
31	Event functionality

	a. The video management software shall be equipped with an event functionality, supporting events triggered in a camera, encoder or other network connected device, and include support for the following triggers:
	b. Detectors functionality 1. Video motion detection 2. Audio detection 3. Alarm functionality c. Hardware functionality d. Storage functionality 1. Failover recording recovery - recovery of local recordings in camera or encoder after connection disruption 2. Recording error 3. Storage full e. System functionality 1. Embedded third-party applications 2. Cross Line Detection 3. Action button 4. Lost connection to network camera, encoder or network disk 5. Schedule 6. External I/O and external HTTPS triggers 7. Device event triggers f. Response to triggers shall include: 1. Selecting predefined live-view 2. Visual and audible notification 3. Recording of video at defined image quality and frame rate 4. Storing of pre-alarm video at the captured frame rate 5. Activating external outputs on a camera, encoder or other network connected device 6. PTZ control functionality 7. Notification of event, using email or HTTP
32	The video management software shall provide an event history list, containing up to one year of history
33	a. The video management software shall incorporate support for at least IP, HTTP, HTTPS, TCP, ICMP, RTSP, RTP, RTCP, SMTP, DHCP, UPnP, DNS, Bonjour and LDAP.
	b. The SMTP implementation shall include support for SMTP authentication.
34	a. The video management software shall operate using static or dynamic IP addresses.
	b. The video management software shall provide support for addresses provided by a Dynamic Name Server (DNS).
	c. The video management software shall allow for automatic detection of cameras and encoders using UPnP and Bonjour.
35	Time a. The video management software shall utilize NTP as provided by the server. b. The video management software shall support multiple date formats for regional adoption.

36	a. The video management software shall provide the following: 1. Authentication of nodes using Kerberos 2. Authentication using Microsoft Active Directory 3. Restrict access to the systems by usernames and passwords at a minimum of three different levels.
37	The video management software shall: 1. Provide the ability to create multiple users of the system, either from local PC users or through Active Directory, each with individual definable user rights. 2. Provide the ability to assign IP address and configure new and replaced cameras and encoders. 3. Provide an ability to back up system configuration. 4. Provide the ability to upgrade firmware in individual cameras and encoders. 5. When connected to Internet, be able to locate suitable firmware updates and download these. 6. Provide an ability to create a system report of the complete system. This report shall include at least camera name, IP-address and firmware version. 7. Utilize a license model supporting unlimited and flexible system growth where scalability is only limited by overall server performance. 8. Support defining of individual database retention per camera for a selectable number of days or hours.

Annexure-III

TECHNICAL SPECIFICATION OF INTERNAL ELECTRIFICATION WORKS

1.ILLUMINATION DESIGN:

a.INPUT DATA

Entire playing arena for Football field of dimensions as per attached drawing shall be considered for the purpose of lighting design by the bidders. Bidders are also requested to take into consideration obstructions due to canopy over the spectators while working out the lighting design. Bidders are advised to visit the site and carry out detailed site survey before quoting.

b.LIGHTING PARAMETERS

Following illuminance parameters shall be considered for the purpose of lighting design and which is also required output:

- ☐ Horizontal Illuminance is to be considered at ground level In addition to the above, following parameters needs to be considered.
- ☐ Glare restriction: Glare rating (GR) ≤ 50 .
- ☐ Color Temperature of lamp: 5700K (± 350 per ANSI CCT standard)
- ☐ Project Maintenance factor to be considered: max 0.85

c. Provision for International Lighting:- High Mast Pole i/c foundation shall be designed as per Lux level defined in Table-A.

d. The switching arrangement needs to be done as per below tabulated lux level .

TABLE-A

S.No Event Application -Area Minimum

Average
horizontal
illuminance

Uniformity

U1:MIN/MAX U2:MIN/AVG

1 National (Non
Televised)

Foot Ball

Ground 1250Lux 0.4 0.6

2 Practice Foot Ball

Ground 800Lux 0.4 0.6

The aiming of fixtures shall be as per events provided in Table-A. However, each fitting shall have individual MCBs also. The switching pattern of the fitting shall be such that by switching on/off by single/combination switch per pole. The schematic diagram shall be displayed and MCBs marked in the panel accordingly. The design & drawing of Electrical Panel shall be got approved from Engineer-in-charge before installation.

d. Agency shall submit computerized lighting design print outs showing the locations of high masts, illuminance plot for vertical and horizontal illuminance values, glare parameters and summary of lighting parameters achieved by them after award of work, which shall be approved by Engineer- in- Charge prior to execution of work.

e. Agency shall submit design of High mast poles, Foundation, Fixtures, Panels and after that complete design and all items as per requirement of AUTHORITY shall be prepared and got approved from competent authority after award of work and prior to execution. All this is in the scope of agency and nothing extra shall be paid on this account.

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SCOPE OF WORK:

Illumination design of the stadium as per above guidelines and approval from competent authority and validation of the same by measurement of illumination levels in the presence of Engineer-in-charge at site. The bidder / OEM must have to be qualify the below mentioned technical parameters during evaluation of technical Bid.

LED Package

1. Identical high power LED packages of 3 watt minimum to 5 watt maximum are to be used in all lamps.
2. The Average Lumen Maintenance summary needs to be submitted at the different case temperature (Soldering Point) at Ts: 55 oC, 85 oC & 105 oC.
3. The Colour Rendering Index (CRI): ≥ 70
4. Maintenance factor: 0.9 for LED
5. Correlated Colour Temperature (CCT): 5700K + 350K

6. The estimate Life span of LED should be > 90,000 hours at driving current of LED to a minimum of 1000 mA and maximum of 1500 mA. The graphical chart for of the TM – 21 needs to be submitted at the different case temperature (Soldering Point) at Ts : 55 oC, 85 oC & 105 oC. For all the three test condition the estimated life hours must be >90000 (as reported L70)
7. Also as per L90 to estimate of life should > 90,000 hours at driving current of LED to a minimum of 800 mA and maximum of 1500 mA. The graphical chart for of the TM – 21 needs to be submitted at the different case temperature (Soldering Point) at Ts : 55 oC, 85 oC & 105 oC. For all the two test condition the estimated life hours must be > 90000 (as reported L90).
8. LM – 80 test report along with TM – 21 report needs to be submitted.
9. The photo biological safety norms need to be submitted as per IEC 62471 / EN 62471 / IS 16108.

LUMINARIES TECHNICAL DETAILS:

1. The wattage of the LED Luminaries minimum 950 Watt & maximum to 1500 Watt.
2. The system efficacy of the Luminaries should be ≥ 110 Lm / W. With CRI – ≥ 70 .
3. The Ingress Protection Should not less than IP 66.
4. The Impact Resistance should not less than IK 08.
5. The offered weather proof LED Luminaire is provided with secondary lens / optics. The same shall of PMMA / Borosilicate glass / Polycarbonate type.
6. Total Harmonic Distortion should be less than 10% for the complete fixture.
7. The fittings shall be provided with pre-installed terminal blocks with Cu. Lugs suitable for termination of 3C x 2.5 sq.mm. copper cable. Offered weather proof LED light fittings shall be suitable for bracket mounting.
8. The product should comfortable with Ambient Temperature: 0 oC to +50 oC
9. The flood light should be a state of the art design allowing easy mounting.
10. The fixture with mounting accessories to be supplied as per site requirement. The housing of the Sports flood light must be Modular type with Pressure die cast aluminum housing with fins The aim & adjustable bracket having smooth finish powder coated embossed / Engraved / printed with company logo.
11. The product Luminaire must be modular type. However, if modular type is provided then maximum 3 (Three) Nos module are allowed with proper air gap for natural cooling. The Heat sink to be suitably designed & properly integrated with the Luminaire body itself for effective cooling of the LED.

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12. The required hardware & fasteners for installation of the offered weather proof LED Luminaire shall be supplied along with each Luminaire. All the supplied hardware & fasteners shall be of Stainless

Steel (SS).

13. The type test report/ certificate as per relevant standards on selected sample need to be submitted as per IS: 10322.

14. The bidder / OEM has to provide the test report for LED junction temperature should not $\geq 85^{\circ}\text{C}$ at the ambient temperature of 25°C and with internal surge protection of minimum 5KV.

15. The BIS of the complete product needs to be provided with the technical bid.

16. The Force driven cooling by Fan/ Liquid cooling single housing Luminaire is not acceptable. The cooling of Luminaire including LED lamp, LED driver, electronic components and all accessories shall be through natural cooling only.

17. The LM 79 from UL/NABL/Third party Lab, LM80, Polar diagram, Cone diagram, IES file, catalogue needs to be submitted during the Bid to evaluate the above parameters.

18. Flood light should be having 5 years warranty. The Firm will arrange the 5 years warranty certificate from the manufacturer clearly mentioning the details of the fitting supplied to AUTHORITY under this contract.

Driver Technical Details:

1. The bidder / OEM has to provide the test report for LED junction temperature should not $\geq 85^{\circ}\text{C}$ at the ambient temperature of 25°C and with internal surge protection of minimum 5KV.

2. The driver should be epoxy encapsulated within the light fixture that has separate optical & driver compartment, driver single Integrated constant current potted electronic driver. The fixture, with the encapsulated driver inside, must be IP-66 compliant.

3. Serviceability of LED Luminaries: The driver can be replaced at site if required.

4. The efficiency shall be more than 85 % in all cases at all times during project period.

5. Maintenance friendly and a separate compartment in main housing for external SPD or external fixing arrangement (bolted only) for external SPD below the light on the non-light emitting surface of the housing.

6. Protection from Voltage surges (SPD) Firm may provide appropriate surge protection arrangement, at each Flood Light, to protect the Flood Light from switching surges, which are expected / prevalent in Flood Light supply networks in India. Additionally, as per ANSI C 136.2-2014/ UL-1449/ IEC 61643-11, External Surge protection (SPD) with Thermal Protection (TMOVs) of minimum 10KV/5KV with capability to withstand a minimum of 15 pulses of 10KV/5KV to be separately installed (fixed with screws) with each fixture below the Light with IP 66 protection for incoming and outgoing wires on SPD and Light. Alternatively, the external SPD may be provided inside the driver compartment or special enclosed compartment adjoining the driver compartment or adjoining it with proper fixing (bolting / DIN rail arrangement) for SPD inside. The SPD shall follow IEC 62305 & IEC 61643-11-2011.

7.Housing - Electrical Compartment of Driver box contains cable glands for cable entries, and push in terminals for mains and control input. Electrical connection box of floodlight contains cable glands and push-in terminals enabling electrical connection to driver box. The end-caps can be easily opened to access the bolts to aim the floodlight; the slot-hole in the bracket facilitates flexible installation.

8.BIS certificate / Safety test for Drivers as per IS: 15885 is must be submitted for driver.

9. The driver should be EMI/EMC Compliance as per IEC:61547.

10. The driver safety requirement needs to be qualify as per IEC:61347-2-13/EN:61347-2-13/IS:15885-2-1.

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TECHNICAL SPECIFICATIONS OF THE EQUIPMENTS:

HIGH MASTS

High masts shall be polygonal, continuously tapering, hot dip galvanized with suitable fixed type head frame for mounting the flood light fixtures.

Polygonal high masts offered shall have following special features

1. Masts shall be structurally designed in accordance with PLG 7– latest edition considering the gust wind speed as per IS 875 prevailing in the region.
2. The steel used in the construction of the masts shall comply with IS 2062 grade E350 / BS EN 10025 or Equivalent having minimum yield strength of 350 N/Sq. mm.
3. The High mast shall be of continuously tapered, polygonal cross section, presenting a good and pleasing appearance and shall be based on proven In-Tension design conforming to the standards referred to above to give an assured performance and reliable service.
4. The mast shaft shall be manufactured from high tensile steel plates confirming to IS 2062/ BS EN 10025 having minimum yield strength of (Grade 65) 350N/Sq.mm and silicon content less than 0.06%.
5. For the environmental protection of the mast, the entire fabricated mast shall be hot dip galvanized internally and externally having a uniform average coating of 85 microns for plates more than 6 mm and 70 microns for plates 6 mm and less thickness. The Zinc shall have minimum 99.995% purity confirming to IS 209.
6. The length of any individual segment shall be such that it can be easily transported and erected. All similar parts shall be made strictly inter-changeable. Mast segments, as far as possible, shall be fabricated in single piece. In case of restriction due to the size of hot dip galvanizing bath, pole segments having outer diameter more than 1mtr may be fabricated in two halves and seamlessly welded after galvanizing. After seamless welding of both halves,

surface of the welded portion shall be cleansed and prepared. Two welded portions shall be galvanized by suitably dipping in hot zinc bath or by metallizing using molten zinc technique. For metallizing, the process as per ANSI/AWS WCZ/D19.0-72 or other National/International standard/Guidelines shall be followed. The thickness of zinc coating by metallizing shall not be less than the minimum specified for hot dip galvanizing.

7. The masts sections shall be joined at site by slip-stress-fit method and minimum overlap distance shall be 1.5 times the diameter at penetration.

8. The mast structure shall be suitable to sustain an assumed maximum reaction arising from a wind speed as per IS 875 Part-3 2015 (three second gust) and shall be measured at a height of 10 meters above ground level.

9. The design life of the mast shall be 25 years. The force co-efficient taken for design of the twenty-sided polygonal structure is to be established from the wind tunnel test data.

10. All welding shall be undertaken and performed as per WPS/PQR in strict accordance with BS 5135 or AWS D1.1.

11. The head frame cross arm brackets shall be of suitable steel construction.

12. The high mast manufacturer should have in-house civil, structural and product design facilities and the shaft is to be manufactured from ISO 9001, ISO 14001 and ISO 45001 certified factory taking care of all aspects of design, quality, environment and safety.

The Luminaries supplier shall have their own in-house testing facilities for testing of photometry, other electrical and mechanical parameters of luminaries with facilities to prepare illumination design for said application.

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13. All MS parts including hardware shall be hot dip galvanized as per BSEN-ISO1461 or equivalent.

Platform and Head frame of the Mast.

1. Stadium mast shall have a fixed head frame at the top of the mast. The head frame shall be with a 15-degree tilt for aiming the luminaries to the proper points. The tilt also helps the maintenance man, while working on the top.

2. The head frame shall have a shaft section like other mast sections in the middle and cross arms to mount required number of luminaries. Suitable provision shall be provided in the cross arms for fixing of luminaries and support the cables. Suitable opening on each side of the shaft and window in back side is to be provided to take and facilitate passing the cables to the luminaries through cross arms.

3. An inspection opening shall be provided on the head frame shaft. Support shall be welded

on the head frame shaft to suspend the luminaire cables from the top. Cables are to be bunched and supported with stainless steel suspension ropes of suitable length. No other equipment shall be mounted in the path of the cables inside the mast as it will affect the safety of electrical cables for the luminaries.

4. Lightning finial shall be provided on the mast top of the shaft. Provision to be made on the top cross arm to mount the aviation obstruction light accessible from the ladder.

5. A suitable platform shall be provided on top of the mast. The platform shall be such that the maintenance man can safely stand on the platform and work. The platform shall have protective railing on three sides for safety purposes. There shall be ladders from the platform to the top of the head frame for access to the luminaries mounted on the cross arms. Safety rope is to be provided to hook the PPE (Full body harness).

6. The platform shall have suitable docking facility for the man rider unit to enable the maintenance man to enter the platform from the man rider unit.

7. The connection between the head frame and mast top shaft is by a flanged joint and bolted together. No slip joints in this position shall be used.

8. Access to the floodlights on the head frame shall be by a minimum number of four vertical ladders of the full head frame height.

Man rider Unit

1. Access to the mast head frame flat form shall be by a detachable and mobile man-rider unit with a minimum safe load carrying capacity of 300 Kg. The unit shall be of galvanized steel construction with twin cage arrangement along with spring loaded wheels encasing the mast shaft for proper balancing and to avoid swaying of cage while climbing. Suitably rated motor and double drum winch shall be installed in the base of mast. The hoisting arrangement shall comprise of AISI 316 grade stainless steel wire ropes of 8 mm diameter and cast aluminum pulley with gunmetal bush bearing. The unit will have a climb rate not in excess of 9 meters per minute and shall contain required safety features. Man rider will incorporate secondary fall arrester system for protection against failure of the main rope.

2. Man-rider should be detachable type with wheels for moving from one location to other and common for all the masts of the stadium.

3. A portable control box fabricated out of 14swg CRCA sheet housing and finished with powder coating of shade 631 as per IS:5 comprising 32A TPN MCB incomer, contactors suitable for the rating of motor for raising and lowering operation of the man rider. Push button to raise and lower the man rider is to be provided with 5 m cable to operate from a

distance. There shall be 32 Amp TPN plug wired to the control box to take power to control box. A Three pin socket is to be provided on control box to hook the motor plug.

4. Aviation Obstruction Light : Supply of Single dome aviation obstruction lights of type LED AOL. Two numbers per mast.

FEEDER PILLAR

Work of feeder Pillar shall be carried out as per AUTHORITY for Electrical works Part –I (internal) -2013 and & Part –II (External) 1994 amended up to date. Supplying , erection , testing and commissioning of floor mounted double door outdoor type feeder pillar of suitable size (as per design requirement) fabricated out of minimum 1.6mm/ 2.00 mm thick nominal CRCA MS sheet (2 mm outer and 1.6 mm inner) with suitably thick angle iron frame of suitable dimensions and suitable to accommodate and S/F of all required accessories there in i/c connection , interconnection with suitable size copper wire , numbering , power coated after applying pretreated by seven tank process and making brick foundation complete as required Standard :

The equipment shall confirm to this specification and latest revision of following codes with all amendments: -

S. No. Title Indian Standard

2.1 IS 5039 Specification for distribution pillars below 1000V AC

2.2 IS 13947 part 2 Low Voltage switchgear

2.3 IS 8623 Specification for low voltage switchgear

2.4 IS 12063 Classification of degrees of protection provided

by enclosures of electrical equipment.

2.5 IS 13703 Low voltage HRC fuses

2.6 IS 5 Color of ready mixed paints

2.7 IS 191 Specification for copper

2.8 IS 5082

Wrought Aluminum & Al alloy plates & sheets for electrical applications

2.9 IS SP72 Sports Lighting

3.1 Supply Voltage 3 phase neutral, AC 415Volt +/-10%

3.2 Supply Frequency 50 Hz +/- 5%

3.3 Location of panel

Outdoor, on complete refurbished area

Nehru

place

3.4 Pollution Heavily Polluted and Dry

3.5 Humidity 90% maximum

3.6 Ambient Temperature Average 40 Deg C, Maximum 50 Deg C

3.7 Incoming supply to feeder pillar

From distribution transformer or Main

feeder

panel pillar panel

3.8 Seismic Zone 4

1.Complete design/drawings of feeder Pillar, Nos, their locations etc to be got approved from Engineer in Charge prior to execution of work.

2.Suitable M.S. top cover with suitable slop, overhang shall be provided for protection against

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rain/weather etc.

3.Detachable cable gland plates 3 mm thick shall be provided at the bottom having suitable knock out for compression glands. Adequate space shall be provided below the same for safe bending & termination of cables.

4.The enclosure shall be provided with ventilation louvers covered with the wire mesh, lifting hooks, supporting legs, double earth terminals with double nuts & washers.

5.The internal arrangement shall be compartmentalized for incoming, outgoing switch gears/bus bars & design shall be such as to permit suitable arrangement for incoming & outgoing cables. Provision shall be made for lighting inside the feeder pillar.

6.All incoming and outgoing switch gears shall be properly marked, indicating the connected load, cable sizes, and outgoing connections etc as required.

7.Interconnection of the various mountings on the feeder pillar shall be done using PVC insulated conductor or solid strips with PVC taping / sleeving of appropriate sizes. Termination shall be made such that local heating is avoided. Feeder pillar shall be pre-treated with 7 tank process followed by powder coating.

8.All the metal work of feeder pillar shall be painted prior to erection with one coat of anti-rust primer. After fabrication, they shall be painted with two coats of appropriate enamel paint as required, on all sides wherever accessible

All connections and inter connection wires inside the feeder pillar shall be provided with tags /

ferrules for identifications.

■ **TECHNICAL FORMAT –750 KVA Diesel Generator Set**

<u>S. No.</u>	<u>Parameter</u>	<u>Details to be Filled by Vendor</u>
1	DG Set Rating	750
2	Make s model	Engine: SGB 750 PR-IV Alternator: /LS/MECCALTE/CG

3	Engine Details	Model: 6M33G4D4/5 No. of Cylinders: 6 Cooling Type: RADIATOR Aspiration: TURBOCHARGED BHP: 885 Displacement: 19.6 Ltrs.
4	Alternator Details	Make: /LS/CG/MECCALTE Brushless: Yes Insulation Class: H AVR: Yes
5	Fuel Type	High-Speed Diesel (HSD)
6	Fuel Consumption (100% Load)	149 liters/hour
7	Fuel Consumption (75% Load)	117 liters/hour
8	Starting System	Through Controller
9	Control Panel	AMF Panel: No Type: Manual/Auto Controller Make/Model: DEIF SGC 420
10	Acoustic Enclosure	CPCB IV Compliant Sound ≤ 75 dBA @ 1m Sheet Thickness (Base/Doors): 1.6 mm
S. No.	Parameter	Details to be Filled by Vendor
11	Compliance	CPCB IV Certification: Yes
12	Dimensions (L×W×H)	7200 mm × 2200 mm × 3395 mm
13	Weight	10530 kg (Total set weight)
14	Battery Details	No. of Batteries: 2 Rating: 150AH Make: EXIDE

15	Cooling System	Radiator Type: RADIATOR Air Flow: NA Coolant Type: Coolant
16	Lubrication System	Oil Capacity: 61 L Recommended Change Interval: 500 hrs./ one year
17	Fuel Tank Capacity	990 liters (Base Tank)
18	Exhaust System	Silencer Type: Residential Pipe Diameter: 200 mm
19	Lube Oil Consumption	<0.3 % of Fuel Consumption
20	Noise Level	≤75 dBA @ 1 meter (CPCB IV Norms)
21	Warranty	Engine: 5 C 5years Alternator: 2 years Complete DG: 2 years/ 6000 hrs
22	Service Support	Nearest Service Center: VIBHUTI KHAND, GOMTI NAGAR, LUCKNOW
23	Number of Free Service Visits	1 Nos. within warranty period

<u>S. No.</u>	<u>Parameter</u>	<u>Details to be Filled by Vendor</u>
24	Delivery Time	3-4 Weeks from PO
25	Installation Scope	Excluded
26	Certificates	CPCB IV / ISO / Factory Test / Type Test: (Attach copies)
27	Control Panel Features	Protections: LLOP, HWT, Overspeed Display Type: Digital Remote Monitoring: Yes
28	Safety Features	Earth Fault, Emergency Stop, Auto Shutdown
29	Paint Finish	Powder Coated / CED Coated Corrosion Resistant: Yes
30	Other Inclusions	AVMs, Foundation Bolts, Tool Kit, Document Set, First Fill (Oil C Coolant) and Def also



■ TECHNICAL FORMAT – 400 KVA Diesel Generator Set

<u>S.No.</u>	<u>Parameter</u>	<u>Details to be Filled by Vendor</u>
1	DG Set Rating	400
2	Make s model	Engine: 6M21G2D4/5 Alternator: LS/CG/MECCALTE
3	Engine Details	Model: 6M21G2D4/5 No. of Cylinders: 6 Cooling Type: RADIATOR Aspiration: TURBOCHARGED BHP: 489 Displacement: 12.54 ltrs.
4	Alternator Details	Model: Make: LS/CG/MECCALTE Brushless: Yes Insulation Class: H AVR: Yes
5	Fuel Type	High-Speed Diesel (HSD)
6	Fuel Consumption (100% Load)	80.8 liters/hour
7	Fuel Consumption (75% Load)	61.3 liters/hour
8	Starting System	Through Controller
9	Control Panel	AMF Panel: No Type: Manual/Auto Controller Make/Model: DEIF SGC420
10	Acoustic Enclosure	CPCB IV Compliant Sound ≤ 75 dBA @ 1m Sheet Thickness (Base/Doors): 1.6 mm
<u>S.No.</u>	<u>Parameter</u>	<u>Details to be Filled by Vendor</u>
11	Compliance	CPCB IV Certification: Yes

1 2	Dimensions (L×W×H)	5700 mm ×2100 mm × 3113 mm
1 3	Weight	6748 kg (Total set weight)
1 4	Battery Details	No. of Batteries: 2 Rating: 150AH Make: EXIDE
1 5	Cooling System	Radiator Type: RADIATOR Air Flow: NA Coolant Type: Coolant
1 6	Lubrication System	Oil Capacity: 34 L Recommended Change Interval: 500 hrs./ one year
1 7	Fuel Tank Capacity	900 liters (Base Tank)
1 8	Exhaust System	Silencer Type: Residential Pipe Diameter: 105 mm
1 9	Lube Oil Consumption	<0.3 % of Fuel Consumption
2 0	Noise Level	≤75 dBA @ 1 meter (CPCB IV Norms)
2 1	Warranty	Engine: 5 C 5years Alternator: 2 years Complete DG: 2 years/ 5000 hrs
2 2	Service Support	Nearest Service Center: D-56, VIBHUTI KHAND, GOMTI NAGAR, LUCKNOW
2 3	Number of Free Service Visits	1 Nos. within warranty period
2 4	Delivery Time	2-3 Weeks from PO

<u>S. No</u>	<u>Parameter</u>	<u>Details to be Filled by Vendor</u>
25	Installation Scope	Excluded
26	Certificates	CPCB IV / ISO / Factory Test / Type Test: (Attach copies)
27	Control Panel Features	Protections: LLOP, HWT, Overspeed Display Type: Digital Remote Monitoring: Yes
28	Safety Features	Earth Fault, Emergency Stop, Auto Shutdown
29	Paint Finish	Powder Coated / CED Coated Corrosion Resistant: Yes
30	Other Inclusions	AVMs, Foundation Bolts, Tool Kit, Document Set, First Fill (Oil C Coolant) and Def also

FIRE FIGHTING WORKS

Technical Specifications

Internal

A. GENERAL

1) CONTRACTORS RESPONSIBILITIES

1. CONTRACTORS RESPONSIBILITIES

The Contractor is responsible for the quality and the satisfactory operation of the installations entrusted to him, as well as for compliance with the performance stipulated in this document. Consequently, for his own account and under his own responsibility, he must carry out all calculations and select the necessary materials and equipment. The contractor scope also includes approval from local authorities. Necessary compliance has to be done by EPC contractor.

Apart from the required performance definitions, this document and the relevant drawings also provide many indications resulting from the studies carried out by the Engineer.

The Contractor shall review these studies and check the corresponding indications.

The same applies to equipment selection, for which the information given in this document must be deemed as indicative and defines only the minimum requirements.

2) SCOPE DESCRIPTION

The contractor shall furnish all labour, materials, tools, supplies, equipment, transportation, supervision, technical, professional, and other services, and shall perform all operations necessary and required to satisfactorily complete all the necessary engineering, procurement services, construction work and commissioning for the fire protection systems and equipments for the project.

3) BASIC DESIGN CRITERIA

Refer tender Drawings and Documents.

4) CODES AND STANDARDS

All the systems shall be designed and installed in accordance with the requirement of International Codes and Standards and Local Authority having Jurisdiction. They shall be particularly in accordance with the following NBC 2016 / BIS / NFPA /BS /EN standards:

- IS1239-2004(Part-I) Specifications for mild steel tube, tubular and other steel pipe fittings.
- IS 1239-2011 (Part-II) Specifications for mild steel tube, tubular and other steel pipe fittings.
- IS 1536-1976 Specification for centrifugally Cast (Spun) Iron pressure pipes with flanges for water, gas and sewage.
- IS 1538 (Part 1 to 23) Specification for Cast Iron fittings for pressure pipes for water, gas and sewage.
- IS 1726-1960 Code for cast iron manhole frame and cover.
- IS 3589-1981 Specification for electrically welded steel pipes for water, gas and sewage.
- IS 4736-1986 Galvanizing G.I. Pipes
- IS 636-1988 Non percolating flexible fire fighting delivery hose (third revision)
- IS 694-1990 PVC insulated cables for working voltages up to and including 1.100 volts (third revision)
- IS 778-1984 Copper alloy gate, globe and check valves for water works purposes (fourth revision) (Amendment 2)

- IS 780-1984 Sluice valves for water works purposes (50 to 300 mm) size (sixth revision) (amendment 3)
- IS 884-1985 Specification for first-aid hose-reel for fire fighting (for fixed installations) (first revision) (with amendment No.1)
- IS 900-1992 Code of practice for installation and maintenance of induction motors (second revision)
- IS 901-1988 Specification for couplings, double male and double female, instantaneous pattern for firefighting (third revision)
- IS 902-1992 Suction hose coupling for fire fighting of purposes (third revision)
- IS 903-1984 Specification of fire hose delivery couplings branch pipe, nozzles and nozzle spanner (third revision) (Amendment 5)
- IS 937-1981 Specification for washers for water fittings for fire fighting purposes (revised) (with amendment No, 1)
- IS 1520-1980 Horizontal centrifugal pumps for clear cold, fresh water (second revision)
- IS 1536-1976 Horizontally cast iron pressure pipes for water, gas & sewage (first revision) (with Amendments No. 1 to 4)
- IS 1554-1988 Part I PVC insulated (heavy duty) electric cables (working voltage up to and including 1100 volts (third revision)
- IS 1554-1988 Part II PVC insulated (heavy duty) electric cables (working voltage from 3.3 KV up to and including 11 KV (second revision)
- IS 1648-1961 Code of practice for fire safety of buildings (General) Fire fighting equipment and its maintenance (with amendment No.1)
- IS 3624-1987 Pressure and vacuum gauges (Second revision)
- IS 4736-1968 Hot-dip zinc coatings on steel tubes (with Amendment No.1)
- IS 5290-1983 Specification for landing valves (second revision) (with Amendments No.6)
- IS 5312- 1984 Part I Swing check type reflux (non-return) valves Part I single door pattern (with amendments nos. 1 & 2)
- IS 5312- 1986 Part II Swing check type reflux (non-return) valves Part II Multi door pattern (with amendments nos. 1 & 2)
- IS 7285 Seamless cylinders for storage of gas at high pressure.
- IS 2189-1962 Code of practice for Automatic Fire alarm system
- IS 2195-1962 Specification for heat sensitive fire detectors
- IS 732-1973 Code of practice for electrical wiring installation
- NFPA 10, Standard for Installation of Portable Fire Extinguishers
- NFPA 11, Standard for the low, medium and high expansion foam
- NFPA 11A, Standard for low, medium and high expansion foam system
- NFPA 12, Standard for carbon dioxide extinguishing system
- NFPA 13, Standard for the Installation of Sprinkler Systems
- NFPA 14, Standard for the Installation of Standpipe and Hose Systems
- NFPA 15, Standard for water spray fixed system for fire protection
- NFPA 17, Standard for dry chemical extinguishing systems
- NFPA 17A, Standard for wet chemical extinguishing systems
- NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection
- NFPA 22, Standard for Water Tanks for Private Fire Protection

- NFPA 24, Standard for the Installation of Private Fire Service Mains and their Appurtenance
- NFPA-25, Standard for Inspection, Testing, and Maintenance of Water Based Fire Protection Systems
- NFPA-70, National Electric Code
- NFPA 72, National Fire Alarm Code
- NFPA 92A, Standard for Smoke Control Systems
- NFPA-101, Life Safety Code
- NFPA-110, Standard for Emergency and Stand by Power systems
- NFPA-170, Standard for Fire Safety Symbols
- NFPA 204, Standard for Smoke and Heat Venting
- NFPA-220, Standard for types of Building Construction
- NFPA-221, Standard for Fire Walls and Fire Barrier Walls
- NFPA 780, Standard for the Installation Lightning Protection Systems
- NFPA-2001, Standard on Clean Agent Fire Extinguishing systems
- NFPA 5000, Building Construction & Safety Code
- OSHA, Code of federal regulations, Title 29, Part 1926
- BS EN3 for portable fire extinguishers
- BS EN 1866 for mobile extinguishers
- BS EN 671-1 for fixed fire fighting system
- BS 5041-3 for dry riser inlet
- BS EN 54 Standard for installation of Fire Alarm System.

EPC Contractor can provide compliance to the Local Norms against each code based on written approvals from Local Authorities.

5) SCOPE OF WORK

This specification covers the supply, delivery and complete installation on site and in full working order of the equipment specified in this document and/or shown on the drawing

Full particulars, performance curves and illustrations of the equipment, complying as closely as possible with this specification, shall be provided with the tender, but any deviations from the specification must be fully and clearly indicated in the tender submission schedules.

The Contractor shall provide and install:

- The complete fire pumping station, including the firewater pumps (pumps, diesel engines drive, pump controllers, skid & pump), the jockey pump (pumps, electric drive, electric drive controllers), the piping & hanging, the valves, check-valves, relief valves, fittings, the instrumentation, the storage fire water tanks and feeding controllers (valves & controllers).
- The firewater mains (sprinkler, standpipe & hydrant), including the piping, the fittings, the hanging, the block-valves & the hydrants.
- The wet sprinkler systems, including the control valves, the piping, the hanging, the heads, the instrumentation.
- The hose reels (standpipes, hose connections, external hose streams).
- The portable extinguishers

- Clean agent fire suppression system for the rooms mentioned in the drawings.
- The marking of all the safety equipment

The Contractor shall be responsible for all the following aspects of the provided systems:

- The checking of the tender drawings and any calculations supplied with the drawings. The Contractor shall check each drawing and satisfy himself that the design is correct for the equipment offered and will meet all applicable rules and regulations
- The provision of any additional information required by the Contractor's installation engineers who are particular to the equipment being supplied e.g. fabrication drawings, equipment data sheets, commissioning instructions etc.
- The provision of drawings and equipment data related to the systems as required by the Engineer.
- The supply of all required equipment and other fixtures associated with the systems.
- Shop testing of equipment and provision of inspection facilities
- The provision and fittings of suitable wall boxes, transits and plates where pipe work or cable passes through walls, etc...as well as fire rating reinstatement materials
- The supply of as built drawings and as built calculations
- The provision of scaffolding, ramps and any other equipment required to enable the systems to be installed, tested and commissioned correctly
- A demonstration to key personnel in the use and testing of the systems and equipment supplied
- Operating and maintenance manuals.

6) MATERIALS

The Contractor shall supply all materials necessary to make up effective and operable fire protection, detection and alarm systems, voice alarm system and emergency & exit lighting systems for the facilities indicated in the drawings and in the present specification, and particularly :

- All the necessary pipe work, valves, equipment and instrumentation required for the facilities
- All electrical cable between panels, junction boxes, sensors, call points, pressure switches, alarm bells, flashing lights, and generally all the cable (and their supports) required for the facilities.
- Local alarms indicating actuation of the systems
- All detectors, fire signaling, and alarm cabling shall be installed by the Contractor using materials in accordance with international standards.
- All emergency lights, exit lights with directional arrow marks & pictograms as required, central battery panels, addressable monitoring panel, interface modules, phase monitoring relays and interconnecting cabling shall be installed by the contractor using the materials in accordance with international standards.

The main electrical supply to the Contractor's equipment will be by others.

All instrumentation and electrical equipment will be enclosed to suit the Hazard Class of the area. The Hazard Class of each area is indicated on the Hazardous Area Layouts.

Hazardous Area Certificate will be required for each item supplied within the Hazardous

Area.

The Contractor shall define in the quotation the full specification of every system proposed (pipe work, cables, equipment).

7) QUALITY OF MATERIALS.

Only materials meeting quality guidelines mentioned specifically for the products shall be subject to the approval of the Authorized Engineer. Wherever applicable, the system and material is to comply with the relevant International Standards or British Standards /NFPA /LPCB. All Materials should have at least been certified by two independent Certification Organizations from International Testing Laboratories & Accredited Certification Bodies as BSI Kitemark /Vds and or UL/FM.

8) APPROVAL LISTING OF MATERIALS

The equipment shall have been tested and, where applicable, shall have been granted a certificate of approval or listing for the intended service. UL listed, FM approved, BSI Kitemark, Vds approved equipment shall be used where possible. Where equipment is offered without the above approval or listing, these items shall be listed with the type of certificate or approval granted indicated.

The Contractor shall supply only proven and established equipment which is suitable for the duty.

The Engineer Incharge reserves the right to call for either substitute or alternative units, or to nominate manufacturers or models for any class of equipment.

9) SUBMITTALS

The installing contractor shall submit the following design information and drawing for approval prior to starting work on this project.-

PRODUCT DATA: SUBMIT MANUFACTURERS TECHNICAL PRODUCT

Field installation layout drawings having a scale of not less than (1:100m) detailing the location of all equipment's, pipe runs including pipe sizes and lengths, controls and other accessories.

Auxiliary details and information such as maintenance panels, door holders, special sealing requirements and equipment shutdown.

Separate layouts, or drawings, shall be provided for each floor plans (i.e.; sectional drawings, raised floor drawings, and above false ceiling drawings) for mechanical and electrical work.

A separate layout or drawing, shall show isometric details of clean agent storage containers, mounting details and proposed pipe runs and sizes.

Electrical layout drawings shall show the location of all devices and include point-to-point conduit runs and a description of the method(s) used for detector mounting.

A complete sequence of operation shall be submitted detailing all alarm devices, shutdown functions, remote signalling, and agent discharge for each system.

Submit drawings, calculations and system component data sheets for approval to the local Fire Prevention Agency, and all other Authorities Having Jurisdiction before starting installation. Submit approved plans to the Architect/Engineer for record.

10) DRAWINGS

SHOP DRAWINGS

The Sub-Contractor shall provide shop drawings for each system floor wise in detail as required by the engineer in charge and Authority having jurisdiction. It is the contractor responsibility to co- ordinate with other services while preparing the shop drawings and obtain approval from the engineer in charge.

AS BUILT DRAWINGS

Upon completion of each system, the installing contractor shall provide four (4) copies of system "As- Built" drawings to the owner. The drawings shall show actual installation details including all equipment locations as well as piping and conduit routing details. Show all room or facilities modifications, including door and/or damper installations completed. One (1) copy of reproducible engineering drawings shall be provided reflecting all actual installation details.

These drawings shall be as accurate and complete as possible.

11) COMMISSIONING AND TESTING

Performance tests shall be carried out at site in the presence of Civil Defence personnel.

All tests shall be carried out in the presence of the Engineer Incharge's, insurers, or their nominated representatives. The Contractor shall provide all the necessary tools and equipment for testing and commissioning activities.

FIRE PROTECTION SYSTEM:

All First Aid Equipment's (Fire Extinguishers, Hose Reels, Fire Hose Rack, Fire blankets) shall have been certified by two Certification Organizations from International Testing Laboratories & Accredited Certification Bodies as UL listed/FM Approved.

1. FIRE EXTINGUISHERS (FIRST AID EQUIPMENT)

1.1 GENERAL

- Fire Extinguishers shall be manufactured to comply with BS EN 3 (portable), BS EN 1866 (Mobile) standards.
- Fire Extinguishers shall comply with NFPA-10 or BS 5306 for the installation.
- The classification of fire extinguishers shall consist of a letter that indicates the class of fire on which a fire extinguisher has been found to be effective, preceded by a rating number (Class A, Class B and Class F only) that indicates the relative extinguishing effectiveness.
- The distribution of fire extinguishers shall comply with the prescribed requirements of NFPA- 10, as

shown on the drawings and the specific requirements of the local Civil Defense Authorities.

- Cabinets housing fire extinguishers shall not be locked.
- Portable fire extinguishers shall be maintained in a fully charged and operable condition, and kept in their designated places at all times when they are not being used.

1.2 DEFINITIONS

- The type of extinguisher needed depends on the right type of fire that may occur in the room or building.
- According to NFPA 10, several classes of fire have been defined:
- Class A Fires: Fires in ordinary combustible materials, such as wood, cloth, paper, rubber, and many plastics.
- Class B Fires: Fires in flammable liquids, combustible liquids, petroleum greases, tars, oils, oil-based paints, solvents, lacquers, alcohols, and flammable gases.
- Class C Fires: fires that involve energized electrical equipment where the electrical non-conductivity of the extinguishing media is of importance. (Where electrical equipment is de-energized, fire extinguishers for class A or B fires can be used safely.)
- Class D Fires: Fires in combustible metals, such as magnesium, titanium, zirconium, sodium, lithium, and potassium.
- Class K or Class F Fires: Fires in cooking appliances that involve combustible cooking media (vegetable or animal oils and fats.)
- Building presenting class B or C fire hazard shall be equipped with a regular number of class A extinguishers dedicated to the building protection and shall also be equipped with adding class B or C extinguishers.
- According to these definitions, all parts of the buildings shall be equipped with class ABC type extinguishers. In the meantime, rooms such as Storages, Workshops and other rooms housing electrical equipment's, shall be equipped with adding class C extinguishers.

1.3 DRY POWDER FIRE EXTINGUISHER: (POTASSIUM BI-CARBONATE)

Dry powder fire extinguishers shall be manufactured in accordance with BS EN3 / NFPA 10 for portable extinguishers and BS1866 for mobile extinguishers and shall be operated by means of a lever/squeeze handle operated valve provided with a safety pin which shall avoid inadvertent operation and the valve shall be capable for controlling partial discharge. The cylinder shall have minimum working pressure of 14bar. The temperature shall range from -20° to 60° C. It must be coated externally by electrostatic polyester powder and oven baked for corrosion resistance. The cylinder shall be made special cold rolled steel sheet with Argon/CO2 automatic welding process and the suction tube shall be made of PVC material. All extinguishers shall carry instructions for operation and maintenance in English and Arabic.

The product should have at least been certified by two Independent Certification Organizations from the International Testing Laboratories & Accredited Certification Bodies as UL Listed/FM approval.

The extinguishers are recommended with the capacities and minimum fire rating as follows:

SL #	Description	Capacity	Fire Rating
1	Dry Powder Fire Extinguisher, Portable	1 Kg	8A 34B
2	Dry Powder Fire Extinguisher, Portable	2 Kg	13A 89B
3	Dry Powder Fire Extinguisher, Portable	3 Kg	21A 89B
4	Dry Powder Fire Extinguisher, Portable	4 Kg	21A 113B
5	Dry Powder Fire Extinguisher, Portable	6 Kg	34A 183B
6	Dry Powder Fire Extinguisher, Portable	9 Kg	43A 233B
7	Dry Powder Fire Extinguisher, Portable	12 Kg	55A 233B
8	Dry Powder Fire Extinguisher, Trolley	25 Kg	IIIB
9	Dry Powder Fire Extinguisher, Trolley	50 Kg	IVB
10	Dry Powder Fire Extinguisher, Trolley	100 Kg	IVB

1.4 CARBON DIOXIDE FIRE EXTINGUISHER: FIRST AID EQUIPMENT

Carbon dioxide fire extinguishers shall be manufactured in accordance with BS EN 3 (portable) and BS EN 1866 (mobile) and shall be operated by means of a lever /squeeze handle operated valve provided with a safety pin which shall avoid inadvertent operation and the valve shall be capable for controlling partial discharge. The cylinder shall be made of high grade seamless carbon steel pipe or aluminium alloy and it must be coated externally by electrostatic polyester powder quating and oven baking to resist corrosion. The cylinders shall be free from leakage during hydrostatically pressure tested to 250bar. The temperature shall range from -20° to 60° C.

The suction tube shall be Aluminium. All extinguishers shall carry instructions for operation and maintenance in English and Arabic. Typical applications are electrical & electronic equipment's, food preparation areas, laboratories, and printing or duplicating areas, telephone equipment Rooms, Engine Rooms, Control Rooms, Paint spray Booths, Flammable liquid storage areas etc,. Since the agent is discharged in the form of a gas/snow cloud, it has a relatively short range of 3 ft to 8 ft (1 m to 2.4 m). This type of fire extinguisher is not recommended for outdoor use where windy conditions prevail, or for indoor use in locations that are subject to strong air currents because the agent can rapidly dissipate and prevent extinguishment. The concentration needed for fire extinguishment reduces the amount of oxygen (air) needed for life safety when the discharge is in a confined area (space).

The Carbon dioxide fire extinguishers: The product should have at least been certified by two independent Certification Organizations from International Testing Laboratories & Accredited Certification Bodies as LPCB approval/KITE mark approval and or UL listed/FM Approved.

The CO2 extinguishers are recommended with the capacities and minimum fire rating as follows:

SL #	Description	Capacity	Fire Rating
1	CO2 Fire Extinguisher, Portable	2 Kg	34B

2	CO2 Fire Extinguisher, Portable	5 Kg	55B
3	CO2 Fire Extinguisher, Trolley	10 Kg	70B
4	CO2 Fire Extinguisher, Trolley	30 Kg	Min. 113B

1.5 WATER FIRE EXTINGUISHER (FIRST AID EQUIPMENT)

Water type Fire extinguisher shall manufactured in accordance to BS EN 3 (portable) and BS EN 1866 (mobile) and shall be operated by means of a lever operated self-closing control valve to enable the discharge to be interrupted temporarily and provided with a safety pin. The cylinder shall have minimum working pressure of 14bar. The temperature shall range from +5° to 60°C. The extinguisher must have a plastic base. It must be coated inside by electrostatic PVC resin to resist corrosion. The cylinder shall be made special cold rolled steel sheet with Argon/CO2 welding process and the suction tube shall be made of Rigid PVC with filter. The water type fire extinguisher capacity shall be of 9 Ltrs stored pressure type or 2-1/2 Gallon. All extinguishers shall carry instructions for use in English and Arabic.

The capacity of the extinguisher shall be of 9Lts and 2 ½” Gallon shall have a minimum fire rating of 13A as per BS EN3.

The water type fire extinguishers: The product should have at least been certified by two independent Certification Organizations from International Testing Laboratories & Accredited Certification Bodies UL listed/FM approved.

The water extinguishers are recommended with the capacities and minimum fire rating as follows:

SL #	Description	Capacity	Fire Rating
1	Water Fire Extinguisher, Portable	6 Ltr	13A
2	Water Fire Extinguisher, Portable	9 Ltr	21A
3	Water Fire Extinguisher, Trolley	20 Ltr	Min. 13A
4	Water Fire Extinguisher, Trolley	25 Ltr	Min. 13A
5	Water Fire Extinguisher, Trolley	45 Ltr	Min. 13A
6	Water Fire Extinguisher, Trolley	50 Ltr	Min. 13A
7	Water Fire Extinguisher, Trolley	90 Ltr	Min. 13A
8	Water Fire Extinguisher, Trolley	100 Ltr	Min. 13A
9	Water Fire Extinguisher, Trolley	135 Ltr	Min. 13A
10	Water Fire Extinguisher, Trolley	150 Ltr	Min. 13A

1.6 FOAM FIRE EXTINGUISHER: (FIRST AID EQUIPMENT)

Foam type Fire extinguisher shall manufactured in accordance to BS EN 3 (portable) and BS EN 1866 (mobile) and shall be operated by means of a lever operated self-closing control valve to

enable the discharge to be interrupted temporarily and provided with a safety pin. The cylinder shall have minimum working pressure of 14bar. The temperature shall range from +5° to 60°C. The extinguisher must have a plastic base. It must be coated inside by electrostatic PVC resin to resist corrosion. The cylinder shall be made special cold rolled steel sheet with Argon/CO2 welding process and the suction tube shall be made of Rigid PVC with filter. The Foam type fire extinguisher capacity shall be of 9 Ltrs stored pressure type or 2-1/2 Gallon. All extinguishers shall carry instructions for use in English and Arabic.

The Foam type fire extinguishers: The product should have at least been certified by two independent Certification Organizations from International Testing Laboratories & Accredited Certification Bodies as LPCB approval/Kitemark approval and or UL listed/FM Approved.

The capacity of the extinguisher shall be of 9Lts and 2-1/2Gallon shall have a fire rating of 21A & 183B as per BS EN3.

The Foam extinguishers are recommended with the capacities and fire rating as follows:

SL #	Description	Capacity	Fire Rating
1	Foam Fire Extinguisher, Portable	3 Ltr	8A & 70B
2	Foam Fire Extinguisher, Portable	9 Ltr	21A & 144B
3	Foam Fire Extinguisher, Portable	9 Ltr	21A & 183B
4	Foam Fire Extinguisher, Trolley	50 Ltr	IVB
5	Foam Fire Extinguisher, Trolley	100 Ltr	IVB
6	Foam Fire Extinguisher, Trolley	135 Ltr	IVB

1.7 WET CHEMICAL FIRE EXTINGUISHER: (FIRST AID EQUIPMENT)

The Wet Chemical Fire Extinguishers shall have UL/FM approved and comply with BS EN3 standards. The cylinder shall be tested to 30 bar and shall have minimum pressure of 10 bar. The capacity shall be 3 liters 25F/13A & 6 liters with 75F/13A ratings. They shall be provided in all the kitchens. The temperature shall range from +5° to 60°C.

The Wet Chemical extinguishers are recommended with the capacities and fire rating as follows:

SL #	Description	Capacity	Fire Rating
1	Wet Chemical Fire Extinguisher, Portable	2 Ltr	5F
2	Wet Chemical Fire Extinguisher, Portable	3 Ltr	8A 25F
3	Wet Chemical Fire Extinguisher, Portable	6 Ltr	13A 75F

The Wet chemical type of fire extinguishers: The product should have at least been certified by two independent Certification Organizations from International Testing Laboratories & Accredited Certification Bodies as UL listed/FM Approved.

1.8 CLEAN AGENT FIRE EXTINGUISHER: (FIRST AID EQUIPMENT)

Clean Agent Fire extinguisher shall have UL/FM Approved and manufactured in accordance to BS EN3

/ NFPA10 standards (portable) and BS EN 1866 (mobile) shall be operated by means of a Squeeze/ lever operated self-closing control valve to enable the discharge to be interrupted temporarily and provided with a safety pin. The cylinders shall be tested to 30 bar and shall have minimum working pressure of 15bar. The temperature shall range from -20° to 60°C. The extinguisher must have a plastic base. The cylinder shall be made special cold rolled steel sheet with Argon/CO2 welding process and the suction tube shall be made of Rigid PVC with filter. The Clean Agent type fire extinguisher minimum capacity shall be of 4 Kg stored pressure type. All extinguishers shall carry instructions for use in English and Arabic.

The product should have at least been certified by two Independent Certification Organizations from the International Testing Laboratories & Accredited Certification Bodies as UL Listed/FM approval.

The Clean Agent extinguishers are recommended with the capacities and fire rating as follows:

SL #	Description	Capacity	Fire Rating
1	Clean Agent Fire Extinguisher, Portable	4 Kg	34B C
2	Clean Agent Fire Extinguisher, Portable	6 Kg	5A 55B C
3	Clean Agent Fire Extinguisher, Portable	9 Kg	8A 70B C
4	Clean Agent Fire Extinguisher, Portable	12 Kg	13A 70B C
5	Clean Agent Fire Extinguisher, Trolley	25 Kg	IIB
6	Clean Agent Fire Extinguisher, Trolley	50 Kg	IIIB
7	Clean Agent Fire Extinguisher, Trolley	100 Kg	IVB

1.9 COMMISSIONING AND TESTING

Performance tests shall be carried out at site in the presence of Consultant / PMC / Client/Chief Fire Officer

All tests shall be carried out in the presence of the Engineer Incharge's, insurers or their nominated representatives.

The Contractor shall provide all the necessary tools and equipment for testing and commissioning activities. securely and properly anchored to the mounting surface in accordance with the manufacturer's instructions. Wheeled-type fire extinguishers shall be located in a designated location.

Fire extinguishers having a gross weight not exceeding 40 lb (18.14 kg) shall be installed so that the top of the fire extinguisher is not more than 5 ft (1.53 m) above the floor. Fire extinguishers having a gross weight greater than 40 lb (18.14 kg) (except wheeled types) shall be so installed that the top of the fire extinguisher is not more than 31/2 ft (1.07 m) above the floor. In no case shall the clearance between the bottom of the fire extinguisher and the floor be less than 4 in. (10.2 cm).

Fire extinguishers shall be installed in a 1.2 mm thick, stainless steel, polished finish cabinets where required in finished rooms / office areas and as shown on the drawings and shall be confirmed with the Architect.

1.10 FIRE HOSE REELS-AUTOMATIC TYPE.

The hose reel drum shall be made of electro galvanized steel sheet or stainless sheet and the cabinet shall be supported with reinforced support arm and swing through 180 degrees. Welding of any part on cabinet front shall not be allowed. The middle piece of the hose reel shall be not less than 200mm diameter.

The reels shall comply with BS EN 671-1 and comprise a reinforced semi rigid hose. The semi rigid hose use for the hose reel shall be LPCB/BSI Kite mark and or having Local Civil Defense approved in conformance to BS EN 694. The semi rigid hose shall be 25mm or 19mm diameter x 30m long, coiled on a revolving drum. The outer end of a hose shall be fitted with a “jet / spray / shut-off” control nozzle. The inner end of the hose shall be connected through the reel to the water supply.

All water passage must be brass chrome plated and plastic parts are not permitted. Complete unit to be listed. The product should have at least been certified by two independent Certification Organizations from International Testing Laboratories & Accredited Certification Bodies as LPCB approval/KITE mark approval. In case of automatic hose reels, the reels shall incorporate a valve that automatically turns on the water supply when approximately 3 mtr of hose is unreeled, and shut off again when the hose is re-wound onto the reel. A manual shut-off valve of the wheel type shall also be installed on the service pipe to each hose reel.

The hose nozzle shall be (JET/SPRAY/SHUT OFF) type nozzle.

Each hose reel shall be installed and tested to BS 5306 and shall deliver not less than 0.4 l/s when the two top-most reels are in use simultaneously providing a jet of approximately 6 mtr. in length. Pressure reducing devices shall be provided whenever necessary to limit the pressure as per local authority remotest point requirement.

Brief operating instructions should be clearly displayed on or by each hose reel in both English & Arabic languages

The hose reels shall be suitable for working pressures up to 12 bar (175psi) and shall be installed in accordance with the manufacturer’s instructions.

1.11 FIRE HOSE RACK: (FIRST AID EQUIPMENT)

Fire hose rack assembly shall be UL/FM approved. The hose rack shall be of size of 1.5 inch x 30 mtr or 2.5 inch x 30 mtr.

Brief operating instructions shall be clearly displayed on the unit.

The hose rack assembly shall be semi-automatic type and suitable for the working pressure of 150Psi and shall be installed in accordance with the manufacturer's instructions.

The product should have at least been certified by two independent Certification Organizations from International Testing Laboratories & Accredited Certification Bodies as UL and or FM

1.12 FIRE BLANKETS: (FIRST AID EQUIPMENT)

Provide fire blankets in Kitchens. Fire blanket shall be good quality with silicon coating provided on both sides. The size shall be 4 feet x 4 feet, 4 Feet x 6 feet and 6 feet x 6 feet. The product should have at least been certified by two independent Certification Organizations from International Testing Laboratories & Accredited Certification Bodies as LPCB/KITE mark approved.

2. STANDPIPE AND HOSE SYSTEMS

2.1 FIRE HOSE & NOZZLE

FIRE HOSE AND NOZZLES: THE PRODUCT SHOULD HAVE AT LEAST BEEN CERTIFIED BY INDEPENDENT CERTIFICATION ORGANIZATIONS FROM INTERNATIONAL TESTING LABORATORIES & ACCREDITED CERTIFICATION BODIES AS UL LISTED/FM APPROVED.

Fire hose shall be of synthetic reinforced rubber lined, 65 mm diameter and 30 m long equipped with brass chrome plated male coupling for the connection with the landing valve, and female coupling for the connection 65 mm chrome plated adjustable diffuser nozzle. The fire hose unit shall include the landing valve specified above, and shall have minimum working pressure of 15 Bar and bursting pressure of minimum 45 Bar.

2.2 LANDING VALVES (PRESSURE REDUCING & RESISTING DEVICES)

Landing valves shall be of pressure reducing and restricting type devices acceptable to the Fire Brigade use inside buildings. This device shall have 65mm inlet diameter bore fitted with 65 mm. instantaneous female coupling conforming to BS 336 and a blank cap secured by a suitable length of chain.

The product should have at least been certified by two independent Certification Organizations from International Testing Laboratories & Accredited Certification Bodies as LPCB approval/BSI KITE mark approval and or UL listed/FM Approved.

The valve shall be of brass / Gunmetal construction with approved finish. If the landing valve is UL listed then the outlet coupling must be quick instantaneous with local fire services. The installation of the coupling should be done by an authorized installer.

Landing valves shall be installed inside the cabinet, at a height above floor level between 750 mm and 1100 mm. The outlet shall be installed to give clearances of not less than 150 mm on both sides and below the valve and not less than 200 mm clearance above the hand wheel.

2.3 HOSE REEL CABINETS

Fire hose cabinets should be UL listed fire rated cabinets for F rating and T rating of 2 hours.

Cabinet material should be Either E.G. sheet, Red (RAL 3000) Powder Coated or any other colors in RAL.

OR Aluminum, Red (RAL 3000) Powder Coated or any other colors in RAL. OR Stainless Steel 304/316L
Brush/Mirror/Titanium Gold Finish.

Type of Cabinet should be Either of Recessed Type, Trim less, Semi – Recessed & Surface Mounted. Upper compartment shall accommodate Fire Hose Reel or Fire Hose Rack.

Lower Compartment shall accommodate Fire Hose, Landing valve, Water Branch Pipe & Portable Fire Extinguisher.

Door Type shall be Fire Rated Glass Door.

The Double fire hose reel cabinet in different locations of the building shall have following specified fire equipments:

- Automatic or manual Fire Hose Reel
- Landing Valves, Fire Hose and Nozzle or fire hose rack assembly
- 2 kg CO2 Fire Extinguisher
- 6 kg DCP Fire Extinguisher

2.4 FIRE BREECHING INLET VALVE

The unit shall be of UL Listed/FM approved.

The inlet breeching piece shall be of horizontal pattern having a 150 mm flanged outlet and four 65 mm instantaneous male inlets complete with blank caps and chains. A non-return (check) valve shall protect the inlet. The coupling shall comply with BS 336. The inlet connections shall be of suitable type of local fire brigade department.

The breaching piece shall be equipped with a 25 mm drain valve to drain the riser.

All parts including valve body, chain and caps shall be brass / gunmetal if it is UL Listed and valves body shall be made of DI body with Brass Inlet Valves polished chrome plated if it is BSI kite mark approved. The product should have at least been certified by two independent Certification Organizations from International Testing Laboratories & Accredited Certification Bodies as UL listed/FM Approved.

2.5 FIRE BREECHING INLET VALVE CABINET

The unit shall be BSI kite mark approved. The product should have at least been certified by two independent Certification Organizations from International Testing Laboratories & Accredited Certification Bodies as BSI KITE mark approval.

The inlet breeching unit shall be housed in an steel flush box painted by polyster powder coated with wired glass glazed front panel as per BS 5041-5 standard and:

- Conspicuously indicated by the words: “Dry Riser Inlet, Sprinkler Inlet, and Wet Riser Inlet” in block letters on the inner face of the glass, depending on the project type.
- Fastened only by means of a spring lock, which can also be operated from the inside without the aid of a key after the glass has been broken.
- Made large enough for hose to be connected to inlets even if the door cannot be opened and the only means of access is by breaking the glass.

2.6 EXECUTION/ INSTALLATION

Standpipe and hose systems shall be installed in accordance with NFPA-14 and Authority having jurisdiction requirements and as shown on the drawing.

The Fire protection contractor shall be responsible to co-ordinate his work with all other trades and shall be completely familiar with and shall make allowance for conditions which affect the fire protection installation.

The Fire hose cabinets shall be mounted securely in the concrete block walls, shimmying the back box and mortaring tightly in place.

Provide a pressure gauge with an isolation cock with inspectors test plug on top and bottom of the each stand pipe risers.

Chrome plated nipples shall be provided in between the landing valve and hose connection. Chrome plated escutcheons shall be provided where pipes penetrate the cabinet.

A water flow switch shall be provided in each standpipe riser and interfaced to fire alarm system for monitoring and to locate the section of water flow during fire fighting operation.

A drain valve and piping, located at the lowest point of the standpipe piping downstream of the isolation valve, shall be arranged to discharge water at an approved location.

2.7 CLEANING AND TESTING

Tubes and all items of equipment shall be delivered, stored and maintained in closed storage with their open ends effectively plugged, capped or sealed. All fittings, valves and sundry items shall be stored in clean bins or bagged and stowed in suitable racks. All such stored items shall be maintained under weatherproofed cover to be supplied by the MEP sub-contractor until they are ready for incorporation in the works. Particular care shall be taken to ensure that electrical equipment and components are kept clean and dry.

Before installations are handed over or subjected to inspection and tests, the entire installation shall be thoroughly cleaned, both internally and externally.

All fire protection installations shall be flushed out with clean water. During the flushing out, provision shall be made to exclude any items of plant, which could be damaged by the cleaning operation. The entire operation shall be carried out to the satisfaction of the Engineer.

The fire protection system shall be tested in accordance with the NFPA codes and the relevant standards, with reference the requirements set forth in this section:

All testing shall be performed under the work of this section. All services required for testing shall be the responsibility of the work of this section. The MEP sub-Contractor shall notify the Engineer of all tests, 48 hours prior to testing.

If the systems are tested in sections, the connection to the previously tested section shall be included.

All tests that may be required by the local fire authorities shall be performed under the work of this section, in the presence of their representative, if so required.

All leaks shall be corrected, and the system re-tested until no leaks are found, at no cost to the client. Functional tests of all water flow alarms are the responsibility of the works of this Section. When the various systems are completed, operation tests shall be run on all equipment to demonstrate proper operating conditions. These tests shall be run under the observation of the inspector and the client's operating engineer. The client's operators shall be instructed during this period. Operation tests shall be performed under the work of this section.

Should any piece of equipment or apparatus of any material or work fail in any of these tests, it shall be immediately removed and replaced by a perfect material, and the portion of the work replaces shall again be tested under the work of this Section.

3. FIRE PUMP SETS

3.1 GENERAL

- 1 Electric Main Fire pump
- 1 Diesel Stand By Fire pump
- 1 jockey pump

Each system shall be design to ensure the maximum pumping capacity even if 1 pump fails.

The fire pumps, motor, engine and electric pump controllers and diesel pump controllers shall be UL listed or FM approved, built in the country where the agreement is made. Unit

responsibility must be submitted from the manufacturer.

The fire pumps and engine driven shall be in accordance with NPFA 20 (curves, starting, protection...).

The contractor shall provide fully certified hydraulic calculations for exact sizing of the pumps.

The pumps shall be furnished with a full set of bench test certificates proving acceptability for the design points of this installation.

3.2 PRODUCTS

3.2.1 FIRE PUMPS

Fire pumps shall be UL or FM approved. Each pump shall have a capacity as shown in pump schedule, adjusted as necessary to suit the hydraulic calculations.

The pumping unit or package shall meet all requirements complying with NFPA 20.

The pumps shall also deliver not less than 150% of rated capacity at a pressure of not less than 65% of rated pressure. The shutoff pressure shall not exceed 140% of the rated pressure at rated capacity.

3.2.2 FIRE PUMPS TYPE

Each fire pump shall be of horizontal split case, centrifugal end suction single stage or multistage construction, specifically labeled for fire service and capable of providing the required flow and pressure of the entire development. The suction supply for the fire pump shall be from a storage tank at a maximum pressure of 20 kPa and a minimum pressure of 0 kPa. The pump casing shall be cast iron and rated to withstand twice the working pressure.

3.2.3 PUMP CONSTRUCTION

The pump construction shall be cast iron casing, Bronze impeller, Alloy Steel shaft and gland packing.

Note: The pump shall also deliver not less than 150 % of the rated capacity at a pressure of not less than 65 % of the rated pressure. The shut off pressure shall not exceed 140 % of the rated pressure at rated capacity.

3.2.4 PUMP DISCHARGE & HEAD:

The pump discharge & head shown on the drawing schedule is an estimate. The fire protection contractor shall select a pump discharge and head to satisfy the fire protection system requirements resulting from the system hydraulic calculations.

3.3 FIRE PUMP ACCESSORIES:

The Fire and Sprinkler Pumps shall include the following accessories, as required by NFPA standards:

Flow Metering Device, shall be of the Venturi type. Pilot and annubar devices will not be acceptable- One metering device shall be provided for each set of pump, or as shown on the drawings. Test Header return to the storage tank.

- Air release valve and fittings.
- Discharge pressure gauge.
- Main relief valve, pilot operated, (diesel drive only).
- Main relief valve with discharge pipes to water tank.(Scope of Contractor)
- Pump casing relief valve for Electric Pump set

3.4 ELECTRIC MOTOR DRIVE:

On installations where the Fire Pump is to be operated electrically, the electric motor shall be a horizontal, open drip-proof type UL listed, wound for 380 V, 3 phase, 50 Hz (cycle) current The motor shall be of such capacity that 115% of the full-load ampere rating shall not be exceeded at any condition of the pump load for UL Listed fire pump.

With an ambient temperature not exceeding 40 deg. C, the motor shall be designed for a temperature rise not exceeding 50 deg. C when carrying fully rated-load continuously, and shall be capable of operating continuously with an overload of 15% without stress or excessive rise in temperature. The locked rotor current shall not exceed the values specified in NFPA Pamphlet No. 20.

3.5 ELECTRIC DRIVE CONTROLLER

Automatic Microprocessor electric controller shall be UL listed and FM Approved. The Controller shall be Microprocessor type. It shall be completely assembled, wired and tested by the control manufacturer before shipment from factory, and shall be labeled 'Fire Pump Controller". The controller shall be located as practical and within the sight of the motor.

The controller shall be so located or protected that it will not be injured by water escaping from the pump or connection. The controller shall be of the combined manual and automatic star delta type and shall be complete with:

- Disconnect switch - externally operable, quick-break type.
- Circuit breaker - time delay type with trips in all phases set for 300% of the motor full load current.
- Motor starter, capable of being energized automatically through the pressure switch or manually by means of an externally operable handle. Motor starter shall be of the Wye Delta
- Running period timer - set to keep motor in operation, when started automatically, for a minimum run period Timer
- Pilot lamp - to indicate circuit breaker closed and power available.

- Alarm relay - to energize an audible or visible alarm through an independent source of power to indicate circuit breaker open or power failure.
- Selector Switch - a two position station shall be provided on the enclosure marked "Automatic" and "Manual".
- Means shall be provided on the Controller to operate an alarm signal continuously while the pump is running.
- Provisions for power supply at 220 V for diesel pump battery chargers.
- Control equipment shall meet all requirements of NFPA20 & NFPA72.

3.6 DIESEL ENGINE DRIVE:

Diesel engine shall be UL listed or FM approved for fire protection service.

The engine shall be of the self-contained, mounted on a suitable base with the following minimum plus any others that may be necessary by NFPA-20 and local CD requirements.

- Dual battery set sized to NFPA -20 requirements with electrolyte shipped in separate containers, rack and cables.
- Dual battery charger of proper type for batteries used (included in UL Listed / FM Approved controller). Power to battery charger shall be supplied from electric pump control panel. Wiring from control panel to battery chargers shall be by the contractor.
- Electric starter with suitable generator and voltage regulator.
- Engine water pump.
- Heat exchanger cooling system.
- Lubricating oil pump and filter.
- Fuel injection system.
- Air cleaner.
- Proper instrument panel, complete with engine run warning light, water temperature gauge, oil pressure gauge, voltmeter, totalizing type tachometer and hour meter.
- Industrial Grade Muffler.
- Cooling water line for the engine heat exchanger assembly.
- Flexible exhaust connectors.

All engine wiring for automatic starting shall terminate in a proper junction box to permit connection to control panel.

3.7 FUEL SYSTEM

A suitable fuel system for the diesel engine shall be furnished. It must be in accordance with NFPA Pamphlet No.20 and shall include above surface day storage tank, flexible hose connectors, combination vent, and fill cap.

Diesel Fuel Tank must have a UL Listed Automatic Filtration System to prevent Toxics.
UL listed Automatic Fuel Filtration and Storage Maintenance

Fuel Storage tanks shall be kept as full at all times, but never below two third of the tank

capacity. A fuel level indicator shall be provided to activate at the two thirds tank level.

The tanks shall ensure to removal of all water and foreign material and shall be sized so that the fuel is consumed within the storage life, or provision shall be made to replace stale fuel which cleans fuel.

AUTOMATIC FUEL FILTRATION SYSTEM SHALL BE USED TO ENSURE THE QUALITY OF FUEL TO THE PRIME MOVER AND AVOID SHUTDOWN OF STANDBY SYSTEM DUE TO FUEL CONTAMINATION THE SYSTEM SHALL CONFIRM TO THE REQUIREMENTS OF NFPA 20, 25, & 110 AND MUST BE UL LISTED.

3.8 DIESEL ENGINE DRIVE CONTROLLER

Automatic Microprocessor Diesel Drive Engine Control Panel: The automatic engine control panel shall be UL/FM approved for fire pump service and meet the requirements of NFPA20. The panel shall be of the floor mounted type, and enclosed in moisture and dust tight housing. A combination manual and automatic type controller with "Manual-Off-Automatic" selector shall be provided and a 240 volt single phase power failure relay or a pressure switch, which will (when the system pressure drops) activate all electric circuits to automatically start the engine an manually stop.

Automatic starting for the diesel engine will be done by automatic cranking from battery 1, and if failed from battery 2, with certain cranking and rest period (period is programmable). Controller will try to crank engine up to six times, but if engine did not start after these six attempts, "Failed To Start Alarm" will be activated,

The engine shall be started automatically by the Controller at least once a week, adjustable, and operate a minimum of 30 minutes (adjustable). An appropriate timing arrangement shall determine the day and hour of this test.

Pressure recorder (7 day drive) shall be provided within the control panel. The controller shall incorporate the following:

- 1.0 Each charger shall be completely independent of the other charger and equipped with its own individual power transformer, rated for a maximum continuous charge current of 10A. The charger shall be of solid state electronic design, with semi-conductor type rectifier
In case of battery failure, the charger shall initiate an alarm and provide a signal to prevent the use of the defective battery during the start attempt cycle.
- 2.0 Relays: All relays shall be equipped with manual test buttons, status "ON" – "OFF" indicators, be of the plug in type and shall meet all voltage and current requirements.
- 3.0 Remote Alarm Circuit:

- Engine run indicator / free contact.
- Test running indicator / free contact.
- Automatic mode indicator / free contact.

- DC power healthy indicator / free contact
- Deluge valve on alarm / indicator / free contact (programmable).
- Remote start on alarm / indicator / free contact

4.0 Description of Operation: A four positions main switch shall provide selection of three starting method and one OFF position.

- OFF position shall shut down engine and alarms under any condition.
- AUTO position: a water pressure switch mounted inside the controller shall provide the engine start on water pressure drop. The automatic starting circuit shall alternate the two storage batteries after each start attempt. The attempt to start cycle shall consist of six cranks and five rest periods of 15 seconds duration. In the event of one battery failure, the starting cycle shall lock itself to the remaining battery. In case of engine failure, the controller shall stop any further cranking and energize the ENGINE FAIL TO START alarm. A manual stop pushbutton shall enable engine shut down, but only after all starting causes have returned to normal. The automatic Weekly Exercise cycle shall also be operational in the auto-position. This cycle shall be programmed on the 7 day time clock. A short opening of the water solenoid valve shall create a momentary pressure drop and cause automatic engine start. A manual test switch located on the time clock shall allow for manual test operation of the weekly exercise cycle. The 7 day time clock shall hold its time on A/C power failure and not require resetting.
- TEST Position: Engine shall start in the same manner as the above exercise cycle start. Auto Start and Manual Shut down
- MANUAL Position: Start pushbutton “Battery 1” or “Battery 2”, shall override all automatic starting circuits, and allow for direct manual engine start.
- Safety Shut Down: Engine over speed condition shall shut down engine without time delay and lock out until manually reset.

The controller shall provide the following additional safety features Engine shut down in case of low oil pressure, test or optional AC failure operation only.

3.9 JOCKEY PUMP:

The Jockey pump capacity and pressure shall be as indicated in the pump schedule on the drawings. Pump shall be constructed as follows:

- Type : Vertical multi-stage motor driven,
- Rotation : Counter-clockwise, viewed down
- Motor : TEFC
- Motor bracket : Cast type, connecting motor to pump Diffuser
- Impellers : Stainless steel
- Shaft, I : Stainless steel, Pump
- discharge : Flanged type

- Control : Definite purpose type, magnetic starter in NEMA II enclosure, with reset button

Pump controller shall be factory pre-wired and tested. Pressure switch shall sense low pressure in the fire pump system. Set cut-in pressure 5 PSI above main fire pump cut-in pressure. Set cut-out pressure at system pressure. Provide minimum run timer to operate the pump for a minimum of 3 minutes.

Across the fire start, H-O-A selector switch. Control panel to contain a disconnect switch, magnetic motor contractor and thermal overload relays with external reset Enclosure to be wall mounted with hinged door.

3.10 MAJOR COMPONENTS TO BE USED IN THE ELECTRIC, DIESEL & JOCKEY CONTROLLERS

SL #	Item Description	Make
1	MCCB, 3 Pole, Molded Case Switch (Non-Auto), J-Frame, Part/Cat No. JDB3250WK, UL Listed	AS APPROVED
2	MCP, 3 Pole (Motor Circuit Protector), with built in 120 VAC Shut Trip coil, Part/Cat No. HMCP250K5WS10, UL Listed	AS APPROVED
3	Rotary Handle and Shaft (J-Frame Series C Rotary Handle) 12" length, Part/Cat No. HM2R12	AS APPROVED
4	Contactor, 3P 50HZ , LC1F-115Q5 -COIL 380VAC	AS APPROVED
5	Relay 24V DC Coils, 4 Core and Marked c/w Din Rail Socket GZT4-6A UL/ Listed, 14Pin	AS APPROVED
6	Pressure Transmitter, Range 0-25 Bar, Output 0-10V DC, UL Listed, Model: MBS-3000-060G3814	AS APPROVED
7	Automatic Battery Charger, Sentinel 300P Range, Input Supply 110/120 - 220/240V AC (50/60HZ), Output 12/24V DC, UL Listed, Model: SNTL300P	AS APPROVED
8	Contactor 240 Volt, 50/60 Hz Coil Supply GMC, UL Listed	AS APPROVED
9	Isolator Switch 25A, 3 Pole with Shaft and Rotary Handle Load Break Switch, UL Listed, CSAUS/CE approved, Prog 31309, Rear Mounting MB34	AS APPROVED

3.11 PUMP TESTING

Each pump set package should be tested according to UL / FM / NFPA 20 Standards at an approved top advanced technology testing facility capable of testing all types of UL / FM fire pumps (End Suction, Horizontal Split Case and Vertical Turbine), electric motor, diesel engines & controllers together.

Pumps testing should be done at suction pressure based on water tank level and not at suction pressure created by other systems.

Each pump set tested should be supported by a computer generated Test Report approved and signed by the Manufacturer

3.12 MANUFACTURER

The Pump Manufacturer should have 20 years' experience in Fire Fighting Industry.

The Manufacturer Quality Management System accredited by recognized bodies such as UL, LPCB & BVQI

The Manufacturer should also have ISO 14001 and BS OSHAS 18001 certification for the Environment Management System and Occupational Health and Safety Management System
Fire pump manufacturer must take complete unit responsibility for the total Fire Pump package

All major components such as Fire Pumps, Diesel Engines and Controllers should be from single manufacturer.

3.13 WARRANTY

The Pump should have a warranty period of 5 years against any kind of manufacturing defect only.

The Pump manufacturer should guarantee the availability of genuine spare parts for the pump set for a period of 10 years

4. FIRE HYDRANTS

4.1 PIPES AND FITTINGS

Underground/Outside pipes shall be Galvanized Steel conforming to BS 1387/1985, ASTM A53/A53M & JIS G3452 (heavy class) duly wrapped and coated with welded joints. The coating / wrapping protection shall be tested.

Pipes for risers ,Basements, headers and floor branches inside the building shall be Galvanized Steel conforming to BS 1387/1985, ASTM A53/A53M & JIS G3452 (heavy class) up to 150 mm dia.

Pipes 200mm dia. and above shall conform to BS :1387/1935 with 6 mm thick walls.

Electro resistant welded pipe to be use pressure exceeding 16kg/cm2.

Joints in risers- All risers shall. be installed with grooved couplings with necessary fittings

.Horizontal & branch floor piping shall be screwed up to 50mm dia. and grooved joints for Higher

pipe sizes shall be used.

All pipes above ground and in exposed locations shall be painted with two coat of Etching type primer and two or more coats (each of 75 microns) of synthetic enamel paint of approved shade. Pipes shall be initially brushed to remove all foreign matter before applying paint / primer.

Pipes (buried) shall be initially brushed to remove all foreign matter and apply 2 coats of primer over the pipe. Primer shall be allowed to dry until the solvent evaporates, and surface becomes tacky. Tape 4mm thick and 150/250mm wide shall then be wound in a spiral fashion and bonded completely to pipe by thermo fusion process. Overlap shall be maintained at 15mm.

Following pressure rating criteria to be followed while selecting the pipes

TABLE: PRESSURE RATING TABLE FOR PIPE, VALVES AND ACCESSORIES

Sr. No.	Description	Pressure Rating
1	Pipes in pump room	PN 25
2	Riser	PN 20
3	All horizontal pipe work after orifice (on each floor level)	PN 10

4.2 VALVES

Valves shall be provided at locations as indicated in drawings and as required.

All valves are to be located for easy access. All valves shall be rated properly to suit the pressure rating for the piping system, where the valves are being installed and shall be supported wherever necessary with Hot dipped galvanized MS brackets.

Valves shall comply with required International standards. (Class I) for C.I sluice valves and G.M valves and tested.

Valves & flanges shall be of same material that of the pipe. All Valves shall be factory tested at 1.5 times the design working pressure for the piping system, where the valves are being installed.

Pump Room Valves shall be with OS & Y type.

4.3 Gate Valve OS & Y /Globe Valve.

Gates valves used in high pressure (head) piping shall be made of Stainless Steel 316 / Brass/ GM/ C.I and of suitable class as indicated in specifications, drawings & schematics or higher if required. Supplying, fixing and testing shall correspond to required International Standards, Specifications for Copper Alloy Gate, Globe and Check Valves for Water Works.

Valves shall be tagged with permanent label under hand wheel indicating type or duty.

All valves shall have manufacturer's test certificate indicating the date of shop test and other quality

control tests with the material used for the same.

Gate valves shall be of the size as specified in the BOQ.

4.4 Foot Valves:

Foot valves shall be cast iron body, brass disc and strainer of approved quality as specified in BOQ.

Foot valves shall be of spring loaded or flapper type depending on the requirement.

Valves shall be tested physically for free operation before being mounted or assembled to the pipeline.

4.5 Butterfly Valves OS & Y Type:

The butterfly valve shall be suitable for waterworks and rated for Pressure requirement as mentioned in the Schedule of quantities.

The body shall be of cast iron to IS: 210 in circular shape and of high strength to take the water pressure. The disc shall be heavy duty cast iron with anti-corrosive epoxy or nickel coating.

Butterfly valves shall be slim seal, short wafer type with standard finish. Valves shall be suitable for mounting between flanges drilled to ANSI 125.

Valve shall consist of disc pivot and driving stem shall be in one piece centrally located. Disc shall move in bearings on both ends with 'O' ring to prevent leakage.

The valve seat shall be replaceable of high grade elastomer EPDM or nitrile rubber with hard backing. The elastomer rubber shall have a long life and shall not give away on continuous applied water pressure. Spindle shall be AISI 41 steel.

The valve in closed position shall have complete contact between the seat and the disc throughout the perimeter.

Valve for normal application shall be suitable for a working pressure to suit the application and service and shall be complete with flow control lever and notches, factory machined companion flanges and bolts and nuts.

Valves shall conform to BS 5155 with electro steel nickel coated SG Iron (N) and seat material EPDM3.

The valve shall be fitted between two flanges on either side of pipe flanges. The valve edge rubber shall be projected outside such that they are wedged within the pipe flanges to prevent leakages.

4.6 Check Valves (Non-Return Valves):

Swing Check Valves /Sluice Valves 80mm dia and above shall be Cast Carbon Steel Double flanged type with SS internal parts non-rising spindle.

Sluice valves below ground shall be provided with caps suitable for operation by a wheel.

Non Return Valves in exposed locations e.g. pump house etc. shall be provided with Cast Iron Wheels.

Valves on G.I. Pipes 65 mm and below shall be heavy pattern gun-metal valves.

Valves shall be measured by numbers and shall include matching flanges, rubber gaskets, bolts, nuts, washers and all items necessary and required and as given in the specifications to complete the work

to the satisfaction of Owner/ Architect/ Engineer Incharge's Representative.

4.7 Ball Valves

The ball valve shall be made forged brass and suitable for test pressure of pipe line. The valve shall be internally threaded to receive pipe connections.

The ball shall be made from forged brass and machined to perfect round shape and subsequently chrome plated.

The seat of the valve body-bonnet gasket and gland packing shall be of Teflon.

The handle shall be provided with PVC jacket. The handle shall also indicate the direction of 'open' and 'closed' situations.

The gap between the ball and the teflon packing shall be sealed to prevent water seeping.

The handle shall also be provided with a lug to keep the movement of the ball valve within 90°. The lever shall be operated smoothly and without application of any unnecessary force. Normal size of a ball valve shall be that, corresponding to the size of the pipe to which it is fixed

Ball Valves with float valve (For Storage Tanks)

Ball valves with floats to be fixed in storage tanks shall consist of cast brass lever arm having copper balls (26 SWG) screwed to the arm integrally.

The copper ball shall have bronze welded seams. The closing/opening mechanism incorporating the piston and cylinder shall be non-corrosive metal and include washers.

The size and construction of ball valves and float shall be suitable for desired working pressure operating the supply system.

Brass valves shall be supplied with brass hexagonal back nuts to secure them to the tanks and a socket to connect to supply pipe.

4.8 GUN METAL VALVES

Gun metal Valves shall be used for smaller dia pipes, and for threaded connections.

The body and bonnet shall be of gun metal. The stem gland and gland nut shall be of forged brass.

The hand wheel shall be of cast.

The Hand wheel shall be of high quality finish to avoid hand abrasions. Movement shall also be easy. The spindle shall be non-rising type.

4.9 Y-Strainers

Strainers shall be preferably of the approved 'Y' type with C.I. construction.

Strainers shall have a removable stainless steel (24 gauge) screen with 3mm perforations and a permanent magnet.

Strainers shall be provided with flanges. They shall be designed so as to enable blowing out accumulated dirt and facilitate removal and replacement of all screens without disconnection of the main pipe.

4.10 Pressure Relief Valves

Each System shall be provided with a Pressure Relief Valves. The Valve shall be spring actuated and set to operate as per field requirement. The Valve shall be constructed of bronze and provided with an open discharge orifice for releasing the water. The Valve shall be open lift type.

Pressure Switch - The pressure switches shall be employed for starting and shutting down operation of pumps automatically, dictated by line pressure. The Pressure Switch shall be diaphragm type. The housing shall be die cast aluminium, with SS 316 movement, pressure element and socket. The set pressure shall be adjustable.

The Switch shall be suitable for consistent and repeated operations without change in values. It shall be provided with IP: 55 water and environment protection.

4.11 External Hydrants

Contractor shall provide External hydrants conforming to required International standards. The hydrants shall be controlled by a gunmetal valve. Hydrants shall have instantaneous type 63mm instantaneous female type coupling, gun metal cap and chain.. The hydrants shall be single outlet conforming to specifications to required height to bring the hydrant to correct level above ground.

Alongside each hydrant, there shall be a hose box to accommodate two numbers of C.P. collapsible hoses each of 63mm dia. and 2 Nos of 15 M long complete with instantaneous Gun-Metal Male & Female couplings) and 1 No. 63mm dia. Gun-Metal Short Branch Pipe with nozzle.

Install orifice plate flanges on all hydrants having excessive pressure (more than 5.5 bar), Orifice plates shall be fabricated from 6 mm thick brass plates with plain central hole without burrs.

The hose cabinet shall be of size to accommodate the following:

Single/Double headed yard hydrant valve

Hose pipe (2 length of 15 m)

Branch pipes, nozzles (2 sets)

Fire man's axe

Orifice plate

Drain in the bottom plate.

Each hose cabinet shall be conspicuously painted with the letters "FIRE HOSE".

4.12 INTERNAL HYDRANTS

Contractor shall provide on each landing and other locations as shown on the drawings

double headed gunmetal landing valve with 100 mm dia inlet, with shut off valves having cast iron wheels as shown on the drawings. Landing valve shall have flanged inlet and instantaneous female type outlets as shown on the drawings.

Contractor shall provide for each internal fire hydrant station two numbers of 63 mm dia. 15 m long rubberized fabric lined hose pipes with gunmetal male and female instantaneous type coupling machine wound with copper wire (hose and couplings), fire hose reel, gunmetal branch pipe with nozzle to IS:903.

Suitable fire door shall be provided for fire shaft on each floor. Fire door SIZE and specification from vendor.

Install orifice plate flanges on all hydrants having excessive pressure (more than 5.5 bars).

Orifice plates shall be fabricated from 6 mm thick brass plates with plain central hole without burrs.

The bore of the orifice shall be designed and calculations to be submitted to the Engineer Incharge's Representative for approval.

Branch pipes shall be gunmetal type of 63 mm dia with nozzle of 20 mm dia.

Hose cabinet shall be of glass fronted with hinged door & lock. The cabinet shall be made of 16 gauge thick MS sheet and spray painted to shade as per local Norms.

Hose cabinets shall be SS 304 with hinged door and lock for FOH areas

The hose cabinet shall be of size to accommodate the following:

Landing Valves (Single/double headed)

Hose pipe

Hose reel (45 mtr.)

Branch pipes, nozzles (2 sets)

Orifice Plate.

Fire man's axe and hand appliances

Fire extinguishers

➤ First Aid Hose Reels

Contractor shall provide standard First-aid Hose Reel with 20 mm dia. high pressure braided rubber hose 36 M long with gun-metal, chromium plated adjustable jet spray nozzle and manual operating valve, all mounted on circular hose reel of heavy duty mild steel construction with Cast Iron Bracket, finished with red and black enamel, having a swivel hinge which can swing upto 170 degrees.

Hose reel drum shall be as per BS Specifications.. A lock shield type isolating valve

shall be installed on the fire hose reel supply piping adjacent to each hose reel.

➤ Branch Pipe, Nozzle

Branch pipes shall be of gun metal with loaded tin bronze ring at the discharge and to receive the nozzle and provided at the other with a loaded tin bronze ring to fit into the instantaneous coupling.

Nozzle shall be of spray type of diameter of not less than 16 mm and not more than 25 mm.

Nozzle shall be of loaded tin bronze branch pipe and nozzle shall be of instantaneous pattern.

➤ Fire Hose Cabinets (FHC) Concealed type

Cabinets shall be concealed type made of masonry construction, sized to accommodate valve(s), hose reel assembly, hoses, multipurpose dry chemical extinguisher and fire accessories.

External cabinets shall be primer-coated, cold-rolled sheet steel, or anodized extruded Aluminium construction.

All fire cabinets shall be painted stove enamelled fire red paint. The inside of the cabinet shall be white baked enamel.

Fire shaft shall have shutter fabricated by M.S/S.S (as per SOQ) powder coated sheet or fully welded construction of 16 gauge with glass-fronted door (glass shall be 2mm thick) with locking arrangement.

Cabinet shall have "FIRE HOSE" written on it prominently (size as given in the schedule of quantities).

Door shall be in two leaves with necessary stiffeners. Shutter shall be powder coated finish of 'Red' out side and 'White' inside and on the glass label of "FIRE" shall be stuck. The letter size shall be min. 75 mm height. There shall be built in breakable glass type feature to keep key.

Cabinet surfaces in contact with the walls shall not be powder coated but instead given two coats of anti-corrosive bitumastic paint.

➤ External Hose Cabinet:

The hose cabinet shall be of size to accommodate the following:

Single headed yard hydrant valve

Hose pipe (2 lengths of 15 m)

Branch pipes, nozzles

Fire man's axe

➤ Internal Hose Cabinet

Internal fire hose cabinets shall not be provided; however following accessories shall be mounted in the shaft with suitable anchors and bolts.

Landing Valves (double headed)

Hose pipe (2 length of 15M)

Hose reel (36.0 mtr.)

Branch pipes, nozzles

Fire man's axe and hand appliances

Fire Hose Pipe

Rubber reinforced lined fire hose pipe of 63mm dia and length as described in BOQ.

The Fire Hose Pipe shall be rated for burst pressure of 35.7 kg/sq cm without undue leakage or sweating. Hose shall be complete with ISI marked brass male and female coupling bound and riveted to hose pipe with copper rivets and 1.5mm copper wire.

4.13 FIRE BRIGADE CONNECTIONS

Provide four numbers of 63mm NB gunmetal Fire Brigade type instantaneous inlets with built in check valves and 150 mm dia. flanged outlet connection with butterfly and check valves.

The collecting heads shall be connected to fire water wet risers for the use of local Fire Brigade. Fire brigade connection shall be enclosed in a suitably sized glass fronted box mounted at a suitable position. It shall be connected to the storage tank with a 150 mm fire brigade pumping connection. This connection shall not be taken directly into the side of the storage tank, but arranged to discharge not less than 150 mm above the top edge of the tank such that the water flow can be seen. The connection shall be fitted with stop valve in a position approved by the Engineer Incharge's Representative.

An overflow connection discharging to a drain point shall be provided from the storage tank. The fire brigade connection shall be located as to make the inlets accessible from the outside of the building. The size of the wall box kept beside the inlet shall be adequate to allow hose to be connected to the inlets, even if the door cannot be opened and the glass has to be broken.

Each box shall have fall of 25mm towards the front at its base and shall be glassed with wired glass with "FIRE BRIGADE INLET" painted on the inner face of the glass in 50 mm size block letter. Each such box shall be provided with a steel hammer with chain for breaking the glass.

In addition to the emergency fire brigade connection to the storage tank, a 150mm common connection shall be taken from the four 63mm instantaneous inlets direct to

hydrant main so that the fire brigade may pump to the hydrants in the even of the hydrant pumps being out of commission.

The connection shall be fitted with a sluice valve and reflux valve. Location of these valves shall be as per the approval of the Engineer Incharge's Representative. Two way collecting head with two numbers 63 mm instantaneous type inlets shall be connected to the sprinkler header.

4.14 Air Vessel

The air vessel shall be provided to compensate for slight loss of pressure in the system and to provide an air cushion for counter-acting pressure, surges, whenever the pumping sets come into operation. It shall be normally half full of water, when the system is in normal operation.

Air vessel shall be fabricated with 8 mm thick M.S. plate with dished ends and suitable supporting legs.

It shall be provided with one 100 mm dia flanged connection from pump, one 25 mm drain with valve, one water level gauge and 25 mm sockets for pressure switches.

The air vessel shall be tested to pressure for 12 hours at 2 times the operating pressure or 1.5 times the shut-off.

4.15 Auto air vent

Every wet riser shall be provided with an air cushion tank at its top most point. The air cushion shall be provided with an automatic air release cock, 20 mm dia drain pipe, drain valve and shut off valve.

4.16 Pressure reducing Valve (UL listed)

Providing, Fixing, Testing and Commissioning of Ductile Iron body UL Listed FM Approved Pressure Reducing Valve assembly Diaphragm Nylon Fabric Reinforced, Natural Rubber, Diaphragm cover fasteners as Galvanised carbon steel, Pilot valve of Brass and Stainless Steel with Nylon fabricated reinforced natural rubber, strainer of Brass and S.S, with all necessary accessories such as pressure gauge, consumables complete in all respects.

The valve shall comply with ANSI Class 150 (ANSI 300) pressure rating/ flange standard, globe (angle), style valve.

The valve shall maintain accurate control of the downstream pressure regardless of fluctuation in flow or upstream pressure.

Prior to shipment, testing shall include UL (pending approval) approved hydrostatic pressure tests and a Singer full function and operation test.

4.17 Orifice Plates

For restricting pressure in the system, orifice plates of appropriate sizes shall be fitted at all floor levels, at the branching points from Riser Main.

The Diameter of such orifice shall not be less than 50% of the dia of pipe into which it is to be fitted, which shall not be less than 50mm dia.

These orifice plates must be of stainless steel with plain central hole without burrs, and the thickness shall be 3mm for pipe size up to 80 mm, 6 mm for pipes from 80 to 125 mm dia and 9 mm for pipes greater than 125 mm dia.

Such orifice plate must have a projecting identification tag.

The orifice plate shall fitted not less than two pipe internal diameters downstream of the outlet from any elbow or brand.

5. AUTOMATIC SPRINKLER SYSTEM

5.1 HAZARD CLASSIFICATION

The sprinkler system shall be designed as per NFPA-13 Installation of Sprinkler System requirements. Spacing of sprinklers shall suit the hazard of the occupancy as shown in the drawing. The entire sprinkler installation shall be designed to make it a hydraulically balanced system. The pressure requirement at typical floors shall be designed for 0.5 to 1 bar at each sprinkler outlet. Pipes fittings and support shall be the same as for Fire Hydrant System. Jointing shall be the same as for Fire Hydrant System. All risers shall be installed with flexible joints with necessary fittings. Valves shall be the same as for Fire Hydrant System.

5.2 Sprinkler Heads

Sprinkler heads shall be of brass/quartzoid bulb type containing liquid having high vapor pressure held in position by forged GM yoke and deflector and sufficiently strong, in compression to withstand any pressure, surge or hammer likely to occur in the

The yoke & body shall be made of high quality gun metal brass with arms streamlined to ensure minimum interference with the spread of water.

The bulb shall contain a liquid having a freezing point below any natural climatic figure and a high coefficient of expansion.

The temperature rating of the sprinkler shall be stamped on the deflector & the colour of the liquid filled in the bulb shall be according to the temperature rating as per NFPA 13

standard.

The sprinkler heads shall be of type & quality approved by the local fire brigade authority

Sprinklers shall have 15mm nominal size of the orifice.

The orifice size shall be marked on the body or the deflector of the sprinkler.

Metal guards for protection of sprinkler against accidental or mechanical damage shall be provided as desired by the Project Manager.

Temperature rating of sprinkler heads shall be 68 °C for conditioned areas and 75 °C for non-conditioned areas or as specifically mentioned in the areas.

False ceiling voids greater than 800 mm are to be provided.

The deflector of suitable design shall be fitted to give even distribution of water over the area commanded by the sprinkler.

Sprinkler temperature shall match with table indicated on legend drawings.

Sprinkler heads shall be provided at appropriate spacing to cover 12 sq.m. per sprinkler head .

Spacing's shall be in conformity with the drawings and properly co-coordinated with electrical fixtures and air-conditioning ducts, diffusers and grills and other ceiling services.

Detailed shop drawings for sprinkler system shall be prepared and submitted to the Engineer Incharge's Representative for approval before starting the work.

Sprinkler head shall be of type and make approved by the Engineer Incharge's Representative.

The inlet shall be screwed for 15mm dia. as specified. The sprinkler head shall have UL approval or listing.

Supply 2% spare sprinkler heads and one spanner (not separately payable), neatly installed in a wooden cabinet with glass shutters as approved by the Engineer Incharge's Representative.

5.3 FLEXIBLE SPRINKLER DROPS

UL Listed, corrugated stainless steel flexible drops made from AISI 304 and AISI 316L with high tensile strength shall be used in architecturally sensitive areas, all suspended ceiling areas, and most congested areas to fix sprinkler at designated place.

It shall be complete with snap clamp type end brackets as Manufacturer's product and part of flexible drops.

The flexible shall be corrugated type, wrapped with AISI 304 wire of high tensile strength.

The technical specifications shall be as follows:

Minimum bending radius	76mm
Maximum working pressure	200 psi
Test pressure	1000 psi (Bursting)
Connection	Branch line-25mm NPT
Sprinkler	1/2 or 3/4 NPT
Lengths	0.6, 0.8, 0.9,1.2,1.5 & 1.9 meters
Temperature Rating	3000F

5.4 Installation Control Valve:

Installation Control Valve for sprinkler system shall consist of a vertical alarm valve complete with 50mm dia. drain and 15mm test valve with a provision to install water operated turbine alarm.

A Cast Iron Butterfly Valves shall be provided on upstream of alarm valve.

The Butterfly Valve shall be strictly as mentioned above.

One water operated turbine alarm motor with gong shall be provided for each sprinkler installation control valve on the sprinkler main.

The alarm shall operate and sound a gong on the drop of pressure and flow of water in the mains.

Turbine alarm shall be approved by the Engineer Incharge's Representative and installed at approved locations. The alarm shall be provided with suitable test cock. Both alarm valve and turbine alarm must have UL/ listing.

Installation control valve shall be measured by numbers and shall include upstream C.I. Butterfly Valve, Alarm Valve, Alarm Motor and Gong, Drain Valve, Test Valve, Drain Piping and all fittings including 2 Nos. pressure gauges required to complete the work.

5.5 Inspection And Test Valve Assembly

Inspection and testing of the automatic starting of the sprinkler system shall be done by providing an assembly consisting of gunmetal valves, gunmetal sight glass, bye-pass valve and orifice assembly as per approved drawing. valves have forged brass body with chrome plated brass ball valve and PTFE seats. The valves complies with the requirements of NFPA-13, NFPA13R and NFPA-13D. valves are single handle ball valves with three working positions. They include tamper resistant test orifice and sight

glass for the visual control.

Technical data

- Rated pressure: 300 psi Materials
- Forged brass body
- Chrome plated ball
- Steel handle
- Valve seat in PTFE
- Indication disk in brass
- Sight glasses in polycarbonate

5.6 Flow Switch

Flow switch shall have a paddle made of flexible and sturdy material of the width to fit within the pipe bore. The terminal box shall be mounted over the paddle/ pipe through a connecting socket. The Switch shall be potential free in either NO or NC position as required. The switch shall be able to trip and make / break contact on the operation of a single sprinkler head. The terminal box shall have connections for wiring to the Annunciation Panel. The flow switch shall have connections for wiring the seat shall be of S.S to the Annunciation Panel. The flow switch shall have IP: 55 protections. The flow switch triggering threshold bandwidth shall work at test orifice $K = 5.6 \text{ GPM} / (\text{PSI})^{1/2}$. Further, it shall have a 'Retard' to compensate for line leakage or intermitted flows.

Technical Specifications

System Service Pressure Up to 3.1 MPa (450 PSI)

Flow Sensitivity Range For Signal 15-38 LPM (4-10 GPM)

Maximum Surge 5,5 m/s (18 FPS) Contact Ratings One or Two sets of SPT (Form C) 15.0 Amps at 125/250VAC 2.0 Amps at 30VDC Resistive Environmental Specifications Suitable for indoor or outdoor use with factory installed gasket and die-cast housing.

IP54/NEMA 4 Rated Enclosure - use with appropriate cable or conduit fitting.

Temperature Range: 4,5°C/49°C, 40°F/120°F. Non-corrosive sleeve factory installed in saddle.

Conduit Entrances Two Knockouts for 22,5mm (1/2"- Ø.886) conduit provided Service Use NFPA 13, 13D, 13R, 72

5.7 Pressure Switch:

Pressure type water flow switches shall be installed on the fire sprinkler system as shown and or specified herein. Switches shall be provided with a ½" NPT male pressure connection and shall be connected to the alarm port outlet of; Wet Pipe Alarm Valves, Dry Pipe Valves, Pre-Action Valves, or Deluge Valves. The pressure switch shall be actuated when the alarm line pressure reaches 4 - 8 PSI (0,27 - 0,55 BAR). Pressure type water flow switches shall have a maximum service pressure rating of 300 PSI (20,68 BAR) and shall be factory adjusted to operate on a pressure increase of 4 - 8 PSI (0,27 - 0,55 BAR).

Pressure switch shall have one or two form C contacts, switch contact rating 10.1 Amps at 125/250 VAC, 2.0 Amps at 30 VDC. Pressure type waterflow switches shall have two conduit entrances one for each individual switch compartment to facilitate the use of dissimilar voltages for each individual switch. The cover of the pressure type waterflow switch shall be Zinc die-cast with rain lip and shall attach with one tamper resistant screw. The Pressure type waterflow switch shall be suitable for indoor or outdoor service with a NEMA 4/IP55 rating. The pressure type waterflow switch shall be UL and CSFM listed.

5.8 Alarm valve

Alarm Valve is a double seated clapper check valve with grooved seat design, which ensures positive water flow for alarm operation and is designed for installation in wet pipe sprinkler system.

External bypass prevents false alarm under all supply pressure condition. In the event of variable pressure condition, false alarms are prevented with the provision of retard chamber, thus the design allows for installation under both variable and constant supply pressure condition.

The valve shall have Housing of Cast Iron, Seat of Bronze, Clapper of Bronze, Seat of Neoprene rubber.

Following specification is expected:

Maximum service pressure: To suit the system working pressure.

Threaded opening: NPT

Mounting: vertical

Flange connection: IS:1538

Factory hydrostatic test pressure: 1.5 times the system working pressure.

Valve Supervisory Switch:

Provide at each valve in main and riser piping. Mount switch on valve and arrange to detect abnormal open or closed position of valve. This includes necessary wiring and

conducting up to fire command centre.

The Main Stop Valve

These shall be of cast iron body of requisite size. When closed, these will shut off supply of water to the installation.

A location plate must be fixed on the outside or an external wall, as near to the main stop valve as possible, bearing the following words on raised letters or other approved type letter.

Sprinkler Stop Valve Inside: The word 'sprinkler stop valve' shall be in letters of at least 35mm and the word "INSIDE" at least 25mm in height. The words shall be painted white on black background.

All stop valves shall be right handed i.e. they shall be so constructed that in order to shut the valve the spindle shall turn from left to right. There shall be an indicator which will show whether the valve is open or shut.

5.9 Pipes For Drainage

Sprinkler pipes shall be so installed that the system can be thoroughly drained. As far as possible all pipes shall be arranged to drain to the installation drain valve as shown in the drawing for ordinary hazard system.

In the case of basement & other areas where sprinkler pipe-work is below the installation drain valve & in other trapped points in the system, Gate valves of the following dia shall be provided:

20 mm valves for pipes upto 50 mm dia

25 mm valves for pipes upto 80 mm dia

50 mm valves for pipes larger than 80 mm dia

5.10 Pressure reducing Station

Valves shall maintain a constant downstream pressure regardless of fluctuations in demand and shall also prevent a pressure rise when demand is zero. Valve shall be suitable for horizontal or vertical installation.

No separate chambers shall be allowed between the main valve cover and body. Valve body and cover shall be of cast material. Ductile Iron is standard and other materials shall be available.

The valve shall contain a resilient, synthetic rubber disc, with a rectangular cross-Section

contained on three and one-half sides by a disc retainer and forming a tight seal against a single removable seat insert. No O-ring type discs (circular, square, or quad type) shall be permitted as the seating surface. The disc guide shall be of the contoured type to permit smooth transition of flow and shall hold the disc firmly in place. The disc retainer shall be of a sturdy one-piece design capable of withstanding opening and closing shocks. It must have straight edge sides and a radius at the top edge to prevent excessive diaphragm wear as the diaphragm flexes across this surface. No hourglass-shaped disc retainers shall be permitted and no V-type or slotted type disc guides shall be used.

The diaphragm assembly containing a non-magnetic 303 stainless steel stem of sufficient diameter to withstand high hydraulic pressures, shall be fully guided at both ends by a bearing in the valve cover and an integral bearing in the valve seat. The seat shall be a solid, one-piece design and shall have a minimum of a five-degree taper on the seating surface for a positive, drip-tight shut off. No center guides shall be permitted. The stem shall be drilled and tapped in the cover end to receive and affix such accessories as may be deemed necessary. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure.

The flexible, non-wicking, FDA approved diaphragm shall consist of nylon fabric bonded with synthetic rubber compatible with the operating fluid. The center hole for the main valve stem must be sealed by the vulcanized process or a rubber grommet sealing the center stem hole from the operating pressure. The diaphragm must withstand a Mullins Burst Test of a minimum of 600 psi per layer of nylon fabric and shall be cycle tested 100,000 times to insure longevity. The diaphragm shall not be used as the seating surface. The diaphragm shall be fully supported in the valve body and cover by machined surfaces which support no less than one-half of the total surface area of the diaphragm in either the fully opened or fully closed position.

The main valve seat and the stem bearing in the valve cover shall be removable. The cover bearing and seat in 6" and smaller size valves shall be threaded into the cover and body. Valve seat in 8" and larger size valves shall be retained by flat head machine screws for ease of maintenance. The lower bearing of the valve stem shall be contained concentrically within the seat and shall be exposed to the flow on all sides to avoid deposits. To insure proper alignment of the valve stem, the valve body and cover shall be machined with a locating lip. No "pinned" covers to the valve body shall be permitted. Cover bearing, disc retainer, and seat shall be made of the same material. All necessary repairs and/or modifications other than replacement of the main valve body shall be possible without removing the valve from the pipeline. Packing glands and/or stuffing boxes shall not be permitted and components including cast material shall be of approved manufacture.

The valve manufacturer shall warrant the valve to be free of defects in material and workmanship for a period of three years from date of shipment, provided the valve is installed and used in accordance with all applicable instructions.

The valve manufacturer shall be able to supply a complete line of equipment from 1 1/4" through 24" sizes and a complete selection of complementary equipment. The valve manufacturer shall also provide a computerized cavitations chart which show flow rate, differential pressure, percentage of valve opening, Cv factor, system velocity, and if there will be cavitations damage.

Valves shall be single-seated, hydraulically - operated. Valve body and cover shall be cast iron, Class 150, flanged. Trim shall be bronze. Valve seat shall be replaceable. There shall be no external packing glands.

Valves shall have integral low flow by-pass line.

Main valve and all trim shall be factory- assembled into one unit.

PRV shall be complete with station with isolation valve, pressure gauge before after PRV along with bypass line with stand by PRV and isolation valves, pressure gauge before and after PRV.

5.11 Flow Meter

FM approved sprinkler system flow meter that can be installed between flanges or with grooved couplings. The unit includes an integral restrictor and bleed assembly, filter and drain assembly plus spare metering glass. The preferred installation pipe layout would include the optional full bore isolating valve upstream of the meter and a control valve downstream of the meter. Pressure & Temperature Safe Working Pressure: 20 Bar Accuracy: $\pm 2\%$ full scale defection Material Specification Main Orifice Carrier - 316 Stainless Steel flow orifice mounted in polyester coated carbon steel carrier. Bypass Flow Indicator - Nickel plated copper tubing with brass connections. Stainless steel element.

Borosilicate glass indicator tube. Polycarbonate filter bowl. Viton seals shall be part of Flow meter.

5.12 ISOLATING VALVES OS & Y TYPE

Isolating valves shall be UL 262 Listed and shall be fitted to the installation in order to shut the valve, the spindle must turn clockwise. The hand wheels of all stop valves shall be clearly marked to indicate which direction the wheel is to be turned to close the valve.

An indication shall also be provided which shows whether the valve is open or shut.

Each main stop valves shall be installed with a tamper / supervisory switch and interconnected to the building fire alarm system or secured open by a padlock or riveted strap.

6. LINEAR HEAT DETECTION TUBE-BASED DIRECT LOW-PRESSURE AUTOMATIC

Internal

CLEAN AGENT FIRE SUPPRESSION UNIT FOR ELECTRICAL PANEL PROTECTION

6.1 General

The scope covers the Supply, Installation, Testing, and Commissioning of an Automatic clean agent-based Local Flooding System complete for electrical panels with flexible fire detection tubing, cylinder, valves, integration with Main Fire Alarm Control Panel for status monitoring etc. The scope of work includes, but not limited to the following,

Providing Direct Panel Gas Flooding System with flexible Linear Pneumatic Heat/fire detection/ discharge tubing inside the panels.

Clean agent storage cylinder for flooding gas inside the panels.

Any other item required to the successful commissioning of the system.

The electrical panel fire suppression system shall be complete with UL Listed Clean Agent storage cylinders for required capacities, extinguishing agent as specified, fire detection tubing, filling and end-of-line adaptors, pressure switches, control equipment, Clean Agent Cylinder/Valve Assembly, Cylinder Mounting Bracket and all necessary accessories to protect the Electrical panel in case of fire. The system will have an interface with Main Fire Alarm and Control Panel. In case of fire in the concerned Panel, indication of Fire / discharge status should come in Main Fire Alarm and Control Panel.

6.2 Design Requirements

All the detecting devices, alarm, indicating devices, containers and other related Equipment shall have required approvals & Authorization.

All installations shall conform to NFPA 2001 requirements.

The Clean Agent should have Zero Ozone Depletion Potential.(ODP = 0)

The Clean Agent should not have a Global Warming Potential of more than 1.

The Clean Agent should be a low-pressure agent with atmospheric lifetime of 5 days

6.3 System Equipment

Linear Heat Detection Tube (UL Listed)

The tubing shall be installed throughout the Electrical Panel with one end connected to the top of the Clean Agent container valve. The tubing shall be pressurized with Dry Nitrogen to 13.5 Bar and maintains the system in the “OFF” position. The tubing shall perform three functions

Heat Detection.

System Activation.

Clean Agent discharge.

Clean Agent Container (UL Listed)

Cylinder shall be UL Listed and Seamless, made of Aluminium Alloy. Each storage container shall be equipped with a nickel-plated brass valve, a pressure gauge to monitor container pressure, and a quarter-turn ball valve that interfaces with the detection tubing. The quarter-turn ball valve shall be kept closed at all times when the container is not in service.

Pressure Switch (UL Listed)

UL Listed Pressure Switch shall be provided to monitor the Pressure Drop in the Tube in case of actuation of the system or leakage, Switch Point 5 Bars.

6.4 Technical and Installation Requirements

Provide a sufficient amount of Extinguishing Agent to Inert the Microenvironment being protected considering the following when computing volume to verify suitability and to establish design limitations:

Volume of the hazard area.

Specific volume of Clean Agent.

Specifications for Electrical and Mechanical Works.

Discharge time and flow rates.

Design concentration and design factors.

Detector/discharge tubing placement.

Placement of the cylinder

System should have provision to Interface system with main control fire alarm system and BMS.

All doors and holes in the enclosed/equipment should be closed or sealed to maintain the tightness of enclosure.

Each clean agent pre-engineered automatic system is equipped with its own detection/discharge tubing.

The unit shall be a self-contained and shall be equipped with its own non-electric automatic detection system to detect the fire and agent release system into the Electric panel to suppress the fire. The Clean Agent is stored in UL Listed Cylinders as compressed liquid, super-pressurized with Dry Nitrogen to 13.5 Bar. The ambient operating temperature range for all system components should be 0 degree C to 54 degree C. Each UL Listed container is equipped with a nickel-plated brass valve, a

pressure gauge to monitor container pressure, and a quarter-turn ball valve that interfaces with the Detection Tubing.

Provide wall-mounted painted steel bracket to mount the container/valve assembly in a vertical (upright) position. Each bracket should be equipped with integral quick-clamp straps. Install equipment as indicated on the approved shop drawings, and in accordance with requirements of NFPA-2001.

Make final connections between equipment and system detection tubing under direct supervision of factory trained and certified representative of manufacturer. It shall be so designed that it does not affect the IP ratings of electrical panels. The Sub-Contractor has to coordinate with manufacturer of electrical panels for provision of holes to run the tube and brackets for mounting the tube. The entry of tube inside the panel shall be through suitable size of connector. The tubing shall be manufactured from specially processed polymer material to achieve the desired heat detection and delivery characteristics. The tubing shall be capable of working even when contaminated with oil, dust and debris as long as the contamination will allow the heat to pass through the tube.

7. INERT GAS IG-541 BASED TOTAL ROOM FLOODING SUPPRESSION SYSTEM

The selected Clean Agent System shall comprise of a fixed operational total flooding extinguishing system designed, installed, and be tested as per NFPA 2001. The complete System shall be VdS Approved with a constant flow technology. The clean agent to be used shall be as designated as IG 541. The Clean Agent system shall be designed to operate and flood the entire volume of the protected room (i.e., including false ceiling and false flooring if any).

Clean agent system shall be designed to meet a minimum design concentration by volume according to the latest NFPA 2001. All these technical parameters shall be confirmed by vendor as per latest NFPA 2001 guidelines.

The Detectors (Main Fire Alarm System) used in this application are of an analogue addressable type and upon receipt of signal confirmed fire signal in the protected enclosure to the Fire Alarm Panel (Main Fire Alarm System) located at individual floors, is transmitted through the designated Control module for each risk area which further shall provide signal to Master gas release Panel located at Ground Floor cylinder room.

A Repeater Panel is provided at individual floors for the status of discharge, and alarms of the respective floor, a dedicated Standalone gas release Panel for discharge & alarm status has been provided for Data Hall for specific data hall status.

2 nos. of Potential free contacts for each Risk area for System discharge & Manual release activated shall be provided to the Floor wise Fire Alarm Panel for further annunciation

The system shall be complete in all respect and suitable to operate. It shall include all

mechanical & electrical installation, control equipment, clean agent storage cylinders, cylinder skid with brackets, clean agent gas, actuator, check valves, discharge nozzles, piping and fittings, manual release station, system abort switch, audible & visual device (pre-alarm, pre-discharge alarm, discharge alarm), and Local clean agent release panel necessary for a functional VDS approved. Specific approval for gas release system shall be provided for the local control panel as that of the clean agent system. All system components shall be UL/FM/VDS approved.

Each Manifold outlet shall be fitted with an NRV for safe operation and erection of the system in case of Multi cylinder system.

Manifold made of ASTM A-106 Grade B Carbon Steel Seamless Pipe Schedule 80.

System Pressure shall 300 bar system and VdS Approved.

The clean agent system vendor shall provide engineering services and calculations of the system according to VdS approved software.

The discharge network shall be dimensioned using software, recognized specifically in the VdS approval, of the hardware configurations for which the product has been listed. The discharge of the extinguishing agent shall be calculated in no more than 120 seconds, for the 95% agent mass. The software will be in the version indicated on the manufacturer's approval. Vendor shall provide a Hydraulic calculation to demonstrate the same.

Major components like selector valve shall be operated by PAE unit along with Sectional Control Valves Components.

Discharge Valves:

The valves shall be manufactured by System OEM only and should not be used from any other manufactured or outsourced locally. Valve should be VdS approved and marked with the following: The valves shall be equipped with a pressure gauge & pressure switch for monitoring the pressure of the cylinder. Valve must be equipped with over pressure relief device to relieve the overpressure when the temperature exceeds 50 °C.

Cylinder:

The clean agent cylinder shall be PESO Approved and cooler will be fire red according to RAL 3000 or equivalent. The cylinder capacity shall be 140 liters maximum. GA drawing of the cylinder shall be stamped by the listing agency by VdS.

All containers supplying the same manifold outlet for distribution of the clean agent shall be interchangeable and of one select size and charge. Each cylinder connecting to the common manifold shall be provided with a check valve at manifold inlet.

The number of cylinders required shall be defined on the basis of the required design concentration for the required duration & volume of protected room.

Actuators:

The actuation shall be by an electrical solenoid placed on the master cylinder of the skid. In addition to electric actuation manual actuation shall also be possible. On actuation of master cylinder by electric actuator or mechanical actuator the slave cylinders shall be actuated through pneumatic actuators.

The actuators shall be VdS approved depending upon system approval.

Nozzle:

Nozzles shall be provided inside the area to be protected, to uniformly distribute the agent to its designed concentration. The nozzles shall be of the dropping from the ceiling. The nozzles are to be oriented such that the entire volume has to be filled with the clean agent. The nozzles shall be listed for intended use. Listing criteria shall include flow characteristics, area coverage of about 30 M2 for 360 °C, height limits of about 5 M, Discharge orifices shall be of a material that is corrosion resistant to the agent used and the atmosphere in the intended application. Nozzle shall be VdS Approval.

Discharge nozzles shall be permanently marked to identify the manufacturer as well as the type and size of the orifice.

Discharge nozzles shall conform to cl. no. 4.2.5 of NFPA 2001 and shall be VdS approved.

Pressure Reducer:

Pressure Reducer shall be a part of the cylinder valve to make it a constant flow technology.

Cylinder Rack/Brackets:

All the components for supporting cylinders / brackets / racks shall be from OEM made only, Local support or brackets shall not use and not acceptable.

8. FK-5-1-12 (FLUROKETONE) BASED ROOM SUPPRESSION SYSTEM

Fire Suppression System - Materials and Equipment

The cylinders should be complete with all accessories. The contractor shall take care of all equipment as required.

The number of nozzles and their positions must be chosen so that the design concentration is established everywhere in the enclosure. The gas release panel should have manual override and manual discharge keys/lever.

Cylinder

The cylinder shall be high pressure, seamless steel gas cylinder, flat type, concave bottom as per IS 7285 complete with neck ring and PESO Approved.

Appropriate fill density shall be chosen based on the cylinder location and piping retrofit. The hydraulic calculations should prove that the fill density is appropriate and

total discharge will take place within 10 seconds.

The cylinders shall be super-pressurized with dry nitrogen to 42 bars at 20°C. The cylinder shall be capable of withstanding any temperature between -30° C and 70°C.

The cylinder shall withstand Hydrostatic test pressure up to 250 bars and maximum working pressure at 15°C shall be 150 bars.

The Cylinder Valve Assembly must be UL/FM approved with seamless CCOE approved cylinder and undertaking from manufacturer must be submitted with the tender to comply the same.

Valves

The discharge valve shall be suitable for gas suppression and pressure shall be of adequate rated with the complete necessary arrangement of gas suppression system. All the gaskets, O-ring, sealant, and another valve components shall be constructed of materials compatible with the clean agent. This would include main discharge valve, solenoid, check valve / non-return valve and pneumatic actuators.

Pipes and Fittings

All Pipes shall be of ASTM - A-106, Gr: B, schedule - 40 seamless Mild Steel Pipes and fittings shall be as per ASTM-A-105 standard. or copper pipe

Discharge Nozzle

Nozzle shall control the flow of gas to ensure high velocity, proper mixing in the surrounding air and uniform distribution of the agent throughout the enclosure. The number of nozzles and their positions must be chosen so that the design concentration is maintained everywhere in the enclosure. Nozzle shall be located where they can be adequately supported on walls, ceiling or structural members. Software-generated calculation supporting the nozzle design shall be submitted by the successful bidder before signing of contract.

Active Fire Protection systems

Automatic FK 5-1-1-2 (Fluroketone) Gas-Based Fire Suppression System

This system shall be provided at equipment rooms with other rooms as per the design report with FK 5-1-12 (Fluroketone) gas-based fire suppression shall have 25 Bar pressure and shall activate by detecting smoke using highly sensitive LASER-based Smoke Detectors in the Room.

Once smoke is detected a basic alarm (strobe/hooter) is annunciate called as 1st stage alarm. This alarm states, that the area is under fire state & necessary action to be taken. If the alarm is not reset by the set time another alarm called as 2nd stage alarm is annunciate. 2nd stage alarm is an audible voice alarm stating people, to vacate the room. In between both these, alarms the security manager or the controller can reset the panel electronically.

If the panel is not reset after the 2nd Stage alarm a solenoid valve switch activates the FK 5-1-1-2 (Fluroketone) cylinder, allowing the high-pressure gas to flow out & quench the fire in the room. Alarm cannot be reset / aborted from person has to physically go to location of fire to reset / abort the gas release.

The fire suppression system shall include and not be limited to gas release control panel, seamless cylinders, discharge valve (with solenoid or pneumatic actuator) as the case may be, discharge pipe, non-return valve and all other accessories required to provide a complete operation system meeting applicable requirements of NFPA 2001 or ISO standards and installed in compliance with all applicable requirements of the local codes and standards.

9. Steel Wire Rope Hangers& Supports:

Wire Hangers shall be used to suspend all static Electrical services.

Wire Hangers should consist of a pre-formed wire rope sling with a range of end fixings to fit various substrates and service fixings, these include a ferruled loop, permanently fixed threaded M6 (or M8, M10,M12) stud/eyebolt, permanently fixed nipple end with toggle, at one end or hook or eyelet, cladding hook, barrel, wedge anchor, eyebolt anchor or any other end fixture type or size as per manufacturers recommendation and design. The end fixings and the wire must be of the same manufacturer with several options available. The system should be secured and tensioned with a double channel wedge type lock at the other end. Once the grip is locked for safety purpose unlocking should only be done by using a separate setting key and should not be an integral part of the self-locking grip. In case unlocking arrangement is an integral part ie. button/pin type, the button/pin shall be hidden under a separate housing cover made of same material as of housing. To guard against accidental unlocking, the unlocking button/pin should be accessible if and only if the housing cover is removed. Only wire and/or supports supplied and/or approved, shall be used with the system. Springs used inside the lock shall be made up of stainless steel for good corrosion resistance.

Wire Hangers should have been independently tested by Lloyds Register. APAVE, TUV, CSA, ADCAS, Intertek, ECA, and SMACNA, approved by CSA and comply with the requirements of DW/144 and BSRIA. Wire rope should be manufactured to BSEN 12385:2002.

Wire Hangers shall be independently tested by reputed third party testing organization to sustain safe working load for 120min at elevated temperature.

The contractor shall select the correct specification of wire hanger to use for supporting each particular service from table 1 below. Each size is designated with a maximum safe working load limit (which incorporates a 5:1 safety factor).

The correct specification of wire hanger required is determined using the following formula.

Weight per meter of object suspended (kg) X distance between suspension points (m) = weight loading per Hanger suspension point (kg).

Where the installed wire rope is not vertical then the working load limit shall be reduced in accordance with the recommendations give in the manufacturer's handbook.

The contractor shall select the correct length of wire rope required to support the service. Lengths from 1-10m lengths. Specials can be made, check with manufacturer. No in-line joints should be made in the rope.

The standard range of Hanger Kits should contain galvanized high tensile steel wire rope or stainless steel wire rope as per the application, the minimum specification is as above and should be manufactured to BS 302 (1987), BSEN12385. Comply with manufacturer's load ratings and recommended installation procedures. Rigid support must also be used in conjunction with wire rope hangers with electrical services as per Support GFC/design drawings. The testing shall be done to the minimum breaking load of the wire thus giving a minimum safety factor of 5:1.

Supports can be provided for: Busbar, Cable Ladder, Cable Tray, Cable Basket, Channel, Trunking, Light Rafts, Luminaires, Secondary Supports, Safety Lines, High Bay/Low Bay Lights, Electrical Cables, CCTV and Catenary Supports: Y-Fit solution shall be used to a maximum width of 500mm Cable Tray. For Tray over 500mm cradle support method or independent supports must be taken as appropriate based on load. Any other solution can be used based on manufacturer's recommendation on site conditions after prior approval.

Catenary Supports: Refer to manufacturer's recommendations on Catenary supports with C-clip, special care should be taken with tensioning of the wire and angles at which the installation of services are made.

Stainless Steel Supports should be available for food, chemical and High Corrosion areas near coastlines.

Refer to manufacturers catalogue and installation guide for further technical information. Comply with manufacturer's load ratings and recommended installation procedures.

Rigid Supports to be used in conjunction with wire hanger support:

Rigid supports if required in conjunction with wire hangers shall be of steel, adjustable for height and Zinc chromate primer coated and finish coated black or galvanized Modular Strut support system of required strength and profile can also be used. Where supports and clamps are of dissimilar materials, a gasket shall be provided in between.

All the supporting system, including all accessories such as struts, threaded rod, etc. shall be supplied from same manufacturer/supplier and the warranty shall be given for the items including the accessories by the same manufacturer/supplier.

10. Advanced Grooved Piping System :

In lieu of rigid pipe offsets or return bends for sprinkler drops, the Grooved Fittings Multiple-Use Flexible Stainless Steel Sprinkler Drop System may be used to locate sprinklers as required by final finished ceiling tiles and walls.

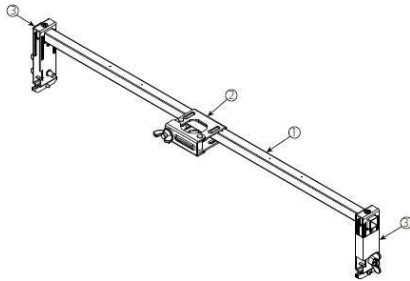
The drop system must be with ANNULAR CORRUGATION, which also allows the flex drop to be bended just after the end fittings. The drop system shall consist of a BRAIDED type 304 stainless steel flexible tube, zinc plated steel Male threaded nipple for connection to branch-line piping, and a zinc plated steel reducer with a female thread for connection to the sprinkler head and with a numbering on the reducer to ease the process for vertical positioning of the sprinklers.

The drop shall be FM & VDS approved & minimum number of 90 Degrees bends allowed should be 3 & Minimum Bend Radius should be 178 mm as per FM & 76.2 mm as per VDS.

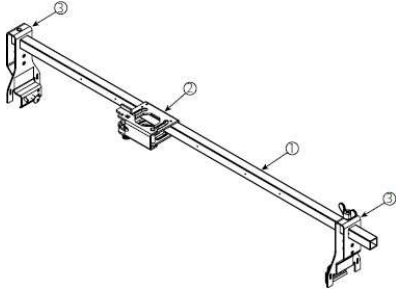
Union joints shall be provided for ease of installation.

Flexible drop should have max. Working pressure of: 200 PSI / 13.75 bar – FM Approval | 232 PSI / 16 bar – VDS Approval

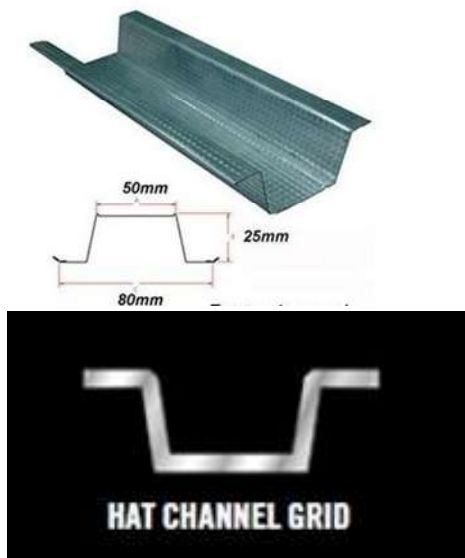
The flexible drop shall be attached to the ceiling grid using a one-piece open gate Series Ab7 Bracket



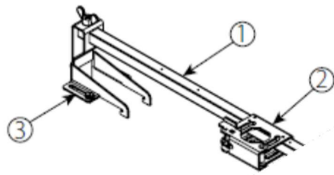
Series Ab2 bracket which allows vertical adjustment after the sprinkler is installed without damaging the plasterboard ceiling shall be used.



In case of having hat firing channel profiles similar to below :



Series Ab4 bracket which allows vertical adjustment after the sprinkler is installed without damaging the plasterboard ceiling shall be used.



Grooved Mechanical Couplings:

UL Listed & FM Approved Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure-responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. Mechanical Coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A- 449 and A-183, minimum tensile strength 110,000 psi (758450 kPa). Couplings should not require Torque while tightening upto 12" & Tongue & Groove Coupling are not allowed.

Rigid Type:

“Installation Ready” rigid joints shall be Victaulic FireLock® EZ Style 009H and Style 107H which are designed for direct “stab” installation onto grooved pipe without prior disassembly of the coupling. Housings shall be cast with offsetting, angle-pattern bolt pads.

Standard rigid joints shall be Victaulic Style 005 (FireLock® 005) or 07 (Zero-Flex®). Housings shall be cast with offsetting, angle pattern bolt pads to provide system rigidity and support and hanging in accordance with NFPA 13

Rigid couplings shall require visual pad-to-pad verification of complete installation. Tongue and recess type couplings which require the use of a torque wrench to achieve the exact required gap between housings are not permitted.

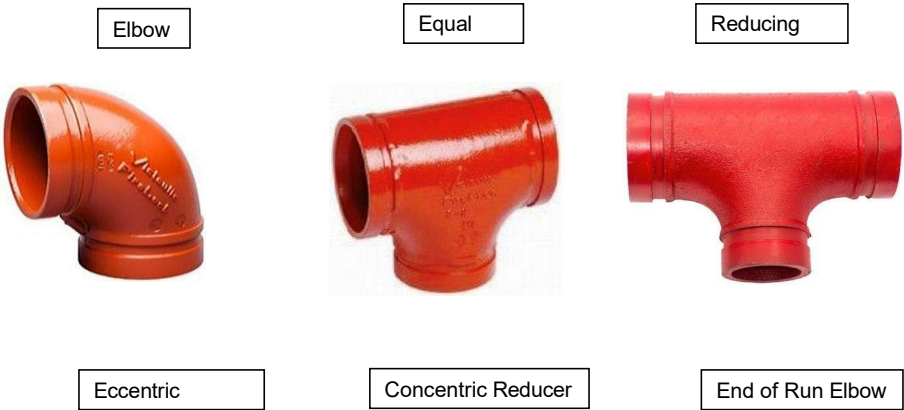
Flexible Type: Use in seismic areas where required by NFPA 13.

“Installation Ready” rigid joints shall be in sizes 2”(DN50) through 8”(DN200), which shall be designed for direct “stab” installation onto grooved pipe without prior disassembly of the coupling. .

Standard flexible couplings shall be of similar as like in Images below :



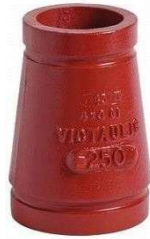
Victaulic Grooved End Fittings: UL Listed & FM Approved Fittings shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12 (Fire Lock®), forged steel conforming to ASTM A- 234, Grade WPB 0.375" wall (9,53 mm wall), or fabricated from Std. Wt. Carbon Steel pipe conforming to ASTM A-53, Type F, E or S, Grade B. Fittings provided with an alkyl enamel finish or hot dip galvanized to ASTM A-153. Zinc electroplated fittings and couplings conform to ASTM B633.



Internal



Equal



Grooved Flange



Grooved X
Threaded Reducer



Bolted Branch Outlet:

UL Listed & FM Approved Branch reductions on 2"(DN50) through 8"(DN200) header piping. Bolted branch outlets shall be manufactured from ductile iron conforming to ASTM A-536, Grade 65-45-12, with synthetic rubber gasket, and heat treated carbon steel zinc plated bolts and nuts conforming to physical properties of ASTM A-183.



UL Listed & FM Approved Header connections for sprinklers, drop nipples, sprigs, gauges, and drains on 1-1/4" through 2-1/2" header piping. Outlets shall be manufactured from ductile iron conforming to ASTM A-536, Grade 65-45-12, with synthetic rubber gasket, and heat treated carbon steel zinc plated bolts and nuts conforming to physical properties of ASTM A-183.



11. EXECUTION

11.1 GENERAL INSTALLATION AND TESTING OF FIRE PROTECTION SYSTEM

Scope of work under this section comprises of furnishing all equipment, appliances, material, and labor necessary and required to install Fire Fighting System as required by the drawings, specified herein or as given in the bill of quantities.

Without restricting to the generality of foregoing, the Fire Fighting system shall include the following:

Galvanized iron Class C (heavy class) main Fire Fighting distribution piping complete with welded, forged steel fittings, grooved, flanges, supports, hangers all required accessories and appurtenances.

Sprinkler heads shall be located in positions shown on the drawings. While slight relocation may result from building construction features or interference from other services, the maximum spacing between sprinkler heads and coverage area shall not exceed those stipulated in the Indian Standards regulations and the NFPA 13-Latest Edition Rules.

Allowance shall be made for such relocations within a radius of 1500 mm of the indicated positions without additional cost.

The Fire Protection Services Trade shall co-ordinate with the ceiling Trade to set out the sprinkler locations to suit the site location of the unit grid. In general, all sprinklers shall be located at the centre of the ceiling unit and a provision of about 10% more sprinklers and pipework than required in Fire NOC / NFPA Rules shall be included in this sub-contract.

Chrome plated wire mesh guards shall be used to protect the sprinkler heads which are liable to accidental or mechanical (at no extra cost) damage.

Installation control valves drain valve, test valve and all connecting pipes and fittings.

Sprinkler heads, nozzles and spare sprinklers.

Connections to risers, pumps, and appliances.

Sprinklers Pump, Jockey Pump, Booster pump Motors, Control Panels, Air Vessels, Cabling, Instruments and accessories, as specified.

Sprinkler Lines for each floor shall be left with complete sprinkler drain arrangement with blanked flange.

Hydrant valves and Accessories.

No jute will be allowed in threaded joints.

If header piping is less than 50mm then shoe joints is to be provided.

JOINTING

Welded Joints: Joints of G.I. pipe of size 50 mm and above shall be butt welded or flanged. Joints of G.I. pipes less than 50 mm dia. shall be with conventional heavy class screwed pipe and fittings. Joints between G.I. pipes and fittings shall be made with the pipes and fittings having “V” groove and welded with electrical resistance welding in an approved manner. But welding without “V” groove shall not be permitted. All joints in the pipeline with screwed fittings shall be seal welded after testing and the weld plus the adjoining portion shall be given two coats of zinc rich primer.

Flanged joints (50mm dia and above). Flanged joint shall be made with 3 mm thick insertion rubber washer/ gaskets, bolts and nuts (Galvanized). Straight runs at intervals not exceeding 25-30m on pipe lines of 50 mm dia and above and as directed by the Engineer Incharge’s Representative. For jointing all types of valves, appurtenances, pumps, connections with other type of pipes, to water tanks and other places necessary and as required for good engineering practice and as shown/noted on the drawings. Flanges shall be with GI bolts and nuts and 3mm insertion gasket of natural rubber .

Unions (up to 50 mm dia): Approved type of dismountable unions shall be provided on pipe lines of 40 mm dia and smaller dia, in locations similar to those specified for flanges.

Grooved flexible couplings and fittings of approved manufacturer shall be provided for all risers piping.

11.2 GENERAL WELDING REQUIREMENTS.

All welding shall be generally in accordance with B.S. 4515: 1965 (Specification for field welding of Carbon steel pipelines.) This will be modified where appropriate for other materials and may be relaxed or varied by order of the Engineer Incharge’s Representative, provided there is a reasonable request for an alternate.

Tack welds shall be performed by fully qualified welders and all tack welds shall be of a length equal to twice the pipe thickness and shall fully penetrate the pipe walls.

Where welding is carried out in the proximity of inflammable materials special precautions shall be taken to prevent risk of fire or other damage to the building fabric.

Where oxyacetylene cutting equipment or any welding plant is being used by an operative for any of the works defined in the contract documents, then fire extinguishers shall be

supplied and carried as part of the equipment. The operators of cutting and welding equipment shall be trained in the use of the fire extinguishers which they carry and all extinguishers shall be fully charged and ready for use. In all cases, extinguishers shall be positioned immediately adjacent to the position where cutting and welding is being carried out and shall be readily accessible for use in the event of an emergency.

All accommodation, benches, tools, welding plant, acetylene, oxygen or electricity, filler rods and electrodes, which are necessary for installations where welding is required shall

be provided as part of this contract.

Welding shall not be done at a temperature of 5 degrees Centigrade or below unless the parent metal is preheated by torches or other approved means until it is warm to the hand (about 27 degrees C) for about 150mm either side of the joint. No welding shall be done below minus 18 degrees C. After preheating, the heated portion including the welded joints shall be covered with muffs or suitable insulation materials to allow cooling free from draughts. Any open ends of the pipe or assembly shall be effectively sealed to prevent heat flow by convection

All welded pipe assemblies shall be constructed so that individual welded joints do not affect each other. The distance between the centres of adjacent welds shall be not less than twice the bore diameter of the pipe.

No welded joints shall be left partially completed. Any joints tacked in position must be promptly finished within the working day. The Engineer Incharge's Representative will reject all work not done in accordance with this instruction.

Where work is rejected, pipes must be machine cut at least 150 mm either side of rejected welds and proper weld preparation must be used on the shortened sector. Where shorter fill-in sections are required because of such rejection and reworking, then new full sized lengths must be supplied.

Where pipes with longitudinal seams are specified, pipe seams shall be arranged such that adjacent seams are opposed 45 deg. from each side of top dead centre and branches shall be made only with weldable fittings.

All filler metals which are coated shall be protected from excessive moisture changes. Filler materials or flexes which show any sign of deterioration shall not be used. If requested by the Engineer Incharge's Representative samples of filler rods to be used shall be submitted to him for approval before any work is done on site. These may be submitted, without additional cost, to an independent testing laboratory for verification.

11.3 TESTS FOR WELDER QUALIFICATION

The purpose of the welder's qualification tests is to determine the ability of the welders to make sound and acceptable welds. Before any site welding on the contract is allowed, each proposed welder shall carry out the tests required in the presence of the certifying agency.

Any weld test specimens which have been suitably marked and approved shall be kept on site by a responsible person, so that they can be produced at any time, at the request of the Engineer Incharge's Representative.

All accommodation, benches, tools, welding plant, acetylene, oxygen, electricity, test pieces, filler rods, electrodes, facilities for cutting and grinding, polishing, bending and examining, which are necessary for welders qualification tests shall be provided. In the absence of any facilities for inspecting the welds, the Engineer Incharge's Representative

may submit the finished samples to an independent laboratory for testing at no additional cost

Under no circumstances shall a welder be employed on the contract, either on or off the site for welding operations other than those for which that welder is qualified.

Copies and records of all test reports shall be promptly given to and kept by the Engineer Incharge's Representative.

Even welders holding a certificate for welding are to be tested at this job site in full accordance with the specifications.

11.4 TESTING OF WELDED PIPE WORK INSTALLATION

Testing of welded pipe work installation shall be by non-destructive test method.

If a weld fails the testing requirements, then two additional welds made by the same operative shall be tested, at no cost to the contract. If both additional welds are successful then, in the case of destructive testing, the cost of making good shall be at no cost to the contract.

If either of the two additional welds fails the test requirements, then further tests on other or all of the welds made by that operative shall be carried out, at the Engineer Incharge's Representative's discretion. All costs resulting from either of the two additional welds failing the test requirements shall be at no cost to the Contract.

If either of the two additional welds fails, then the operative concerned shall not make any further welds on any service unless approved by the Engineer Incharge's Representative. The detailed requirements concerning testing shall be as follows:

Non-destructive testing (Die penetration testing) shall be carried out by a specialist company approved by the Engineer Incharge's Representative, at no additional cost.

WRAPPING PYPKOTE / COATEK

Surface Preparation - The pipe surface shall be cleaned by a wire brush.

Application of Primer - Primer is to be applied on pipes immediately after cleaning. This is to prevent any further accumulation of rust on the pipe. This is a cold applied primer and is applied by brush.

Application of Bitumanistic 4 mm Tape - After the primer is applied on the pipe, it is allowed to dry for about 30 min. till it becomes touch dry. Before adhering the tape to the pipe, it is advisable to gently heat the primer coated pipe by a run of LPG torch. Remove the bottom polyethylene from the tape & then heat bottom surface of the tape by LPG torch or any heat source & start wrapping the tape to the pipe by heating the primer coated pipe & by removing the bottom polyethylene from the tape before wrapping better adhesion between the tape & pipe is obtained. Overlaps are maintained with a minimum of 15.0 mm.

Tape coating of weld joints - The tape is applied over the weld joints after the necessary welding & testing methods of the joints is completed. The procedure for application of tape shall be the same as bare pipe procedure. Overlaps on each side of the weld joints shall be 50 mm.

A final coat of White wash with water based cement paint is done immediately over the entire coated pipe.

11.5 EXCAVATION

Excavation for underground pipe lines shall be as required at site. Pipe lines shall be buried to a minimum depth of 1000 mm. The type of soil to be considered is soft soil.

Wherever required, support all trenches of adjoining structures with adequate timber supports.

On completion of testing and coating & wrapping trenches shall be refilled and compacted with excavated earth in 15 cms. Layers and consolidated to restore ground condition to original status. Prior to excavation ensure that no adjoining structure or pipeline is affected / damaged.

11.6 PAINTING

All Hydrant and Sprinkler pipes shall be painted with post office red color paint. All G.I pipes shall first be cleaned thoroughly before application of primer coat. After application of primer coat two coats of enamel paint shall be applied. Each coat shall be given minimum 24 hours drying time. No thinners shall be used. Wherever required all pipe headers shall be worded indicating the direction of the pipe and its purpose such as "TO RISER NO.1" etc.

Painting shall be expertly applied; the paint shall not over run on surfaces not requiring painting such as walls, surfaces etc. Nuts and bolts shall be painted black, while valves shall be painted blue.

11.7 MAINTENANCE

General

Provide the following free maintenance for a period of twenty four (12) months after handing over the Fire Protection System to client (i.e. during warranty period)

Examinations: Bi-Weekly, including adjustments, cleaning and lubrication of equipment.

Replacement: Replace components when required, using parts produced by original manufacturer.

Spare Parts: Provide necessary spare parts; maintain locally an inventory of all wearing parts of the system.

Call Backs: Provide 24-hour emergency call back service at no expense to Owner.

Records: Maintain complete maintenance records including check charts, lubrication logs and activity logs; provide check charts and activity logs.

Extended Service Contract

At time of Bid, submit cost for full maintenance contract i.e. after the expiry of 12 month warrantee and free maintenance period.

Service: Provide examinations, logs, replacements and spare parts as specified for maintenance, including cleaning of tanks, equipment and machinery spaces required to maintain the water output quality and quantity as per design.

12. FIRE DOOR (IF APPLICABLE)

12.1 SUMMARY

This Section includes the following,

- Steel Doors and Frames – With [or] Without Vision Panel and/or Louver
- Fire Rated Steel Doors and Frames – With [or] Without Vision Panel
- Fire Rated Steel Doors and Frames – With [or] Without Automatic Louver
- Fire Rated Steel Doors with Transom Frames
- Borrowed Light Frames, Transom Frame and Sidelights

Related Sections: The related Sections for this section includes the following,

- Section 08710 - Door Hardware.
- Section 08800 - Glazing: Glass for door lights and borrowed lights.

12.2 REFERENCES

- ANSI/UL 10C - Positive Pressure Fire Tests of Door Assemblies
- ANSI/UL 10B - Fire Tests of Door Assemblies
- ASTM A792 / A792M - Standard Specification for Steel Sheet, 55 % Aluminum-Zinc Alloy- Coated by the Hot-Dip Process
- ANSI/SDI A250.8 - Recommended Specifications for Standard Steel Doors and Frames
- ANSI A250.7-1997 - Nomenclature for : Standard Steel Doors and Steel Frames
- SDI 111 - Recommended Selection and Usage Guide for Standard Steel Doors, Frames and Accessories
- SDI 117 - Manufacturing Tolerances Standard Steel Doors and Frames

- SDI 118 - Basic Fire Door Requirements
- SDI 122 - Installation and Troubleshooting Guide for Standard Steel Doors and Frames
- ANSI/SDI A150.11 - Recommended Erection Instructions for Steel Frames
- NFPA 80 - Standard for Fire Doors and Other Opening Protectives
- HMMA 801-05 - Glossary Of Terms For Hollow Metal Doors And Frames
- HMMA 810-09 - Hollow Metal Doors
- ANSI/SDI A250.6-2003 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames

12.3 SUBMITTALS

General: Submit item by each type in this Section according to the Conditions of the Contract and related sections.

Product Data for type of Door, Frame, Panel, Glass and Louver specified, including details of construction, materials, dimensions, hardware preparation, core, label compliance, profiles, and finishes.

In the Shop Drawings, Include details of Frame type, Elevations of Door Design types, Door Construction Details, Location, Hardware Location and Reinforcements, Details of Joints and Connections, Anchorage and Accessory details, and finish requirements.

12.4 QUALITY ASSURANCE

Provide Fire Rated Doors and Frames complying with the following,

- ANSI/UL 10C [Positive Pressure Fire Tests of Door Assemblies]
- ANSI/UL10B [Fire Tests of Door Assemblies]
- SDI 117 [Manufacturing Tolerances Standard Steel Doors and Frames]

Wherever relevant and applicable, ANSI/SDI A250.8 [Recommended Specifications for Standard Steel Doors and Frames] can be referred and implemented.

At any case, The UL Standards take precedence to any-other standards mentioned above]

Source Limitations: Obtain Steel Doors and Frames, through one source, from a Single Manufacturer.

For Fire-Rated Door and Transom Frame Assemblies: Assemblies complying with ANSI/UL 10C that are Certified/Listed/Labeled with UL, for the Fire Protection Ratings indicated.

Test Pressure: During the Fire Test, the Pressure should have been maintained as nearly equal to atmospheric pressure as possible below the neutral plane which should have been established at 40 in above sill level. Above the neutral plane, pressure greater than

atmospheric pressure should have been established.

Hose Stream Test: Immediately after the fire exposure, the assembly must have been withdrawn from the furnace and subjected to the impact and cooling effects of the 30 psi water hose stream for a minimum of 75 seconds, as specified in the Test Standard.

Temperature: The average unexposed surface temperature rise, measured after 30 min of Fire Exposure should not exceed 1000°F

Oversize Fire-Rated Door Assemblies: For units exceeding the Design and Following Sizes of the tested assemblies, provide Sub-Contractor Construction Certificate that gives an undertaking that the doors matches the Standard Construction requirements of Tested assemblies except for Size,

- For Swinging Type Fire Rated Steel Doors with Impregnated Kraft Paper Honeycomb Infill,
 - a) Width of Single Leaf Doors - 1282 mm
 - b) Width of Double Leaf Doors - 2450 mm
 - c) Height of Doors - 3010 mm

- For Swinging Type Fire Rated Steel Doors with Steel Stiffened Mineral Wool Infill,
 - a) Width of Single Leaf Doors - 1118 mm
 - b) Width of Double Leaf Doors - 2122 mm
 - c) Height of Doors - 2269 mm

[All the Sizes Indicated above, in the Sub-division 1.5.3.4 is Structural Opening Sizes]

Fire-Rated, Transom Frames: Assemblies complying with ANSI/UL 10C that are Certified/Listed/Labelled with UL, for the Fire Protection Ratings indicated.

12.5 MATERIALS

Cold-Rolled Steel Sheets conforming to ASTM Designation ASTM A792 / A792M [Standard Specification for Steel Sheet, 55 % Aluminum-Zinc Alloy-Coated by the Hot-Dip Process], commercial name – Galvalume.

The Steel Sheets are to be coated, by Hot-dip Galvanizing technique, with 55% Aluminum, 43.5% Zinc and 1.5% Silicon, to a coating designation of AZM 150.

Supports and Anchors: Fabricated from not less than 1.2 mm thick Steel Sheet.

Inserts, Bolts, and Fasteners: Manufacturer's standard and compatible units shall be provided, to match the supplied materials.

12.6 DOOR AND FRAMES

Doors: Provide Doors complying with requirements indicated below, by referencing ANSI/SDI A250.8 for Level, Model and Physical Performance Level,

- Level 2 and Physical Performance Level B [Heavy Duty], Model 1 [Full Flush] – 18 Gauge [1.2 mm] Steel.

Frames: Provide Frames complying with requirements indicated below, by referencing ANSI/SDI A250.8 for Level,

- Level 2 – 16 Gauge [1.5 mm] Steel.

Door Core Construction: One of the following Manufacturer's Standard Core materials, that complies with ANSI/SDI 250.8 and/or ANSI/UL 10C, that is used to fabricate a Door,

- Resin-Impregnated Kraft Paper Honeycomb [or]
- Vertical Steel Stiffened system with Mineral wool [100 Kg/m3] Infill

*[Fire Doors should have been tested, under UL Standards, with one of the Cores mentioned above]

Hardware Reinforcement: Fabricate Reinforcement plates from the material as same as the Door Leaf Face sheets [or] GI [Galvanized] Steel Sheets to comply with the following minimum sizes:

- Hinges: Minimum 4.5 mm Thick, 36 mm wide and 230 mm long reinforcement plate secured to the Door and Frame with not less than 6 spot welds.
- Lock Face, Strike, Door Closers, Automatic Swing Door Operators, Exit Devices, Flush Bolt and Concealed Holders: Minimum – 2.0 mm Thick.
- All Other Surface-Mounted Hardware which require Reinforcement: Minimum - 2.0 mm thick GI [Galvanized] Steel [or] Metallic Coated Sheet.
- Top and Bottom Inverted Channel: Minimum 1.2 mm thick Metallic Coated Sheet

Plaster Guards: Provide minimum 0.7 mm thick steel Plaster/Mortar Guards/Boxes at back of hardware cutouts, for Frames, where Mortar or other materials might obstruct hardware operation and to close off interior of openings.

Door Silencers: Except on Frames with Weather-Strip and/or Ambient Temperature Smoke Seal, Drill Frame Stops to receive 3 silencers on Strike Jambs for the Single Leaf Door Frames and 2 silencers on Frame Heads of Double Leaf Door Frames.

Supports and Anchors: Fabricated from 1 mm, Electro-Galvanized [or] Metallic-coated Steel Sheet.

Inserts, Bolts, and Fasteners: Manufacturer's standard and compatible units shall be provided, to match the supplied materials.

Door Louvers: Provide Louvers for Steel Doors, where indicated, based on the following details,

- For Non Fire Rated Doors, provide Insert type Z Blade Type Louvers, with Blades

formed from a minimum of 1.0 mm Steel material that is as same as the Door Leaf Face-sheet material, and that comply with SDI 111C. These Louvers are to be Sight-proof type, in a Straight line of Sight.

- For a Fully Louvered Door, all the details shall be followed as in the Sub-Division 2.3.9.1. A minimum 150 mm rail occurs at the top, bottom and at the vertical edge, for this type of unit. A Fully Louvered Doors shall not be Fire Rated, at any case.
- For Fire Rated Doors, provide spring loaded Fusible link Louvers to control flames and intense heat passage. The link release temperature is recommended to be not more than 167°F (75°C). These louvers must be labeled [or] listed under UL Standards and shall not have size exceeding [610 X 610] mm. Also, these Louvers shall not be smaller than a Size [Width X Height] of [305 X 155] mm. Fusible link louvers are allowed only at the bottom of fire doors. Doors with this type of Fusible Link Louvers shall not have Fire Rating exceeding 90 Minutes. In addition to the above, no portion of the louver shall be installed in the area 40 in. (1016 mm) above the sill, for Fire Rated Doors.

Glazing Systems: Provide Manufacturer's standard kits of Glazing systems based on the following details,

- For Non Fire Rated Doors: Provide Manufacturer's standard kit consisting of Vision Panel Frame, Glass, Screws and Glazing Tape. The Glass shall be either Wired or Non Wired, as per the project requirements.
- For Fire Rated Doors: Provide Manufacturer's standard kit consisting of Vision Panel Frame, Glass, Screws and Glazing Tape where the Glass may change depending upon the Fire Rating, based on the following details,
 - a) For Fire Rated Doors not exceeding a Fire Rating of 90 Minutes, the Glass used shall be Georgian Wired Glass, where the Glass is not required to be a labeled/listed product. The Maximum Exposed Area of the Glazing, in case of Georgian Wired Glass, shall not exceed 100 in², where either of the sides shall not exceed a size of 508 mm.
 - b) For Fire Rated Doors not exceeding a Fire Rating of 90 Minutes and that require Exposed Glazing size to be bigger than 100 in², the Glass used shall be 5 mm Thick Fire Rated Ceramic Glass, where the Glass is strictly required to be labelled [or] listed under UL Standards.

The Maximum Exposed Area of the Glazing, in this case, shall not exceed 103.15 in², where either of the sides shall not exceed a size of 508 mm.
 - c) For Fire Rated Doors exceeding 90 Minutes and less than or equal to 120 Minutes Fire Rating, the Glass used shall be a 5 mm Thick Fire Rated Ceramic Glass, where the Glass is strictly required to be labeled [or] listed under UL Standards. The Maximum Exposed Area of the Glazing, for 120 Minutes Fire Rating, shall not exceed 100 in², where either of

the sides shall not exceed a size of 305 mm.

- d) For Fire Rated Doors, with Glazing system, the Glazing Tape used is strictly required to be labeled [or] Listed under UL Standards.
- e) For Fire Rated Doors, with Glazing system, the Glazing/Vision Panel Frame used is strictly required to be listed under UL Standards and shall be fabricated from minimum 1.0 mm Thick Metallic Coated Steel Sheet.
- f) Fire Rated Doors with Louvers, cannot have a Glazing system integrated into it.

Astragal for Double Leaf Doors: Astragal is not mandatory for Non Fire Rated Doors. Fire Rated Doors require a minimum of one Astragal, where the design and integration of the Astragal shall be as per Manufacturer's standard.

Hardware and Accessories: Provide Hardware and Accessories that is compatible with Steel Doors and as per the requirement of the Client. Where the operation of two or more hardware/accessory is conflicting/contradicting, the manufacturer to provide proposal to Contractor/Client based on the function/type of the Door. For Fire Rated Doors, the Hardware is strictly required to be labeled [or] listed [or] Classified under UL Standards.

12.7 FABRICATION

Fabricate Steel Door and Frame units to be rigid, neat in appearance, and free from defects, warp, or buckle. Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site. Refer with ANSI/SDI 100, wherever applicable and relevant.

- Steel Door Construction: Steel Doors shall have a Mechanically Interlocked Pan and Lid Construction fabricated from two face-sheets, where one of the Face-sheet is interlocked to the other Face-sheet with the help of Tab and Slot design where the spacing between each tab/slot shall be provided as per the Manufacturer's Standard. All the Doors shall be permitted to have Visible Edge Seam running continuously along both the Vertical Edges of the Doors. Top and Bottom open portion of the Doors are reinforced with Inverted Horizontal Closures.
- For Doors with Resin-Impregnated Kraft Paper Honeycomb Infill, the Void Space between two Face-sheets is filled with Resin-Impregnated Kraft Paper Honeycomb Infill, where the Infill is glued to both the Facesheets with the help of Manufacturer's Standard Adhesive.
- For Doors with Steel Stiffened Core, the Space between the Face-Sheets are Stiffened with Hat Shaped Vertical Stiffeners attached to each Face-Sheet. The First and the Last

Stiffeners are spaced in such a way that their nearest edge is at 110 mm from their nearest Leaf Edge. Each Stiffener has a dimension of [20 X 20 X 80 X 20 X 20] mm and the adjacent Stiffeners are placed at a Centre to Centre spacing of 220 mm.

- The stiffeners are attached to the face sheets with welding equally spaced at 102 mm, vertically. The number of Stiffeners depends upon the Width of Door whilst the maximum number of Stiffeners required per Face-sheet is four. The Void Space between the adjacent Stiffeners is filled with Mineral Wool Infill whilst the same is not required for the Void Space within the Stiffeners. The Welds are to be ground smooth as needed. For Non Fire Rated Doors, the spacing between the adjacent Stiffeners may vary as per Manufacturer's Standards and in accordance to the Door Width.

Steel Frame Construction: Steel Frames shall have Mitered Corners at the Intersection of Head and Jamb which may be either of Welded Type [or] Knockdown Field Assembly [Tab and Slot or Screw] Type, depending upon the Client's requirements and Size requirements. Frames Wider than 2500 mm and/or taller than 3000 mm shall have Knockdown Field Assembly type construction

Knockdown Field Assembly type Frames shall have visible hairline seam at the intersection of Head and Jamb.

- Welded Frames shall be provided with temporary manufacturer standard spreader bars
- Wherever seal is not required, drill stop in strike jamb to receive three silencers for Single Leaf Door Frames and a drill stop in frame head to receive two silencers for Double Leaf Door Frames.
- Frames shall have manufacturer's standard Anchoring provision such as U Anchor, Flat Bar/Back Plate Anchor, etc. The Anchoring provision also depends upon the wall type to which the Frame is going to be anchored.
- Pipe-spacers [or] Tube [or] Pipes are not required when Sleeve type Expansion Shield Anchor Bolt is used.
- Floor Anchors are not required for three sided frames and/or Welded Frames.
- Head Anchors are not required for Single Leaf Door Frames and/or Frames shorter than 1300 mm in width.

The Spacing of Anchors and Hinges shall be as per Manufacturer's Standards.

Location of Hardware shall be as per Client's requirement in conjunction with Manufacturer's Standards, and feasibility and function of the Hardware

Tolerance: Comply with the requirements of SDI 117 [Manufacturing Tolerances Standard Steel Doors and Frames].

Clearances: Max. 4 mm at the Jambs and Heads, between the Leaf and Frames, Max. 4

mm between the meeting pairs of Doors and Max. 19 mm at the Bottom [between the Door and the Floor] of the Door. For Fire Rated Door, the Clearances shall not exceed the ones followed during the Fire-test.

Glazing Frames/Stops shall be formed in accordance to Manufacturer's Standards design and construction where, It is required to provide Non-Removable Glazing Frame/Stop on the Outside of Doors and Screw-Applied Removable Glazing Stops on the secure side of the Doors.

12.8 FINISHES

Surface Preparation: Welded Surfaces are to be Sand and Ground properly. Surfaces are to be cleaned with nonpetroleum solvent so that surfaces are free of oil or other contaminants.

Doors and Frames, intended to be used in Interior and Exterior Locations, are to be Factory-applied with Single Coat of Thermo-Setting TGIC Polyester Powder, by Electrostatic Powder Coating system. The Dry Film Thickness of the coating shall not be lesser than 80 microns. Comply with coating manufacturer's written instructions for cleaning, applying and baking.

Doors and Frames that are Factory-applied with Polyester Powder coating does not require Prime finishing.

Intelligent Addressable Fire Detection System

General Specifications

Abstract

The following document will provide the Specifier Engineer with a general format of specification layout for Fire Detection System for any kind of commercial or residential building Application.

1. General Description

- 1.1. The fire detection and alarm system shall monitor and display the activation of each device in the system, such as heat detector, smoke detector, manual break-glass unit, sprinkler water flow switch, sprinkler valve tamper switch, hose reel water flow switch and hose reel valve tamper switch or any other input device which may be required.
- 1.2. The system shall initiate output functions such as automatic alarm annunciation via speakers, fans shutdown, automatic notification to the Fire main control PC and activation of audible hooters/directional sounders/strobes.
- 1.3. The system shall be of the addressable intelligent type, completely supervised, such that a break in any wire (loop) shall not prevent any device from operating. The system shall be of the type such that each device connected to the system shall be provided with unique address and separately identified at the Main control panel (MCP).
- 1.4. The wiring shall be monitored against faults such as opens, shorts, earth's or data transmission failure. Each detection addressable loops, capable of handling up to 240 addressable points shall return to the control panel.

2. Terminology & Abbreviations

- 2.1. **LCD:** Local Civil Défense, local authority having jurisdiction
- 2.2. **Class A:** Means Loop connected topology, in such a way, the circuit will start from the rack or device and will terminate back to the device.
- 2.3. **Style 7:** is a NFPA72 style of connection, in which a single fault of "Short Circuit or Open Circuit" shall not affect other devices and the loop will not lose a single device in case of a single fault.
- 2.4. **I/O:** Input &/Or Output Device
- 2.5. **FACP:** Fire Alarm Control Panel
- 2.6. **FCC:** Fire Command Centre

3. Scope

- 3.1. The Main control panel shall be located in the main control room now called the Fire Command Centre (FCC) as located in the drawings. The appropriate authorities shall approve the exact location.
- 3.2. A active & networkable remote repeater panel shall also be installed at designated places and shall repeat all alarm functions displayed at the main control panel.
- 3.3. The Fire Alarm System shall be integrated on Cloud for Displaying the Real Time Fire & Fault information for user by using Any Standard Web-browser
- 3.4. Configuration & Programing of Panel shall be done using Cloud based software & all the config data for all panels shall be stored on Cloud using Secured User Name & Password

4. System Operation

- 4.1. The system shall be arranged for categories of alarm inputs and provide output functions appropriate to each of the categories:

- 4.1.1. Supervisory Monitor input: The following inputs shall be considered supervisory monitoring functions:
 - 4.1.2. Sprinkler system shut off valve tamper switch.
 - 4.1.3. Hose Reel cabinet tamper switch
 - 4.1.4. Removal of a smoke detector from its base.
 - 4.1.5. Fire / Sprinkler pump status (i.e. running, power available, malfunction).
 - 4.1.6. Wiring faults.
 - 4.1.7. Activation of a supervisory monitoring device shall provide the following indications:
- 4.2. The MCP and remote annunciators shall indicate an audible and visual "TROUBLE" condition. In addition, the "trouble alarm" shall be displayed on the graphic display unit for the type of alarm.
- 4.3. An alarm signal shall be automatically sent to the local control room as well as REMOTE control room if designed. This may be accomplished by means of an web server /Netcom/ digital dialer.
- 4.4. In case of fire all lift call and door buttons and signals shall become inoperative, lifts serving that floor shall be signaled to immediately return to the ground floor or as designated by the local Fire department and be held for the exclusive use of the Fire Brigade. Should such an alarm occur on the ground floor, the lifts shall be signaled to return to an alternate floor which is not in alarm.
- 4.5. Signals shall be sent directly to heating, ventilating and air conditioning fan motor controllers for status monitoring circuits to confirm the operation of the fan systems.
- 4.6. The details of the fan control sequence shall be as follows:
 - 4.6.1. All fans serving the areas affected by the alarm condition shall shutdown.
 - 4.6.2. Smoke extraction fan system shall have to be started
 - 4.6.3. Stair pressurization fans shall be started.
 - 4.6.4. Signals shall be transmitted to the paging system to display zone in alarm.
- 4.7. All access control doors shall be released in case of fire condition shall allow for more than one floor at a time to be displayed.
- 4.8. The automatic voice evacuation alarm shall be initiated from the fire alarm system upon activation of an alarm. The alarm shall consist of a "slow whoop" alarm tone for a maximum of fifteen (15) seconds followed by an automatic preselected voice evacuation message. At the end of each message the 'slow whoop' shall continue for fifteen (15) seconds followed again by the automatic voice evacuation signal. This sequence of alarm shall sound until the signal silence switch is operated at the main fire alarm control panel or the fire alarm has been reset as described previously. The voice evacuation signal shall be distinct, authoritative without any inflection and shall be repeated in several languages as agreed with the fire brigade.
- 4.9. The alert tone shall consist of an introductory pulse tone for fifteen (15) seconds followed by an alert message to advise that this floor is not in alarm but the floors that are in alarm shall be stated. The message shall also state that the occupants shall be prepared to evacuate the building when the evacuation alarm is given. The alert tone shall be distinctly different from that of the evacuation alarm.

4.10. Each stairwell shall receive a voice message without a fire alarm tone. The message shall state that there is an emergency in the building anyone presently in the stairwell shall not re-enter any floors but should proceed immediately to the ground floor exit level. Zone circuits shall be designed for this activity

5. Coordination with Other Systems

5.1. The fire detection and alarms system shall have interface with other building systems, which are described under other sections of the report, as follows:

- 5.1.1. Heating, Ventilating and Air Conditioning (HVAC)
- 5.1.2. Building Automation System (BAS)
- 5.1.3. Sprinkler / Pumps system
- 5.1.4. Etc. any other systems based on project requirements

5.2. The life safety system is required to monitor fire hydrant / sprinkler pump status. The pump controllers shall have the necessary volt free output signals available.

6. Quality Assurance

6.1. Acceptable Manufactures: Minimum of 10 years of local presence and references in the UAE, and at least 30 years International Existence with a sound track record of installation in the Life Safety Systems complying with EN54 part 2,3 ,16, EN54 Part 24 and UL listed and approved by the local Civil Defense Authority.

6.2. The following are the acceptable Fire Alarm Manufacturer List

- Notifier Honeywell-USA
- Gent Honeywell-UK
- Bosch
- VELOX-UAE
- Siemens

6.3. The following are the acceptable Battery Manufacturers

- Rocket
- Exide
- Power sonic

7. Approvals

The proposed products must comply with all the following standards:

- 1.1. UAE Fire and Life Safety Code of practice 2017 Edition
- 1.2. EN54 part 2
- 1.3. EN54 part 3
- 1.4. EN54 part 4

- 1.5. EN54 part 5
- 1.6. EN54 part 7
- 1.7. EN54 part 17
- 1.8. EN54 part 23
- 1.9. LCD (Local Civil Defense) Approved

8. Manufacturer Guarantee

- 8.1. All the proposed products for Fire Detection System i.e. FACP, Call Points, Smoke Detectors, Heat Detectors, Multi-Detectors, I/O Modules, Sounders, Flashers & Power supplies shall be covered with 5 Years Manufacturer Guarantee.
- 8.2. The Guarantee shall be offered directly from only Manufacturer, the guarantee offered from Agent/Distributor or Installer shall not be acceptable.

9. Touchscreen Fire Alarm Control Panel (FACP)

- 9.1. The Fire Alarm Control Panel (FACP) should be touchscreen type & shall have 8 Loop on-board with expandable capacity to 12 Loops.
- 9.2. FACP should be EN54 compliant Intelligent Analogue Addressable type with capability to connect 240 devices in any combination of any types
- 9.3. The FACP should support 2km Loop Length based on the Loop Load calculations,
- 9.4. FACP shall be having Human Interface of Color TFT Touchscreen Display with minimum 480x272 resolution,
- 9.5. FACP should be Aesthetically good & should be Compact size with dimensions not more than 50cmx50cm. The FACP Touchscreen display should support minimum 10 Languages like English, Turkish, Arabic etc.,
- 9.6. FACP shall be EN54 part 2 & 4 approved & the power supply charger should be EN54 part 4 compliant,
- 9.7. Commissioning & configuration for panel should be possible by using the Windows software as well as from Front Touchscreen. FACP should not be locked & limited with a Dongle for Programming. FACP should support Programming by using USB Pen Drive as well as remotely using Cloud. The Cloud programming shall be possible remotely from any location.
- 9.8. FACP shall be Networkable using CAN Bus protocol by addition of Network cards & it should support all kind of Third party integrations using MODBUS.
- 9.9. The Touchscreen shall support the customization of Logo/Screen-saver as per customer requirement, which means if customer wants the panel to display there Logo/Brand name this should be possible in the panel. Customer will be providing JPEG or BMP Image of the Logo which should be able to uploaded on Panel as screen-saver.
- 9.10. The FACP shall be configurable using a Standard USB Memory stick /Pen Drive, FACP which require any specialized Dongle for configuration & programming shall not be acceptable.
- 9.11. Configuration & Programing of FACP shall be done using Cloud based software

& all the config data for all panels shall be stored on Cloud using Secured User Name & Password, user shall be able to access the Configuration from remote site location using any standard Web-browser & Internet connection.

9.12. FACP shall support Open Protocol for communication with Detectors & Devices, which means customer should get flexibility to connect any Brand detectors to FACP in future during Maintenance.

9.13. FACP shall come with default 5 Year Manufacturer Guarantee & should cover all kind of Manufacturing defects or failures occurred due to Quality of product or Manufacturing.

9.14. FACP Technical Specification

Display	:	4.3" Color TFT Touchscreen Display 480x272
Battery Capacity	:	24V 18Ah internal, 24V 48Ah external
Power	:	110-230 V AC (+10% -15% tolerance)
On board power supply	:	3 Amp High efficiency switch mode
On Board sounder	:	500mA programmable.
Aux Supply	:	1 x 24V 300mA
Zone LEDs	:	Minimum 50 (Optional)
Acoustic Messages	:	Buzzer
Programming Port	:	USB & IP(Cloud)
Log Events	:	800
Software Zones	:	150+
Dimensions	:	Less than 50cm x 50 cm
Loops	:	1 Onboard
Expandability	:	Expandable to 9 by Add Loop cards
Networking	:	Minimum 30 Panels
Warranty	:	5 Years Guarantee
Operating Temperature	:	+5 °C to +35 °C

10. Open Protocol

Fire Alarm Control Panels shall support "Open Protocol", where the user can exchange multiple brands of detectors on the same Fire Alarm Control Panel (FACP). Allowing the user to be flexible in after sales services.

11. Cloud Interface for Monitoring & Maintenance

The FACP shall be integrated with Cloud a centralized software platform offer in services for the remote control of connected objects for Monitoring & Maintenance of Fire Alarm System using Internet and any Web Browser.

The Cloud Platform shall perform below important tasks:

11.1. Network Management

Cloud Platform shall manage the lifecycle of your connected objects. It offers you tools to configure your network and analyze its usage, performance and working conditions over time.

11.2. Mapping

During the commissioning phase, objects can be localized using our mobile Application. The network of FACP shall be visible on a Map. The Cloud shall support the WMS protocol enabling you to work with either Google Maps or any custom mapping server. Cloud Platform will facilitate the user to create indoor image maps of building.

11.3. Monitoring

Retrieved data from sensors/detectors & Devices shall be straight forward uploaded in Real time on the Cloud making it seamless integration between the Cloud Server, FACP & Field Devices i.e. Sensors. The Cloud Platform shall have Login ID & Password specific to the Project/Site/Customer & shall have of data storage and data aggregation possibilities The Server should also be equipped with powerful tools to analyses data.

11.4. Remote Control of Detectors /Devices

Controlling a connected object is at one mouse click shall be possible on Cloud Service. Commands shall be scheduled or automatically triggered in reaction to alarms or specific measurements.

11.5. Notifications

The Cloud Server shall have capability to generate notifications (in apps, emails, SMS, phone calls) if critical measurements are detected on a connected object.

11.6. Programming & Configuration

The FACP shall support Configuration & Programming Over cloud from remote locations. The configuration data of FACP shall be stored on cloud for future maintenance and Modifications.

The system is also able to detect false alarms avoiding useless firemen displacements.

11.7. Maintenance

The Cloud Platform shall also support fire alarm systems maintenance process. If a failure is detected in a device, client will receive a notification email. It will be able then to select a maintenance company and schedule an appointment.

In mobile application, the technician shall be able to access information related to the fire alarm system of the client. And can visit field & can start automated tests procedures, allowing him to locate the problem. At the end of the maintenance, a report is automatically generated, and the technician can ask for the customer signature. Finally, the customer receives an email with a satisfaction form.

12. Intelligent Analogue Addressable Manual call point

- 12.1. The unit shall fully comply with EN54-11 and it should be connected on the same loop and loop powered.
- 12.2. The device shall be equipped with the latest state of the art microprocessor which shall hold the fire algorithm, hardware and software monitoring capability the device shall be embedded with the variable time communication protocol and allow the safe and soft addressing.
- 12.3. The device shall equip with inbuilt isolator to protect the loop against short circuit or open circuit.
- 12.4. The unit shall be tested by using universal test key which can use for reset also.
- 12.5. The unit shall come with 5 Year Manufacturer Guarantee.

12.6. Technical Specification

Approval	:	LPCB or Kitemark or BSI & Civil Defence
Storage Temperature	:	-10°C to + 55°C
Operating Temperature	:	-10°C to + 55°C
Ingress protection	:	IP42
Vibration	:	5 to 60Hz
Average current consumption	:	70µA
Power Supply	:	15-40V

13. Loop Powered Analogue Addressable Sounder

- 13.1. The unit shall fully comply with EN54-3 + A1 and it should be connected on the same loop and it should be loop powered.
- 13.2. The device shall be equipped with the latest state of the art microprocessor which shall hold the fire algorithm, hardware and software monitoring capability the device shall be embedded with the variable time communication protocol and allow the safe and soft addressing.
- 13.3. The device shall equip with inbuilt isolator to protect the loop against short circuit or open circuit.
- 13.4. The unit shall come with 5 Year Manufacturer Guarantee.

13.5. Technical Specification

Approval	:	CPD & Civil Defence
Operating Temperature	:	-10°C to + 55°C
Ingress protection	:	IP21
Average current consumption	:	70µA
Power Supply	:	15-40V
Output Tones	:	5 Programmable from the panel.

Sound Output : 100dBA @ 1m

14. Intelligent Analogue Addressable Optical Detector

- 14.1. The unit shall fully comply with EN54-7 and it should have Kite Mark listing. Up to 240 devices can be connected to 2 Km Loop Length.
- 14.2. The detector shall support both White and Black smoke. The detector shall contain the fire algorithm and the hardware and software capability.
- 14.3. The detector shall be protected with the continuous precisely perforated screen and the chamber shall be equipped with double dust trap.
- 14.4. The unit shall have 360° visible Bicolor (Red/Green) LED driven by Control Panel
- 14.5. The detector shall have Bi Color LED for indication and the detector shall be equipped with in-built isolator to protect from short circuit or open circuit.
- 14.6. The detector shall be of soft and safe addressing and support 4 level of sensitivity.
- 14.7. The Detector should contain sophisticated algorithms providing decentralized intelligence to compensate the obscuration measurements in case of dust and other similar contaminates inside the chamber.
- 14.8. The “ADC” technology keeps the detection threshold window uniform with fixed detection sensitivity, unlike other drift compensation methods in the market that reduces the detection threshold window allowing a change in sensitivity.
- 14.9. The unit shall come with 5 Year Manufacturer Guarantee.

14.10. Technical Specification:

Power Supply	:	15-40 V
Average Current consumption	:	70µA
Output driver current	:	Iout=6mA @24Vdc
LED Current Consumption	:	Iled=6mA @24Vdc
Storage temperature	:	-30C° to 70C°
Operating Temperature	:	-30C° to 70C°
Ingress Protection	:	IP30 on flat ceiling
LED Color	:	Red & Green
Magnetic Test	:	Yes

15. Intelligent analogue addressable Heat detector

- 15.1. The unit shall fully comply with EN54-5 and it should have Kite Mark listing.
- 15.2. Up to 240 devices shall be able to be connected with 2 Km Loop Length.
- 15.3. The detector shall operate on the low thermal inertia centrally positioned thermistor and shall detect both smoldering fires that emit low heat energy over a time period as per EN54 standard.
- 15.4. The detector shall contain the fire algorithm and the hardware and software capability.
- 15.5. The unit shall have 360° visible Bicolor (Red/Green) LED driven by Control

Panel

- 15.6. The detector shall be protected with the continuous precisely perforated screen and the chamber shall be equipped with double dust trap.
- 15.7. The detector shall have Bi Color LED for indication and the detector shall be equipped with in-built isolator to protect from short circuit or open circuit.
- 15.8. The detector shall be of soft and safe addressing and support 3 level of sensitivity.
- 15.9. The unit shall come with 5 Year Manufacturer Guarantee.
- 15.10. The Detector should contain sophisticated algorithms providing decentralized intelligence to compensate the obscuration measurements in case of dust and other similar contaminants inside the chamber. The “ADC” technology keeps the detection threshold window uniform with fixed detection sensitivity, unlike other drift compensation methods in the market that reduces the detection threshold window allowing a change in sensitivity.

15.11. Technical Specification:

Power Supply	:	15-40 V
Average Current consumption	:	70μA
Output driver current	:	I _{out} =6mA @24Vdc
LED Current Consumption	:	I _{led} =6mA @24Vdc
Storage temperature	:	-30C° to 70C°
Operating Temperature	:	-30C° to 70C°
Ingress Protection	:	IP30 on flat ceiling
Threshold Temperature	:	58°C – A1R Rate of Rise 78°C – Class B fixed high temperature
LED Color	:	Red & Green
Magnetic Test	:	Yes

16. Intelligent Analogue Addressable Multi-criteria detector

- 16.1. The unit shall fully comply with EN54-5 and it should have Kite Mark listing.
- 16.2. Up to 240 devices can be connected to 2 Km loop Length.
- 16.3. The detector shall have fixed level of temperature sensitivity 58C° class A1R as per EN54-5.
- 16.4. The detector shall be protected with the continuous precisely perforated screen and the chamber shall be equipped with double dust trap.
- 16.5. The detector shall have Bi Color LED for indication and the detector shall be equipped with in-built isolator to protect from short circuit or open circuit.
- 16.6. The unit shall have 360° visible Bicolor (Red/Green) LED driven by Control Panel.
- 16.7. The detector shall be of soft and safe addressing and support 10 level of sensitivity.
- 16.8. The unit shall come with 5 Year Manufacturer Guarantee.
- 16.9. The Detector should contain sophisticated algorithms providing decentralized intelligence to compensate the obscuration measurements in case of dust and other similar contaminants inside the chamber. The “ADC” technology keeps the detection threshold window

uniform with fixed detection sensitivity, unlike other drift compensation methods in the market that reduces the detection threshold window allowing a change in sensitivity.

- 16.10. The detector shall have Bi Color LED for indication and the detector shall be equipped with in-built isolator to protect from short circuit or open circuit

16.11. Technical Specification:

Power Supply	:	15-40 V
Average Current consumption	:	70μA
Output driver current	:	I _{out} =6mA @24Vdc
LED Current Consumption	:	I _{led} =6mA @24Vdc
Storage temperature	:	-30C° to 70C°
Operating Temperature	:	-30C° to 70C°
Ingress Protection	:	IP30 on flat ceiling
Threshold Temperature	:	58°C – ROR to AIR
LED Color	:	Red & Green
Magnetic Test	:	Yes

17. Monitor / Input & Control / Output Module

- 17.1. The unit should be Compliant to EN54-18 for Input / Output Modules standards, Inbuilt Isolators complying with EN54-17 standards, shall be Powered from the loop, Automatic and Manual Addressing Features Twin Bi-Color LED for Status and Fire Single Up to 240 devices on a single loop.
- 17.2. The unit shall be supplied with 4"x4" ABS Back box from Manufacturer, only original box shall be supplied no local back box shall be supplied.
- 17.3. The unit shall come with 5 Year Manufacturer Guarantee.

17.4. Technical Specification

Power Supply	:	15 VDC – 52 VDC
Alarm current consume	:	≤ 120mA
Operating temperature range	:	-20°C - 60°C
Number of devices per loop	:	≥ 240
Ingress Protection	:	IP21
Standard	:	EN54-18/17

----- END OF SPECIFICATION -----

**Digital Public Address & Voice Alarm (PAVA) System
Technical Specification**

1. General Description

The objective is to have an effective Public address, Background Music and Evacuation system for the entire building. The system will combine all the essential EVAC functionality- such as zone wise paging & voice evacuation, event logging, digital mixing & feedback cancellation, digital message management. Music playback and a relay based fire alarm panel interfacing.

System shall have priorities of playing various sources in below order.

- I. Paging from Fireman Microphone
- II. Paging from Touchscreen/button microphone
- III. Pre-recorded Automatic Voice messages triggered by Fire Alarm System.
- IV. Fire Drill or PA Test Messages
- V. Background Music

The system should support all 3 types of sources i.e. Live Paging, Pre-recorded Message Playback & Music from DVD Player/USB.

- The contractor shall supply, install, test, connect and commission a high quality fast-acting **IP Based Public Address and Voice Alarm System** complying strictly with EN54-16, BS 5839 part8 and EN60849 and shall be UL approved.
- The Public Address and Voice Evacuation System shall comprise of Audio Matrix Units, High quality speakers, Audio rack all mounted on a 19" Rack.
- The system shall be used for Professional Sound Reproduction for all the areas where possible special events take place.
- Prior to placing order for any equipment, the contractor shall submit comprehensive document comprising working drawings, catalogues and descriptive literature of components, acoustic calculation to meet with BS5839 part8 RASTI (Room Acoustic Speech Transmission Index) requirements of 0.5 on the STI scale and 0,7 on the CIS scale.
- The contractor shall be required to train and instruct client's personnel in the correct use, operation and supervision of the system, preferably prior to the handing over of the project.
- In order to ensure whole site integration capability, the fire and voice alarm system will be awarded to a single specialist local supplier who will be responsible for the design, global operation, management and interfacing of the system.
- The contractor shall make sure that all power tapping of the speakers must be carried out as specified, even if the acoustic calculations indicates less power tapings.

- The contactor must endure minimum of 10dB above the ambient noise levels are achieved.
- The system shall be fully programmed to accommodate fire alarm and voice communication zones as indicated on the drawings and schematics. The system shall be configured to allow on site modifications with the minimum of disruption using the PC based software to facilitate future changes or alterations to the buildings.

2. 8 Zone Master Controller/Processor

The DIGITAL PA PROCESSOR module unit should house: audio digital signal processing (DSP), a matrix, a digital message player, a fully monitored fireman microphone, amplifiers monitoring with switchover to backup amplifier and loudspeaker lines monitoring, on board Zone wise volume control, Front colour TFT touchscreen display for monitoring/Checking faults. It should be able to process and route one security microphone console or up to eight cascaded paging microphones and two 0 dB audio inputs into 2 different channels (Music + Voice). Each input is fitted with volume controls and equalizers.

The PA Processor should be IP based in order to connect it on LAN or VLAN for paging from IP Call Stations. The unit should have capability of Independent MAC Address & Static IP Address so that Multiple PA Processors can be connected on LAN.

The DIGITAL PA PROCESSOR shall be capable of handle 8 Zones as standalone unit & shall be expandable up to 256 Zones minimum by adding slave units. Each slave unit shall be capable of handle 8 zone.

Up to sixteen digital messages can be downloaded and recorded as WAV files directly from a computer into DIGITAL PA PROCESSOR. Two messages can be played simultaneously in different zones. One of the messages can be used as a chime for the Paging Station microphone. Nine monitored alarm inputs making it possible to obtain the pre-programmed routings.

Each DIGITAL PA PROCESSOR module has eight output zones with a+b wiring. Each zone can be routed manually or automatically to one of the system's audio channels (Music and Voice). The Music channel can be switched ON/OFF in each zone separately. In case of Evacuation, the Music channel can be used as a second alarm channel.

A DIGITAL PA PROCESSOR system shall be integrated with BMS system. From the front panels, the user can manually route the fireman microphone signal and three digital messages into the selected zones, adjust the audio level and switch (ON/OFF) the music in each zone separately. In case of evacuation, the zone attenuators shall be automatically bypassed.

Each zone we need separate amplifier / circuit - 1 amplifier for Multiple zone through controller not be acceptable.

As an EN 60849 security system, all DIGITAL PA PROCESSOR components and peripherals are constantly monitored (without music interruption). All incidents are recorded into a data file which can be consulted on the DIGITAL PA PROCESSOR display or on a PC. Also any detected faults and alarm status are signalled by general fault and alarm output contacts. A local loudspeaker enables selective listening to all the sources and the system's output signals. The setup of DIGITAL PA PROCESSOR is realized through a PC computer and the PC DIGITAL

PA PROCESSOR configuration software (Windows compatible). Access can be password-protected. The routing and the level of the music sources can be controlled directly from microphone console & from the front panel of DIGITAL PA PROCESSOR.

The unit should be EN54-16 compliant & supplier shall submit 3rd Party EN54-16 & UL Approval Certificate for verification.

Digital PA Processor Master shall have following main properties: -

- 0dB Audio Inputs for connecting Music or Wireless Microphones
- MODBUS / BACKNET port for 3rd Party BMS system Integration
- IP LAN Port for Programming & Audio Streaming
- Integrated and monitored Fireman microphone at Front Panel
- Red colour EVAC button at Front Panel
- TFT Touchscreen to view Status, Fault, Log events
- Monitoring of 8 Loudspeaker zones (A+B).
- 1000 W max power on each channel ($1000 * 8 = 8000 \text{ W}$)
- Full monitoring microphone consoles.
- Digital message players 4 Hrs.
- Minimum 100 priority level
- 4 user levels
- 2 dedicated Audio In & output for Backup amplifier
- Parametric equalization on Input & Output channels
- Fully Digital 9 input & 8 Control Output
- Simultaneous Control & Routing 48 Audio Channel Over Dedicated Network.
- Possibility to store the event log file on a computer
- Internal Event scheduler
- Store at least 999 Events.

3. 8 Zone Slave Processor

Digital PA Processor Slave unit shall have IP & Fiber Optic communication port for connecting to master unit for increasing 8 zones. The minimum number of Slave units should be 31, which means a complete system (master plus 31 slaves) should be expandable up to 256 zones.

Digital PA Processor slave should have facility for long distance transmission from Master so that system can be distributed in Campus or Building. System should support minimum 1000m cable distance between Master & Slave Processors through net cards & maximum 20 km Distance through fiber net card.

Digital PA Processor Slave shall have following main properties:-

- Integrated and monitored Fireman microphone.
- Monitoring of 8 Loudspeaker zones (A+B).
- 9 alarm input contacts (with surveillance).
- 8 output relay contacts.
- 1000 W max power on each channel ($1000 * 8 = 8000 \text{ W}$)

4. Paging Consoles

4.1. Touch screen Type IP Call Station

The Touchscreen type IP Call station shall be suitable to do following tasks:

- Paging (Broadcast PA announcements)
- Broadcast Pre-recorder Audio messages stored in system
- Intercom communication with other Field Wall Mount IP Call stations

The paging console is a man-machine interface shall allow following functionalities

- Paging
- Group Paging
- 150 Zone buttons
- Pre-recorded Messages Broadcasting
- Intercom
- Music Mute & Un-mute
- Music Volume+ & Volume –
- Selection /routing of Music on Zone

Technical Specification

- 5” Full Colour touch screen
- RJ45 Port CAT6 Connectivity
- Distortion < 0.6% (maximum input)
- Frequency response : 100 Hz to 16 kHz
- Voltage Range : 24 VDC +/- 2V
- Current Consumption <500mA
- LED Indicators: Power/General fault/ Evacuation active
- Monitored from PA Processor
- Minimum 150 Zones Touch fields
- Microphone Flex Length: 200mm Minimum
- Material : Metal back, PVC top and sides
- Operating Temperature: 0 to 55 Deg Celsius.

4.2. 8 Button Paging Console

The Button paging console shall be EN 54-16 Approved and Certified. Supplier shall submit 3rd Party EN54-16 Approval Certificate for verification.

The paging console is a man-machine interface shall allow following functionalities

- Paging
- Group Paging
- Display Fault by LED
- Display Evac by LED

Technical Specification

- 8 Programmable Buttons
- RJ45 Port CAT6 Connectivity

- Cable Distance: 500m from PA Processor
- Frequency response: 100 Hz to 16 kHz
- Voltage Range: 24 VDC +/- 2V
- Current Consumption <500mA
- LED Indicators: Power/General fault/ Evacuation active
- Monitored from PA Processor
- Minimum 8 Zones
- Buttons Expandable by addition of Keypads
- Microphone Flex Length: 250mm Minimum
- Operating Temperature: 0 to 55 Deg Celsius

5. Loudspeakers

5.1. 6W Ceiling Speakers with Fire Dome

The ceiling mounted 6W EN54 Approved speakers shall be installed as depicted in the drawing. The speakers are finished in White in stylish metal chassis. The speakers shall have terminals to allow selection of nominal full power, half power & quarter power. Assembly shall comprise of a twin cone loudspeaker and shall be fitted with a 6Watt/100volt transformer. The loudspeaker baffle shall be a round two part bezel comprising an inner metal mesh grille, and chassis with integral loudspeaker having no visible fixings. Installation shall be by pre mounted torsion-springs for False ceiling mounting. Loudspeaker shall have wide angle dispersion of Cone shall be a damped, high compliance type with a smooth extended frequency response of 57 - 24.000. The speakers shall be very easy to install with mounting clamps . It shall have excellent frequency response with wide opening angle & inbuilt 100V line matching transformer. It should blend aesthetically with interiors.

Technical Specifications

➤ Rated power	6 W
➤ Tapping's 100V line	6/3/1.5W
➤ Operation Voltage	100V or 70V
➤ Effective frequency range	104 - 17.200
➤ SPL @ 1W/m	>98,3 dB
➤ S.P.L. ,@Full power/ 1m, dB	>86,3 dB
➤ Colour	RAL 9016
➤ Approval	EN54- Approved
➤ Ceiling Cut-out	156 mm
➤ Dimensions	181,5x65 mm

5.2. 6W Wall Mount Speakers

The enclosure shall be ported and treated with UV inhibitors. The bowed grille will be manufactured from mild steel construction with an epoxy coated finish. The assembly of the speaker shall comprise of a 160mm diameter bass/midrange treated coned loudspeaker. The loudspeaker shall have wide-angle dispersion of 160° and a smooth extended frequency response of 160Hz ~20kHz. Sensitivity shall be a minimum of 96dB @ 1metre, 1watt test signal bandwidth 100Hz ~10kHz. Transformer shall be 100-volt line with 3dB power taps of 6, 3, 1.5 Watts to be clearly marked on the assembly. The speaker shall be compliant to BS5839 part 8 (Voice Alarm Standard) to include all the above features with the addition of thermal fuse and ceramic terminals to take 2 x2.5mm² cables. Fire Rated cable tail must be fitted for full compliance to BS5839 Part 8. All units to be tested to BS6840 Part 5. Speaker shall be EN 54-24 Approved and Certified. Supplier shall submit 3rd Party EN54-16 Approval Certificate

Internal

for verification.

Technical Specifications

➤ Rated power	6 W
➤ Tapping's 100v line	6/3/1.5 W
➤ Effective frequency range	170 - 18.500Khz
➤ SPL @ 1W/m	98,3dB
➤ SPL @ Full Power	94,0 dB
➤ Dispersion at 1k/2kHz	160/160
➤ Axial Q Factor at 1k/2kHz	>3.6/5.8
➤ Colour	White
➤ Approval	EN54-24
➤ Environment	Indoor

5.3. 20W Outdoor Sound Projector

The unit shall be 20Watt Projector type. Assembly shall comprise of a 130mm, polypropylene twin-cone loudspeaker and a factory mounted 20 watts /100-volt line transformer. The enclosure shall be constructed of a high impact ABS with UV inhibitors. The unit will be weather resistant and fitted with aluminium, epoxy coated mesh grille that covers the drive unit. The mounting will be via a hipped aluminium “U” bracket. Cable entry shall be via a single gland mounted on a removable plate at the rear panel of the loudspeaker. Loudspeaker shall have a wide-angle dispersion of 180°@ 1kHz. Cone shall be damped, high-compliance type with a smooth extended response over a range of 110Hz ~18kHz. Sensitivity shall be a minimum of 92dB@1 meter / 1watt using test signal bandwidth 100Hz – 10kHz. Transformer shall be 100V line with 3dB power taps of 20/10/5/2.5 Watt to be clearly marked on the assembly. The unit shall be compliant to BS5839 part 8 (Voice Alarm Standard) to include all the above features with the addition of thermal fuse and ceramic terminals to take 2 x 2.5mm_ cables. Fire Rated cable tail must be fitted for full compliance to BS5839 Part 8. All units to be tested to BS6840 Part 5. Speaker shall be EN 54-24 Approved and Certified. Supplier shall submit 3rd Party EN54-16 Approval Certificate for verification.

Technical Specifications

➤ Rated power	20 W
➤ Tapping's 100v line	20/10/5/2.5W
➤ Effective frequency range	100 ~18Khz
➤ SPL @ 1W/m	91dB
➤ SPL @ Full Power	104dB
➤ Dispersion at 1k/2kHz	180/120
➤ Axial Q Factor at 1k/2kHz	>2.6/5.6
➤ Colour	White
➤ Approval	EN54-24
➤ IP Rating	IP65
➤ Environment	Outdoor & Indoor

6. Audio Amplifiers Class-D Digital

The Class D amplifier shall be of high quality, suitable for the most demanding PA installations and applications.

The unit shall have a frequency response of no less than 20Hz - 20kHz (+/-3dB). Transformer isolated for 100V. Total Harmonic Distortion at 1kHz shall not exceed 0.1%. The Signal to Noise ratio shall be >80dB. The amplifier shall be capable of delivering 500 Watts RMS Power. Speaker connection shall be via a rear panel barrier strip. The unit shall operate from both AC mains power or from a 24V DC battery supply. The amplifier shall include a built-in trickle charge circuit. The amplifier shall feature overload and overdrive protection and shall also include cooling fans, which should only be active if the operating temperature exceeds a factory pre-set level. The amplifier should have 0dB Input for Power amplification & 100V Input for Booster amplification. Depending on application the installer needs to use it as Power or Booster. The unit shall be packaged in a rugged 1 RU metal chassis suitable for desk or rack mounting. The unit should have Power efficiency of more than 80%. Class D amplifier shall be EN 54-16 or UL Compliant.

Technical Specifications

➤ Rated Output Voltage(RMS)	500W or 2x250W or 4x125W (Depending on Design/BoQ)
➤ Amplification	Class-D Switching
➤ Battery Voltage	24VDC(max 10% deviation)
➤ Frequency Response	50Hz to 20KHz
➤ Impedance	20KOhm
➤ S/N Ratio	>80 dB
➤ Total Harmonic Distortion	<0.1% @ 1kHz
➤ Power Efficiency	>80%
➤ Compliance	EN54-16 or UL

7. AM/FM Tuner & USB Player

The AM/FM Tuner & USB player shall be capable playing MP3 audio tracks from USB.

- Dual use USB Music/Audio Player OR FM/AM Tuner
- Pre-sets are retained when power is turned off
- Large LCD screen
- SCAN & SEEK functions
- Signal strength meter
- Balanced mono XLR output
- Unbalanced stereo RCA output
- 24V DC power supply for uninterrupted music
- Playback in case of AC failure

8. 19” Rack

The equipment shall be housed in a standard rack of suitable height, with Plexiglas door or metal mesh and lock. Ventilation panels of 1U height shall be provided between each item of equipment.

Details of the proposed equipment shall be forwarded to the Consultant with performance specifications, dimensions, construction and finish for approval.

Rack should comply with ANSI/EIA RS-310-D; DIN41491; DIN41494; IEC297-2; and GB/T3047.2-92.

The Rack should have DIN Rail Mounted Terminal Blocks for termination of Speaker Zone cables on the rear.

All cables coming from Speaker zones, Call Stations, Power supply should enter from Bottom.

Rack should be installed at location which has minimum 600mm space from front & back for accessing it easily.

Rack should be installed in well ventilated room preferable Air conditioned. The unit should have Fans from top.
The unit should have Lockable Glass door at front

Dimensions

- Height as per the Quantity of PA Processor & Amplifiers
- Depth 600mm Deep
- Width 19"

The Rack should be built at Manufacturer approved Facility & should be assembled, commissioned & certified by OEM/Manufacturer.

9. Speaker Cables

All cables associated with PA System shall be of following specifications :

The 2 core speaker cable will be connected to the speakers by screw terminals before which it shall be crimped using 1.5 sq. mm. bootlace lugs. Care has to be taken for avoiding any single strand of wire shall not come out of Lug & screw terminals to avoid noise & leakage.

Speaker cables used should be Multi-conductor Stranded type

Flexible Copper Conductor of cross section 1.5 Sq. mm / 2.5 Sq.mm insulated, PVCFRLS sheathed control Cable as per IS 694.

These Cables shall be laid in G.I. Conduits concealed/surface.

10. Call Station Cables

Call station cables should be 4pair CAT6 STP (Shielded Twisted Pair) type,
It should be crimped by RJ45 Shielded Male Connectors.

11. Testing PAVA System

Sr. No.	Description	Visual	Test Readings	Documentation
1	All cables are tested for continuity, insulation, resistance etc.			√
2	System installation proper as per drawing	√		
3	Carry out visual checks on all speakers & Processors are free from any mechanical damage, cables, inter phase modules etc.to ensure they are properly installed.	√		
4	Check for proper termination of bootlace lugs & feruling	√		

5	Check Input A/C Supply Voltage		√	
6	Check location / spacing of loudspeakers as in drawing.	√		√
7	Check Distribution of Zones as per Drawing.	√		√
8	Check full load speaker sound quality & measure Sound pressure level (SPL) in dB.	√	√	
9	Check if local loudspeakers overrides by voice messages in case of emergency evacuation .	√		√
10	If power fails, whether Voice evacuation system is working on battery supply if yes for what time		√	
11	Check if recorder messages are CLEAR, free from any noise distortion & easy to understand with Room acoustic speech transmission Index (RaSTI) value >0.5.	√	√	
12	Processor LED's and all keys are working properly	√		
13	Check for Microphone locations & the sensitivity by paging	√		√
14	Play a soft music & check sound quality	√		

----- END OF SECTION -----